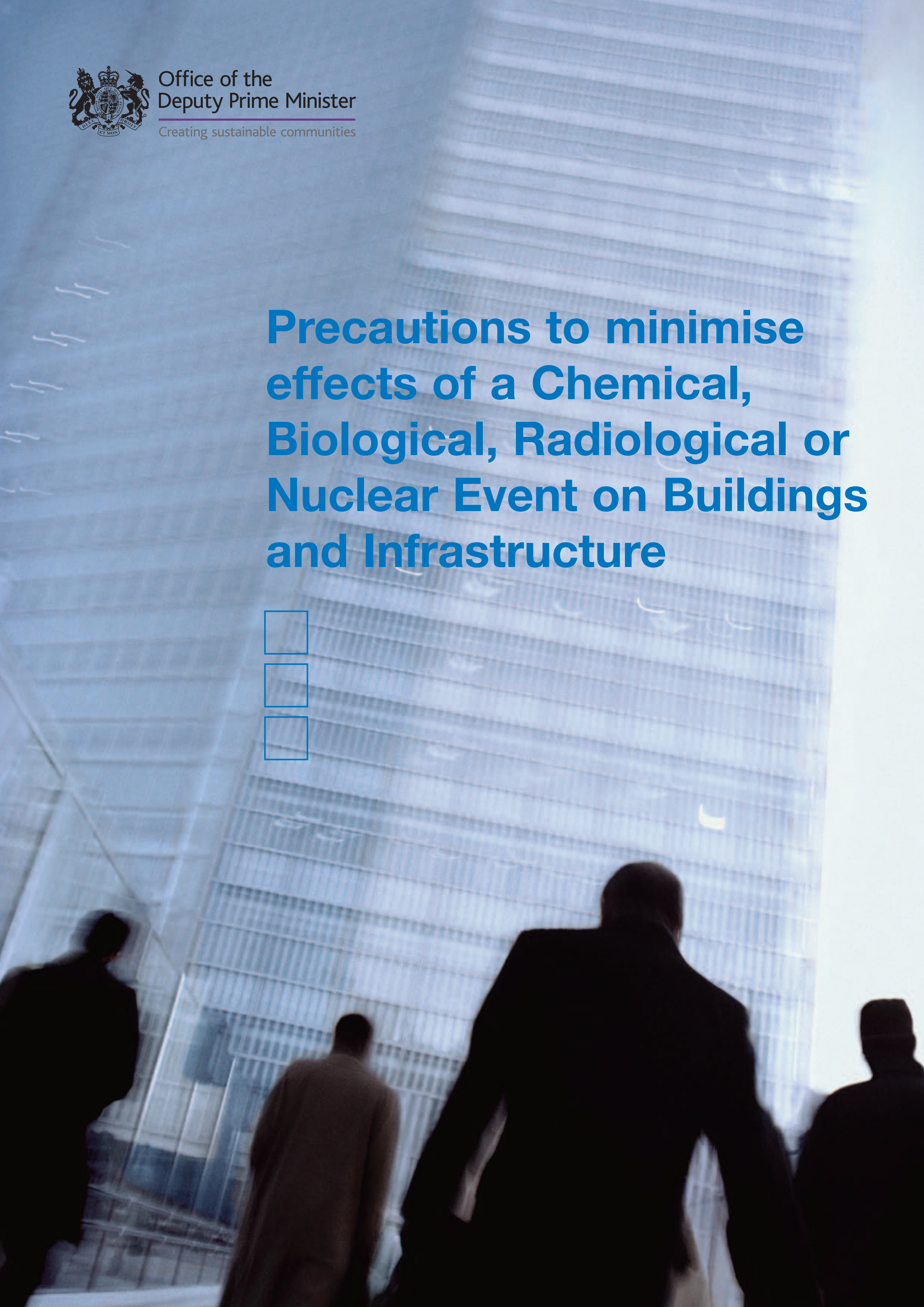
Office of the Deputy Prime Minister

Creating sustainable communities

Precautions to minimise effects of a Chemical, Biological, Radiological or Nuclear Event on Buildings and Infrastructure



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May 2004
Office of the Deputy Prime Minister: London

ODPM acknowledges the significant contribution of BRE in the preparation of this guidance.

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Email: odpm@twoten.press.net
Online: www.publications.odpm.gov.uk

ISBN 1 85112 693 7

Printed in Great Britain on material containing 75% post-consumer waste and 25% ECF pulp

May 2004

Reference no. 03RCU01866

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EXECUTIVE SUMMARY

This publication provides generic guidance to building and infrastructure owners and managers on pre-planning measures to minimise the effects of a CBRN (chemical, biological, radiological or nuclear) event whether deliberate or accidental. It complements the strategic national guidance on building and infrastructure decontamination published by ODPM in 2004.[1]

Guidance is provided here on:

- CBRN hazards;
- risk and vulnerability assessment;
- primary prevention: pre-planning measures to prevent contamination;
- secondary prevention: pre-planning measures to limit the extent of any contamination that does occur; and
- tertiary prevention: pre-planning measures in relation to decontamination.

The hazards from different forms of CBRN incidents and their potential to cause contamination are outlined. In the context of a nuclear event, this publication concentrates on contamination by radioactive fallout following the detonation of a nuclear device rather than the direct effects of the explosion itself. Risks and vulnerabilities of buildings and infrastructure and mechanisms of penetration are described. Other issues addressed include emergency management and training, limitation of business interruption and relationships between tenants, owners, insurers and other agencies. Guidance is provided on methods for prevention and limitation of spread of contamination in terms of physical and operational security. Guidance on pre-planning for decontamination includes building surveys to identify locations, surfaces, systems and contents most vulnerable to contamination, and strategies that can be adopted to reduce contamination, to reduce vulnerability and to facilitate decontamination.

The guidance covers both naturally ventilated buildings and those with mechanical air circulation systems. The main emphasis is on commercial or public buildings rather than domestic dwellings, although the same general principles apply to all buildings. The extent to which the detailed guidance should be adopted will depend on the circumstances for individual buildings. The protection of air inlets to heating and ventilation air circulation systems and the use of systems to limit internal spread of contamination are described.

Throughout the document references are made to sources of further information and guidance on specific issues, together with a list of useful organisations. Consideration is given to simple and more comprehensive structural measures that can be adopted for existing buildings and measures more appropriate for new buildings.

A flow chart for the pre-planning procedures follows and a checklist is provided in Annex 1, setting out what should be done in terms of:

- pre-identifying building risks and vulnerabilities;
- actions to reduce vulnerabilities and measures to limit the spread of contamination (including staff training); and
- requirements for pre-identification of resources, equipment and specialist skills for decontamination.

FLOW CHART FOR PRE-PLANNING PROCEDURES

Business Continuity Management – such as:
- offsite or protected data, IT and communications;
- dispersed operations and backup centres;
- provision for staff home working;
- reciprocal agreements with suppliers and competitors; and
- CBRN pre-planning.

CBRN risk assessment – consider:
- probability of occurrence (threat);
- nature of hazards and severity;
- vulnerability of building;
- impact of an incident on building, occupants or business; and
- cost/benefits of protective measures.

precautions required

Yes

No

review periodically

Primary prevention measures to prevent contamination entering the building – review and upgrade as necessary:
- physical security of site perimeter and building envelope, doors, windows, exterior ducts, CCTV, security lighting and alarms;
- isolate post rooms and goods storage areas;
- vetting of employees;
- screening of visitors, contractors, post and goods:
- access control at building entrance, and reception;
- water and food supplies;
- utilities; and
- location and protection of air inlets building and HVAC services.

could contamination still be released in or enter building

No

Yes

Secondary prevention to limit spread of contamination within the building:
- emergency management planning;
- pre-planning liaison with emergency services;
- measures to limit spread by occupants; and
- measures to limit airborne spread.

Tertiary prevention – pre-planning for decontamination:
- interior surfaces;
- building voids and interstices;
- building contents; and
- heating and ventilation ducting.

TERMS AND DEFINITIONS

Air handling unit (AHU) (Air Handler)

A unit installed as part of an air duct system to contain the air moving fan, filter and heating and/or cooling heat exchangers.

Air leakage (paths or flows)

Paths for the ingress or egress of air to or from the building interior through routes other than those planned and designed to provide ventilation. For example, through unsealed gaps between building fabric components and around service penetrations.

Building Control

Regime governing constructional standards for the erection, extension or alteration of buildings, including control of demolition and dangerous structures, under the Building Act 1984, the Building Regulations and associated legislation.

Building Envelope

The physical barrier between the interior and exterior of the building, usually the external fabric of the building – the walls, roof, windows and doors.

Building systems

Systems such as heating, ventilation and air-conditioning (HVAC).

Building management system (BMS)

A computer (PC)-based central control station used to control and operate the building systems including HVAC systems.

Business continuity management

“A holistic management process that identifies potential impacts that threaten an organisation and provides a framework for building resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities” (Business Continuity Institute 2001).

Containment

Measures to limit or prevent the spread of contamination.

Dampers

Adjustable restrictors to the flow through air ducts designed to control the flow rate of air.

Development control

The regime under land-use planning legislation governing proposals for new buildings, alterations to existing ones, change of use, and the erection of signs and advertisements. It controls when planning permission, listed building consent or conservation area consent should be sought, and provides enforcement powers against unauthorised development.

Hardening

Aspects of building and or services system design that make the building more intrinsically resistant to the effects of an extreme event.

Health and Safety (H&S) File

Part of the building hand over documentation focusing on safety issues relevant to the construction, operation and maintenance of the building and its services systems. The H&S file should deal with issues such as procedures for cleaning, repair, operation and maintenance, and any other relevant information to allow the safe use of the building. It may duplicate, or reference, material from the O&M Manual. The H&S File should be provided by the designer to address health and safety issues that may be involved in the construction and use, and eventual demolition, of the building to demonstrate compliance with the Construction (Design and Management) (CDM) Regulations.

High Efficiency Filter

Filter 90-99% efficient for removal of 1 micron particles and near 100% efficient for 2 micron particles.

High Efficiency Particular Air (HEPA) filter

Filters 99.9% efficient for removal of 0.3 micron particles.

HVAC

Heating Ventilation and Air Conditioning.

Loss adjuster

Chartered professional and independent expert in assessing the loss incurred, managing the mitigation of the loss and negotiating the amounts to be paid following an insurance claim. Loss adjusters are generally commissioned by an insurance company and co-ordinate the work of specialist contractors where needed in order to provide a speedy settlement at minimum cost.

Operation and Maintenance (O&M) Manual

Part of the building hand over documentation in which the building components and systems and their method of operation and control, are fully described. The O&M Manual includes detailed plans and literature describing the installed equipment in detail, together with the results of commissioning the building equipment and services systems. It is used as a reference for those involved in the operation and maintenance of the building and services systems. Providing the O&M Manual is normally a contractual requirement on the designer.

Positive or Negative pressure differential

A difference in static pressure between two locations, provided so that the direction of air flow is known. Air flows from the higher pressure to the lower pressure location, i.e. air will flow out of an area maintained at a positive pressure differential in relation to its surroundings.

Resilience

The ability to handle disruptive challenges that can lead to or result in crisis.

Risk

“Chance of something happening, measured in terms of impact and probability **NOTE** The consequence may be either positive or negative. Risk in a general sense can be defined as the threat of an action or inaction that will prevent an organisation’s ability to achieve its business objectives.” (Business Continuity Institute 2001).

Risk assessment

“Overall process of risk identification, analysis and evaluation.” (Business Continuity Institute 2001).

Sampling

In the context of this guidance, sampling is the collecting of a small amount of contaminant for analysis.

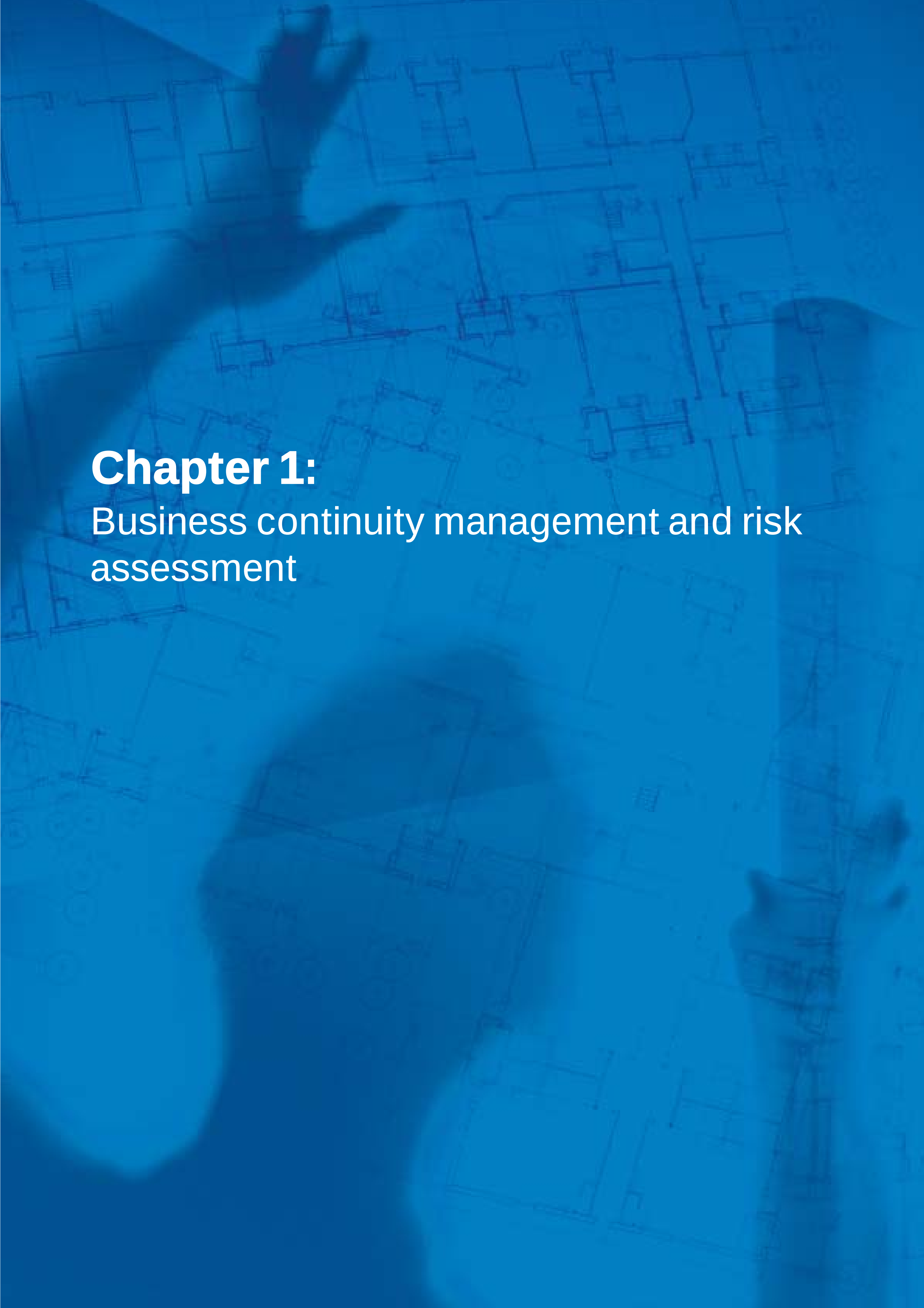
Vulnerability/Vulnerability assessment

In the context of this guidance, this is the susceptibility/assessment of susceptibility to penetration and/or damage of a building, building systems, business or occupant by a CBRN incident.

Zoning of air supply system/Zone

Different areas or spaces within a building may have different requirements for the supply and control of air from the ventilation system, or may need to be isolated from other spaces. Zones are such spaces where the air supply system may be independently provided or controlled.

Chapter 1:
Business continuity management and risk assessment



1. BUSINESS CONTINUITY MANAGEMENT AND RISK ASSESSMENT

This chapter examines the evaluation of risk from chemical, biological, radiological or nuclear (CBRN) incidents. Issues addressed are:

- *business interruption and business continuity management;*
- *the probability of an incident and the assessment of vulnerability;*
- *the different forms of C, B and R agents and their hazards in relation to buildings and building occupants, including the characteristics of contamination and problems associated with decontamination;*
- *routes of penetration of a building by C, B and R agents and aspects of vulnerability to penetration; and*
- *relationships between tenants, owners and other agencies.*

1.1 GENERAL

This document addresses precautions against the contamination of buildings and infrastructure by CBRN incidents. As regards infrastructure, the focus of the guidance is on buildings linked to the infrastructure – for example, in relation to railways, stations rather than tracks. This document supplements other guidance on Business Continuity Management (BCM), for example the British Standards Institution's Guide to Business Continuity Management (BSI PAS56)[2]. The guidance complements the Strategic National Guidance on Decontamination of Buildings and Infrastructure Exposed to CBRN Substances or Material[1] which sets out procedures, roles and responsibilities for decontamination of buildings and infrastructure in the event of a CBRN incident.

The guidance is generally applicable to any existing building and to plans for new ones, but the extent to which it should be adopted depends on the circumstances that apply to individual buildings. Advice is given on range of pre-planning measures that can be implemented to minimise the effects of CBRN incidents. However, it is important to recognise that the extent of investment in primary, secondary and tertiary measures should be appropriate to the risk, the financial and social costs and the perceived benefits. Not all businesses and buildings will need to implement the measures described. To help judge the extent of measures that is appropriate, a list of useful contacts has been included in Annex 5.

In this document the term CBRN is used to describe the whole range of incidents that can occur as a result of a release of chemical, biological or radiological material. The release could either be accidental or deliberate. In this case, the nature of the incident (for instance, whether it is C, B or R) may not be immediately apparent, nor indeed that an incident has occurred.

Chemical, biological and radiological (CBR) incidents differ from nuclear (N) incidents since they involve the release of C, B or R agents. In contrast, an N incident involves the detonation of a nuclear device, which would produce extensive blast and fire damage, intense direct radiation effects and widespread contamination from radioactive fallout. The hazards from radioactive fallout will be similar, but much more severe, to those resulting from the release of a radiological agent. The advice given in this guidance is generally applicable to the hazards from radioactive fallout. However, the consideration of the blast and fire damage resulting from the nuclear incident is beyond the scope of the guidance.

1.1.1 Business continuity management

Business interruption following damage or contamination can severely compromise an organisation. Pre-planning measures can reduce the effect of an incident and hence minimise business interruption. Guidance on business continuity following incidents is available in BSI PAS56[2] and in the Home Office document *'Business as Usual'*[3]. Insurance (if it is taken out) gives no guarantee that a business will recover from a catastrophic loss. It can provide financial assistance that can tide a business over, but it provides no remedy once it is forced out of the market place for a substantial period of time[4]. See also Section 1.4 for further aspects of relationships between tenants, owners and other agencies.

Pre-planning measures to minimise business interruption:
- Adopting a modular approach to the site or building with isolation of air supplies;
- Hardening (isolation and protection) or choice of low risk location for key services such as IT and company archives;
- Backup of company archives at a separate location;
- Dispersal of operations over several sites;
- Provision for home working by staff;
- Continuity arrangements for alternative sources of essential services;
- Arrangements for support of staff affected by an event; and
- Identification of roles and responsibilities, insurance.

You already know what is important to you and your business survival. You probably have plans to safeguard some, or all of these things from other threats already (for example, plans for fire safety or defences against theft).

Action should be along the following lines:

- think about the threats your business/staff/building/assets face – your plans should be proportional to your assessment;
- take the best available advice on things you can do to reduce chances of injury/contamination from an incident; and
- make a business continuity plan (BCP) (including disaster or emergency plan).

This action is applicable to all emergency and business continuity management. Further advice is available through your local Police Counter Terrorism Security Adviser. Annex 5 provides a list of contacts that will also be able to provide useful advice.

It is important to retain as much spare capacity as possible to allow for business resilience. Introducing training programmes, clear guidance for all staff and other occupants of shared buildings, as well as entering into a reciprocal arrangement with neighbouring businesses to share the cost of appointing security guards to protect all member premises will help.

Ways of improving resilience include:

- mothballing old plant or machinery rather than disposing of it where it can serve as a temporary backup if necessary;
- entering into reciprocal arrangements with other companies to share premises, plant or machinery in the event of a loss;
- if resources allow, purchasing second-hand equipment to be stored off site,
- building up buffer stocks;
- securing storage for essential data, possibly off site;
- ensuring that alternative suppliers are identified in case normal suppliers fail or are put out of action in the same incident;
- maintaining a Business Continuity Plan to identify key tasks to re-establish business; and
- securing a source of disaster recovery services.

1.1.2 Aspects of risk assessment

General guidance on risk, vulnerabilities and protection measures, especially with respect to terrorist incidents, is provided by the Home Office document *'Bombs: Protecting People and Property'*[5]. In the event of a CBRN incident, insurance companies will normally use a loss adjuster to handle aspects of the claim. In some cases, the loss adjuster may review the potential for loss before an event has occurred and offer some technical advice.

Evaluation of risks involves:

- the probability of an incident occurring – (the probability or threat);
- the nature of the hazards and their severity – (the hazard);
- the vulnerability of the building – (vulnerability);
- the impact of an incident on the building, occupants or business – (impact); and
- the effects of protective measures taken – (countermeasures).

The probability of an incident occurring depends upon an evaluation of statistical information on incident probabilities. A subset of this is threat, which relates to deliberate acts and involves an assessment of means and intention by the security services. Hazard relates to the type of incident and its severity in terms of the potential damage should it occur. For a contamination hazard one aspect would be its persistence. Vulnerability relates to the ease with which a building might be contaminated by a particular incident and the likely extent of contamination. The impact is an assessment of the loss likely to occur as a result of an incident in terms of the building, occupants and business. Countermeasures are assessed in terms of the extent to which they reduce the vulnerability to an incident and the impact it might have. These aspects are interactive and the overall risk is determined by the interaction of hazard, vulnerability, impact and probability. While hazard and probability may be beyond the control of the building manager, it is important to estimate their magnitude for any particular building. Vulnerability, impact and the countermeasures in place also need to be assessed, and can be improved if necessary to reduce the overall risk.

This section addresses generic CBRN incident risks, probability, hazards and generic CBRN scenarios:

- whether CBRN incidents (either accidental or deliberate) occur, depends on the status and location of a building, the proximity of other high risk buildings or to possible major sources of contamination such as industrial sites, or the probability of hostile acts. A building may be at risk because of its normal use, business or location, but the risk may increase when particular high profile events are scheduled;
- the nature of the hazard depends on the type of incident, the agent released and the location of the release (Section 1.2);
- the severity of the hazard (Section 1.2) depends on the extent of the contamination of the building and its occupants –
  - some minor incidents may present little or no actual hazard, but may cause a certain amount of alarm or disruption;
  - some CBRN incidents may present severe short term hazards to building occupants, but contamination of the building itself may be only transient, although longer term contamination of building surfaces and systems could also occur in some instances;

  - others could cause contamination of building surfaces and systems, which are not immediately dangerous to building occupants but present a long-term health hazard. The building may be unusable unless it can be decontaminated. The main consequences are business interruption, loss of amenity, decontamination costs, distress and disruption (even for relatively low hazard incidents).
- The vulnerability depends on how a building is likely to be affected by a particular hazard and is addressed in Section 1.3;
- The impact on the building relates to the effect an incident would have on the continued function of that building in terms of its effects on the occupants and business continuity. This is addressed in Section 1.4; and
- Countermeasures consist primarily of the pre-planning measures described in Sections 2–4.

Examples: Install bollards around building perimeter, re-site air intake on to the roof, set up visitor security checkpoint outside building entrance.

CBRN incidents, accidental releases and criminal activities

CBRN incidents include both deliberate and accidental incidents. The approaches to risk assessment and pre-planning are similar. For example, a chemical incident inside or outside a building might result from an accidental or a deliberate chemical release or from a fire. The issues relating to penetration and spread of contamination into and through a building, the management of the occupants and subsequent decontamination are likely to be similar. In the same way, security aspects for protecting a building from entry and subsequent actions by any criminals include the same basic features.

Evaluation of risk

The detailed evaluation of threat from large and small-scale deliberate releases is primarily the responsibility of the police and security services and is beyond the scope of this guide. However, further information can be obtained from the security services website www.mi5.gov.uk. The risk from large-scale accidental releases depends on the proximity of potential sources such as COMAH sites (sites designated under the Control of Major Accident Hazard Regulations 1999) notifiable to the Hazardous Installations Directorate of the Health & Safety Executive. The risk of small releases is more related to routine health and safety risk management. Building owners or managers should be alert to warnings issued by the relevant agencies (such as police, fire brigade or local authorities) and consult them as appropriate for pre-planning purposes. The HSE website (www.hse.gov.uk) provides guidance on risk assessment.

It is useful, however, for any building owner to consider the nature and severity of likely incidents and the *relative* probability of their occurrence. The nature of such events, and the costs associated with protection cover a range – from minor events with a relatively high probability to large-scale major disasters with relatively low probability.

For many organisations there is a relatively high probability of the occurrence of minor events requiring detailed pre-planning and precautions.

This risk may merit the effort and expense of taking some basic precautions over and above the existing security or health and safety provisions. The extent of the provisions made depends on the perceived incident probability and the perceived cost (social and financial) of incidents occurring. Depending on their location or profile, some buildings may be considered vulnerable to a relatively major but low probability event, requiring additional, higher cost precautions.

Basic (low cost) pre-planning measures for minor incidents:

- review the vulnerabilities of the building and building systems;
- examine the building's ventilation system and understand the implications of CBRN events (modifying vulnerable access points if necessary);
- review security (in relation to physical security, staff and visitors) and secure access to critical equipment areas, IT systems, mailrooms and goods receipt areas (improving physical security, mailroom isolation and checks on staff, contractors and visitors if necessary);
- develop an emergency response plan;
- remove vulnerable items and line surfaces with materials (such as anti-graffiti paint or removable plastic films) that facilitate decontamination in areas most likely to be exposed to contamination (this may not be an option in historic structures); in some locations it may be useful to install absorbent materials or linings to reduce concentrations of airborne contaminants;
- make provision for business continuity in the event of an incident (backup business archives in a secure location); and
- review relationships, roles, responsibilities and insurance provisions in relation to a CBRN event.

Basic and additional (higher cost) pre-planning measures for major incidents:

The basic elements of pre-planning for a major incident are the same as for a minor incident, but are more extensive. Additional measures that may be considered following specialist advice are:

- enhanced and extended perimeter protection so that outside incidents are well away from the building;
- enhanced hardening of building shell and protection of building air inlets;
- high level of security for access to building and detailed vetting of staff, contractors and visitors;
- advanced air filtration and control systems. In some situations automatic detection systems may be indicated. The Home Office[6] recommends that companies should seek advice from the counter terrorist security adviser in their local police;
- provision of C, B and R protected refuges in the building; and
- diversification of activities on several sites with detailed plans to ensure business continuity.

At the extreme end there may be a very large-scale major disaster sufficient to destroy or seriously contaminate one or more buildings. As part of its Business Continuity Management an organisation may consider its vulnerability and the cost/benefits of dispersal/diversification of the business, so that destruction of one site would not destroy the overall business. For particular high-risk buildings hardened refuges may be considered.

Pre-planning involves considering the importance of the building to the overall organisation and the threat to it of incident occurrence. Since this threat changes with time it should be evaluated on a continuing basis.

1.2 THE NATURE OF CBRN HAZARDS AND VULNERABILITY OF PREMISES AFFECTED

Important aspects of C, B and R agents:

- whether the agent is a solid, liquid or gas;
- the ease with which the agent may be released in a form capable of causing contamination;
- how the agent is dispersed and spread through a building;
- the short term effects the agent may have on a building or its occupants;
- how the agent is detected and the time taken for building occupants to become aware of contamination – how the effects of the agent manifest themselves;

- the immediate and long-term effects of the agent on the building;
- the long-term effects of short or long term exposure on building occupants;
- the implications for decontamination; and
- the implications for the environment and key sites such as historic buildings.

C, B and R agents may be dispersed within a building in a number of ways, but particularly by suspension in air, or by occupants moving around the building.

In terms of the effects on the building and building occupants, and implications for decontamination, incidents fall into three main categories:

1. A reported incident involving a suspected release that is subsequently shown to be non-existent or trivial, with no or minimal hazard to building occupants.

2. Immediate airborne contamination of the building environment, with immediate (and possible long-term) health effects upon building occupants (for example the release of a toxic gas). Contamination of the building may be transient and cleared by venting the building for a short period (but in some cases contamination may be more persistent and may require decontamination).

3. Dispersal and deposition of an agent within the building having little or no immediate effect on occupants but leading to potential long-term contamination, with potential long-term health hazards to building occupants (for example the release of asbestos dust or deposition of certain microbiological contaminants).

Contamination presents a health hazard to building occupants. The main concerns are the concentration of the contaminant and how much the building occupants are exposed to, compared with concentrations or doses causing adverse health effects.

For some substances the effects occur rapidly when people are exposed and depend mostly on the exposure concentration. For other substances the effects are more dependent on a dose received over a period of time.

After an incident it will be necessary to determine if the building is safe to use (i.e. when the health risk is deemed tolerable). This may not mean that the building is completely clear. The extent to which it is worth decontaminating the building or items will depend on the hazards (or potential hazards) to human health and the environment of leaving the contamination in place, the decontamination costs and the value of the contaminated items or buildings. Another consideration is the psychological effect on staff and their willingness to work in a building that has been decontaminated. In some circumstances, sealing the building or demolishing it, might be the most appropriate course of action.

1.2.1 Chemical hazards

A wide range of chemicals may be involved in accidental or deliberate incidents. They may produce toxic effects following inhalation of gases or vapours, absorption through the skin or ingestion. Some have rapid obvious effects on people within seconds or minutes of exposure while others may have long-term health effects or only cause symptoms following long-term exposure. Further information on chemical agents is presented in Annex 2.

Pre-planning issues in relation to chemical agents:

- agents may be gases, volatile liquids, low volatility liquids or solids;
- in general, gases and volatile liquids have rapid effects on occupants and can be detected at an early stage (enabling protective measures to be taken to limit contamination). Gases and volatile liquids mainly contaminate building air and can be removed by ventilation within a few hours;
- in general, low volatility liquids and solids have little or no immediate effects on occupants so that contamination may not be obvious and symptoms may take between days to years to develop. The main health hazard is usually from prolonged exposure. Active decontamination is required;
- airborne contamination is generally most serious as this may be inhaled by all occupants;
- exposure may also occur by dermal (i.e. skin) absorption or ingestion;
- sampling and analysis is needed to identify the agent and characterise the hazard;
- decontamination methods depend on the chemical nature of the agent; and
- the effectiveness of decontamination will need to be verified. This will include sampling by specialist agencies and analysis by independent laboratories.

1.2.2 Biological hazards

Biological agents include bacteria, bacterial spores, bacterial and other toxins and virus particles. An important distinction is between the infectious agents and the toxins (which are non-infectious and can be regarded as a form of chemical agent). Infections take a variable time to develop and become evident. Some biological hazards may develop as a result of an incident, such as mould growth following a flood.

Further information on biological agents is presented in Annex 2.

Pre-planning issues in relation to biological agents:

- contamination may not be detected for at least several days until people start to show common symptoms;
- occupants may be infected by agents in air, water, food or on surfaces, or by contact with other infected people;
- infection is generally more likely to occur the higher the level of contamination. But for many agents exposure to only a small amount of material is required to cause infection;
- contamination within the building may remain active for periods of up to several weeks or even years depending upon the agent;
- once contamination is known to be present the agent must be identified by sampling;
- decontamination methods will depend upon the agent; and
- the effectiveness of decontamination will need to be verified. This will include sampling by specialist agencies and analysis by independent laboratories.

1.2.3 Radiological hazards

Radioactive materials can exist as gases, liquid solutions or solids. The materials most likely to cause contamination of buildings are solids as dusts or in liquid solution. An important distinction is the extent to which the contamination is in a single location, or dispersed. It is also important to establish if the contamination is in the form of a deposit absorbed into building surfaces, and whether a loose deposit exists that could be carried in air by dust particles.

Further information on radiological agents is presented in Annex 2.

Pre-planning issues in relation to radiological agents:

- may be gases but are more likely to be dusts or liquid solutions;
- contamination may not be obvious and symptoms may take between days to years to develop;
- contamination of buildings or occupants can often be detected and localised by simply using radiation monitoring equipment. (The Home Office[6] recommends that companies should seek advice from the counter terrorist security adviser in their local police);
- airborne dust contamination is hard to control as it can disperse, resulting in further spread of deposited contamination, and may be inhaled. Exposure to local deposits of contamination may be avoided (for example by shielding or closing off affected areas);

- appropriate sampling and analysis is needed to identify the agent and characterise the hazard;
- decontamination methods depend on the nature of the agent, the amount of contamination and the contaminated surface (broadly similar to that for chemical agents); and
- the effectiveness of decontamination will need to be verified. This will include sampling by specialist agencies and analysis by independent laboratories.

1.2.4 Nuclear Hazards

The detonation of a nuclear device would result in extensive damage from blast and the intense thermal, gamma and neutron radiation produced. It would also lead to severe radiation problems at the site of the explosion and widespread, severe and long-lasting contamination from radioactive fallout. The hazards from radioactive fallout will be similar, but much more severe, to those resulting from the release of a radiological agent. In the context of this guidance, radioactive fallout will enter and contaminate buildings over a wide area and they will require decontamination.

1.3 GENERIC CBRN INCIDENT SCENARIOS AND VULNERABILITY

1.3.1 General

Generic aspects of CBRN incident scenarios involve the ease and rates of penetration of the building or infrastructure by:

- penetration of airborne agents – gases and particulates, following exterior release;
- deliberate introduction into the building HVAC (heating, ventilation & air conditioning) air inlets;
- release inside the building;
- penetration though articles entering building such as post and deliveries;
- penetration via infected or contaminated visitors;
- penetration though deliberate introduction of agents via water or food into the building; and
- CBR combined with fire or explosion.

The main considerations with respect to incident scenarios are:

- the location of the incident;
- the nature and size of the incident;
- the type and amount of C, B and R release;

- the type and size of building or infrastructure;
- the vulnerability of the building;
- the number of occupants affected; and
- the form of contamination and effects on occupants.

A pre-planning checklist is given in ANNEX 1, which is intended to be used by building owners and managers as part of the vulnerability assessment.

1.3.2 Exterior releases

Key aspects of exterior releases are summarised in the box below. Further information is presented in Annex 3. Guidance on pre-planning methods to prevent building penetration following exterior releases is presented in Chapter 2.

Pre-planning issues for exterior releases:

- the building envelope provides a degree of protection unless windows are open;
- HVAC inlets at high levels provide some degree of protection but are likely to be subjected to some diluted contamination, particularly for city buildings;
- HVAC filtration provides some degree of protection, especially if upgraded;
- HVAC systems can be shut down if an exterior release is identified, but some ingress is then likely to occur through ‘leaks’ in the building envelope including the main and ancillary entrances;
- heavy contamination of building interiors following an exterior airborne release may be relatively unlikely, except for large-scale events, but relatively minor levels of indoor air contamination may cause distress and sufficient contamination to present some health hazards;
- air contamination can often be cleared by ventilating the building after the outside air contamination has cleared (may require authorisation by regulatory authorities); and
- outside contaminants can be carried into a building on the shoes or clothing of visitors.

1.3.3 Interior releases

Key aspects of interior releases are summarised in the box below. Further information is presented in Annex 3. Guidance on pre-planning issues regarding interior releases is presented in Chapter 2.

Pre-planning issues for interior releases:

- the building envelope needs to be protected against breaches that could provide a route of internal release;
- HVAC inlets must be protected from introduction of agents. Otherwise HVAC systems may be used to limit spread or clear the contamination from the building depending upon the system. Consideration will need to be given to potential environmental contamination;
- protection measures against fire are required in buildings, which represent a common form of chemical incident. Reception areas and post rooms should be isolated from the rest of the building, since these are the areas most vulnerable to interior releases. Important areas of the building may be further isolated to improve protection; and
- security measures should be implemented to reduce vulnerability to interior releases.

1.4 RELATIONSHIPS BETWEEN TENANTS, OWNERS AND OTHER AGENCIES

It is important for building owners, occupiers and operators to be prepared with a clear understanding of the roles and relationships that exist between themselves and other interested parties that may become involved in responding to a CBRN incident. It is important to promote the mutual awareness and understanding of potentially competing objectives between the parties. This will reduce uncertainties and delays and in the event of a CBRN release will initiate effective decontamination and rapid resumption of operations. Relationships can be statutory or regulatory, contractual or business-related, involving civil business partners, or on a more informal basis.

While each relationship will have a different focus, all the categories are equally important to consider, and preparedness plans should be developed in consultation with the other parties, where possible and appropriate.

1.4.1 Statutory and regulatory authorities

The different authorities which a building owner or occupier may need to contact include:

Emergency services:

- Police – command and control of incident, investigations, forensic recovery, counter terrorism and crime prevention;
- Fire and Rescue Service – response at site and associated planning, general emergency planning and evacuation; and
- Ambulance Service – casualty management.

Building owners and managers should plan ahead by contacting police and fire authorities about their emergency plan, including details of HVAC control systems and strategies. The publications *Dealing with Disaster*[7] and *Dealing with Disaster Together*[8] provide guidance on the role of police and other agencies. From here onwards reference to *Dealing with Disaster* includes *Dealing with Disaster Together.*

As with a fire, the building manager should be prepared to brief the emergency services immediately on arrival regarding the nature of the incident, the status of occupants and the measures taken to prevent or limit contamination. A deputy to the building manager conversant with the emergency plan should be designated should the building manager be unavailable.

Safety:

- Health and Safety Executive – health and safety of public and staff, technical advice;
- Local Authority Environmental Health – health and safety of public and staff, and technical advice; and
- Environment Agency (and Scottish Environmental Protection Agency) – protection of the natural environment, water supplies etc.

The health, safety and environmental regulators have established systems of working with the police, fire and rescue service and other public agencies. Their primary purpose is to ensure the health and safety of workers (including the emergency services) and the public, and to protect the environment and natural resources. They prefer to do this through advice and consultation, but if necessary have the power to issue statutory notices to improve practices or even to prohibit operations. Waste materials produced during a decontamination process and intended to be transported and disposed of also come under the remit of these agencies. Depending on the nature of the waste, a waste disposal permit process will need to be followed.

Buildings:

- Local Authority Surveyor – safety of buildings following an incident;
- Local Authority Planning Departments – advice on planning related matters and built heritage issues, including alterations to buildings; and applications for planning permission, listed building consent or conservation area consent;
- Local Authority Building Control – engineering and other aspects of building modifications;
- English Heritage, Historic Scotland and Cadw (Welsh Historic Monuments) – advice on listed building, conservation area and other heritage issues, scheduled and ancient monuments;

- The Department for Culture, Media and Sport – applications for Scheduled Monument Consent in England. In Scotland and Wales these go to Historic Scotland and Cadw respectively (for relevant department see ANNEX 5); and
- Environment Agency (EA) in England and Wales, Scottish Environmental Protection Agency (SEPA) in Scotland – environmental aspects.

Building modifications against CBRN incidents discussed elsewhere in this guidance, will in many cases require specific planning permission. It is for the local planning authority to decide whether a proposed change would amount to a significant alteration to the exterior of a building for which a planning application would be necessary. Local authorities have enforcement powers against all unlawful development.

In some case, small-scale demolition may be necessary as part of the process of making building modifications. Most demolition of non-residential properties does not need planning permission or prior approval. However, demolition of residential buildings could require prior approval from the local planning authority, which may impose conditions on the way it is carried out.

If a building has been listed for its special architectural or historic interest, controls are especially strict. Many internal, as well as external, changes, even if they may appear minor in scale, require listed building consent, as would any demolition. It is a criminal offence to breach listed building controls.

The presence of a conservation area, or proximity to a listed building, will be relevant if new build or external alterations are being proposed, as a high design standard is likely to be required. Moreover, conservation area consent may be necessary if the works necessitate demolition of a building with a volume of more than 115 m^3, or demolition of a gate, fence, wall or railing over 1 metre high next to a highway or public open space or over 2 metres high elsewhere. It is a criminal offence to breach conservation area controls.

Local planning authorities and, if appropriate, heritage bodies should be approached for advice as early as possible. Discussions prior to making an application or commissioning designs can save time and money. Local authorities will also need to be involved when decontamination processes are required. They will have to approve the siting of temporary facilities and other works, which will affect the appearance of buildings or local amenity.

Special procedures are in place for Government buildings and other Crown land. Development by or on behalf of Crown bodies is currently immune from planning control and is undertaken under non-statutory arrangements set out in Part IV of DoE

Circular 18/84. However, the Planning and Compulsory Purchase Bill 2004[9] will remove the Crown's immunity from planning control and Crown bodies will normally have to apply for planning permission, listed building consent, conservation area consent and hazardous substance consent in the usual way. Works required in an emergency or required for national security purposes may benefit from new permitted development rights to be introduced when the Crown application provisions of the Bill are brought into force. They will almost certainly also require building control approval.

These authorities should be consulted at an early stage when considering such an approach. During a decontamination process they would also need to become involved in approving modifications to buildings, the siting of temporary facilities, etc.

1.4.2 Contractual and business-related

There are four main relationships to consider in the context of CBRN preparedness:

Staff

The business continuity management approach should be applied to ensure ongoing operations in the event of a CBRN or other incident. All staff should be made aware of the existence of plans and these should be exercised on a regular basis in accordance with good practice as set out in BSI PAS 56[2]. The majority of staff will be engaged in the business recovery process and in ongoing business operations, but some (e.g. facilities management) with knowledge of the relevant buildings will be needed to help manage the decontamination and reinstatement process. Planning for additional facilities staffing may therefore be required.

The psychological and health impacts of a CBRN incident on a building and its staff – and ongoing trauma and uncertainty during the decontamination process – should not be underestimated. Staff will need support throughout.

Customers and suppliers

Responsibilities to customers and suppliers should be addressed in the overall Business Continuity Management process. It is very important to identify situations where organisations depend on a small number of key contracts, or a small number of unique facilities, and alternative provision is difficult or impractical. Organisations should examine their supply chains for these critical links, and attempt to spread risk where possible by the introduction of split site operation and other means. Organisations should also review their terms of supply.

Previous emergencies have shown that these are areas often overlooked. They are in fact vital to business continuity. It is important that these services are integrated into Business Continuity Plans (BCPs).

Insurers and other financial stakeholders

Parties with a financial stake in an organisation (insurers, banks, shareholders) will be generally supportive of advance planning for a CBRN incident, as this will safeguard their investment and minimise loss. Certain classes of business (particularly stock market quoted companies) are subject to financial sector requirement to establish and maintain systems for risk management.

HM Treasury, the Bank of England and the Financial Services Authority have a website[10] providing information on activity under way to improve the resilience of the financial system in advance of possible disruption and to ensure an appropriate response should disruption occur.

The primary means of responding to the financial threat resulting from a CBRN attack is through the purchase of insurance cover. As part of their pre-planning, organisations should consult with their internal risk management function, insurance broker and/or insurance companies to make sure they have established and maintained the most appropriate package of insurance policies, and established the mechanisms to provide support in the event of an incident. Insurance companies and brokers may also be able to offer technical advice on risk management.

In the event of a CBRN incident, insurance companies will normally appoint a loss adjuster to handle aspects of the claim. Sometimes an appointed loss adjuster will review the potential for loss before an event has occurred, and may be able to offer some technical advice. Under a contract of insurance, the insurance company and their appointed agents (loss adjusters, builders, restoration companies etc.) will become involved in the decontamination and restoration process. Specialist contractors are likely to become involved, to establish the identity and scale of contamination, to undertake the decontamination process itself, and to provide demolition/reconstruction/waste management services. The Government is actively considering the establishment of a national decontamination and recovery service. Such a service would provide further advice and assistance on specialist contractors and decontamination techniques.

Building/site owners and/or tenants

Many organisations lease their buildings. The terms of the lease will govern many aspects of planning for CBRN decontamination, including the purchase or provision of insurance, rights to modify the building, requirements to maintain and repair the building, as well as periods of notice, rental costs, sub-letting, etc. As part of the planning process for CBRN decontamination organisations should review the terms of their leases to make sure they understand the implications and that these are appropriate. The advice of a chartered surveyor and/or solicitor may be needed.

Building owners/landlords will also need to review the terms of their leases with tenants, to minimise ambiguity. In some cases it may be desirable and possible to arrange mutually agreed plans between a group of tenants sharing one building (see section 1.4.3).

Building owners ought to consider having contracts in place for decontamination, should the need arise. They should include the provision of pre-planning advice from contractors.

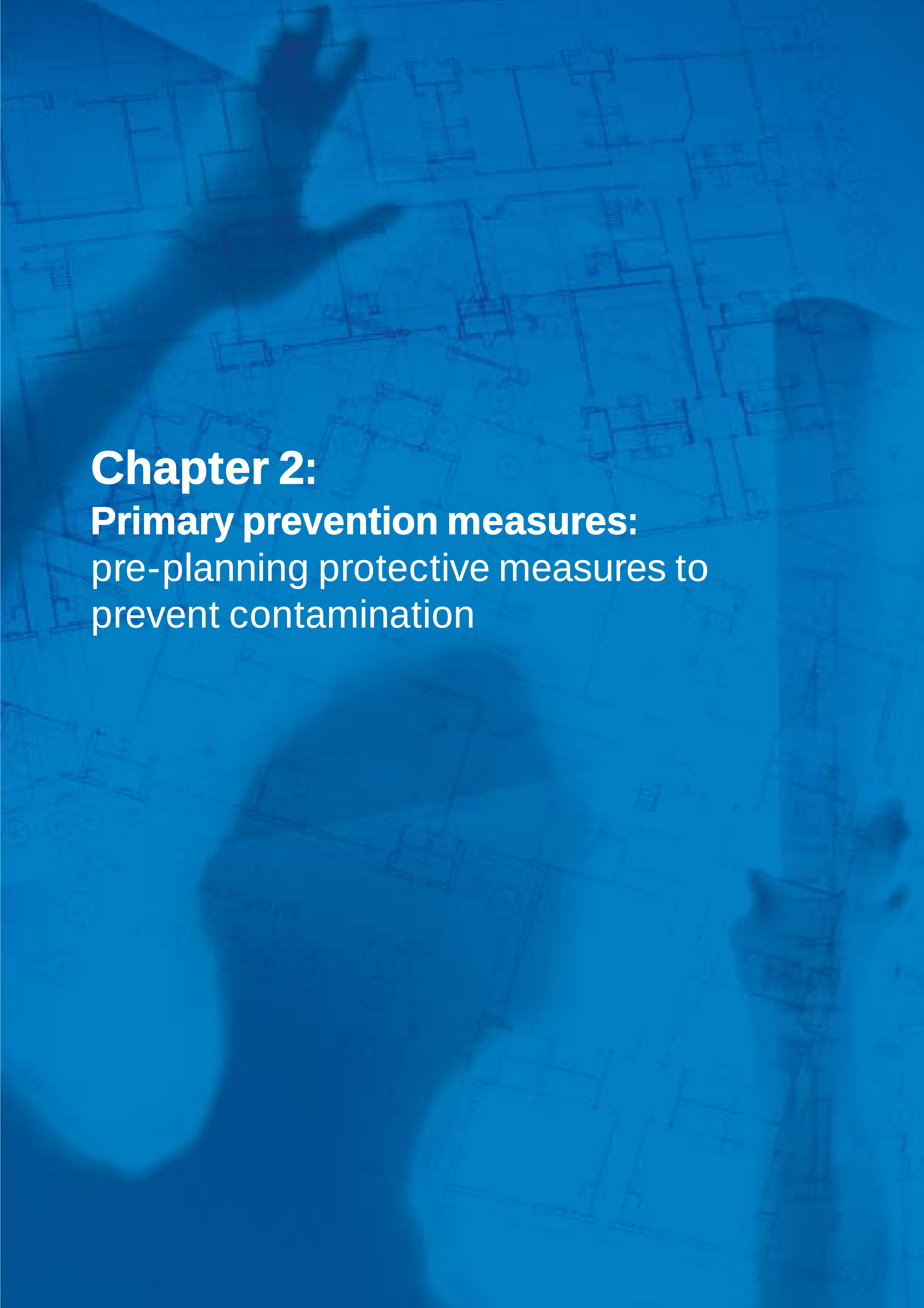
1.4.3 Informal

There are many informal relationships which would be affected by a CBRN incident, may become established before or following such an incident, and which would continue throughout a decontamination process.

Neighbours:

- neighbouring properties – commercial – owners and tenants;
- neighbouring properties – residential – owners and tenants; and
- shared buildings – commercial – other tenants.

It has become good practice for organisations to develop plans for emergency response and recovery in consultation with neighbours, particularly where those neighbours might become directly affected. Issues such as pre-preparation for incidents and the acceptability of additional security equipment such as security lighting and CCTV cameras should be discussed with neighbours and their staff. In shared buildings or building complexes it will be important to undertake CBRN vulnerability assessments and to develop plans for modifications, response and decontamination – jointly or in close consultation. Examples of this might include buildings serviced by single ventilation or air conditioning systems, common or linked fire and security systems (e.g. shopping centres) and/or joint postal delivery systems. The police will provide the lead in communicating with neighbours during and immediately after an incident.



Chapter 2:

Primary prevention measures:

pre-planning protective measures to prevent contamination

2. PRIMARY PREVENTION MEASURES: PRE-PLANNING PROTECTIVE MEASURES TO PREVENT CONTAMINATION

This chapter addresses pre-planning measures to prevent contamination of existing (and new) buildings and infrastructure.

2.1 GENERAL

The building exterior can provide an effective primary barrier against contamination and exposure of occupants to C, B and R agents. Pre-planning measures to prevent contamination involve the use of appropriate physical and security systems. The following areas are addressed:

physical security to protect the building perimeter:

- perimeter protection systems, e.g. barriers, fences, CCTV;
- physical security measures;
- building envelope – glazing; and
- building shell and duct tightness.

physical security and modification or design of air circulation systems to prevent inlet and spread of contamination:

- engineering controls, e.g. ventilation and air conditioning systems.

operational security and control to prevent access by unauthorised persons, and entry of contamination by mail, goods, water or food:

- security – building management procedures for visitors, goods and mail.

The UK Security Services website (www.mi5.gov.uk) provides advice on the measures that can be taken to protect against terrorism and other threats, including CBRN devices. Most pages contain a *"What you can do"* section which lists practical steps that can be taken. The US Federal Emergency Management Agency (FEMA) website (www.fema.gov) also provides a wide range of advice on measures to decrease the vulnerability of buildings to terrorist threats. As part of the Risk Management Series of publications, FEMA has produced a detailed manual and primer providing guidance to building designers and owners to reduce physical damage to buildings, related infrastructure, and people caused by terrorist attacks. This manual (*FEMA 426 –*

Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings) and primer (*FEMA 427 – Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks*) can be downloaded from the FEMA website.

2.2 SCOPE FOR EXISTING AND NEW BUILDINGS AND INFRASTRUCTURE

The same general principles apply to CBRN precautions in existing and new buildings and infrastructure. In general there may be more scope for introducing precautions to reduce vulnerabilities and increase resilience at the design stage for new buildings, and a number of measures are likely to be less expensive to introduce than when carried out as a modification to an existing building.

For new projects, particularly large projects, these concepts should be introduced at the planning stage at both the building and community scale where appropriate.

2.3 PHYSICAL SECURITY MEASURES AND SECURITY MANAGEMENT

A primary defence against many aspects of any incident is building security. This includes the building security management and security personnel and how they interact with the physical building structure and systems, and the visitors and staff in the building. Pre-planning also includes the relationships between building management and other building managers and local authorities in the community, and with the police (see *Dealing with Disaster*[7]).

2.3.1 Protecting the site and its perimeter

For most forms of attack the primary defence is to keep the CBRN material or hostile persons as far as possible from the building. For some sites it may be possible to establish a security perimeter some distance from buildings on the site and more sensitive operations can be established near the centre of the site. Site perimeters can be fenced and/or landscaped to protect and limit overlooking of buildings on the site. The choice of fence will be influenced by site conditions, location, the level of security required and budget. British Standard specifications have been developed for various types of fencing (see Annex 4). Ditches, bollards, other traps or structural features may be used to limit vehicle access.

Some of these measures may require planning consent and listed building consent. Consideration will need to be given to compliance with the Disability Discrimination Act 1995[11]. It is also important that such measures do not prevent or obstruct egress by the occupants in case of fire, fire brigade access, or access by disabled staff or visitors. For example, retractable bollards can be used that can be activated to allow passage by emergency service or other legitimate vehicles.

For some locations it may be possible to extend the security perimeter by forming a defended community such as an area of a city or an industrial estate. A perimeter may be set up to limit access by vehicles or personnel.

The occupier of a building should be aware of everything that happens on the approaches to the premises. An integrated security system should be installed, including lighting and security detection systems such as closed-circuit television (CCTV) and intruder alarms. These should centre on the area around the fence. Outside the fence zone, an area should be subjected to some measure of surveillance. It is also wise to have security lighting outside the perimeter so that persons loitering, suspicious objects and vehicles can be seen.

It is important to consider both the financial and social costs of implementing security systems both to the organisations and its neighbours. These should not unduly interfere with normal access and the normal business of the organisation.

2.3.2 Defending individual buildings

For buildings opening directly onto the street, consideration may be given to hardening the building exterior and protecting vulnerable points such as glazing, duct openings and doors, as detailed in the following sections.

In the case of multiple tenants it is important to concentrate on addressing the issues holistically.

The building owner (landlord) and each tenant need to consider the physical perimeter of their tenancy and the common perimeter of the building or site. They should also consider sharing the cost of security and managing the security risk together.

Where the general public have unrestricted access to parts of the building, physical security measures should be implemented for other vulnerable and important areas.

See also Section 4.2.5, which covers the importance of securing a building after an incident.

By their nature, shopping centres and similar complexes are designed to be freely accessible by customers/public both by foot and by car. Most centres have a number of mall entrances/exits. Facilitating car-borne shoppers makes it desirable for vehicles to be able to access and park close to the shops. Some shopping centres contain public transport interchanges (bus/rail stations) and other public attractions, e.g. theatres, cinemas etc. Measures to control free public access by introducing perimeter barriers and/or controls at entrances would require careful consideration of the implications for the commercial vitality and success of the shopping environment. A range of practical precautionary measures should be considered that would enhance security with minimal effects on reasonable public access.

2.3.3 Building envelope – glazing

The following relevant aspects should be considered in assessing the vulnerability and protection of the building exterior:

- toughness of exterior glazing or other cladding;
- resistance of the exterior to ignition and fire spread; and
- blast resistance of the exterior and measures such as blast deflection screens.

Closed, secure and protected windows can prevent certain types of incidents, as well as providing protection against airborne contaminants outside the building. Windows should be resistant to being broken by thrown objects, but compliant with fire regulations. Blast curtains can be used to protect against spread or glass fragments and debris from explosions[5].

Security window film (anti-shatter film)

Security window film consists of layers of polyester film applied to the interior surface of existing glass. The film can improve the ability of existing glass to mitigate the impact of an explosion and if the glass shatters the shards are held in place[12]. In multistorey buildings, 300 micron security film may prevent glass from falling out of its frames on to the street below[13].

Doors

Exterior doors can be hardened and secured by a range of commercially available systems.

Exterior ducts

Exterior ducts should be mapped and protected against unauthorised access. They could also be alarmed to detect interference. If necessary they should be hardened or re-sited to reduce vulnerability.

2.3.4 CCTV

CCTV cameras may use security lighting, UV or infrared light at very low light levels. Their effectiveness is limited by the vigilance of security staff. This can be enhanced by special software that processes CCTV images and reports unusual behaviour or other occurrences, or by other forms of detection (such as heat or movement detectors). Standards are listed in Annex 4. Advice is also available from the Police Scientific Development Branch on performance specifications for Town Centre CCTV[14,15]. It is also important to consider requirements under Human Rights legislation[16] with respect to "storage of identity" issues.

2.3.5 Security lighting

Five basic techniques used for exterior security lighting (often combined with CCTV) are:

- perimeter lighting;
- checkpoint lighting;
- area lighting;
- floodlighting; and
- topping up.

Standards are listed in Annex 4.

2.3.6 Intruder alarms

Many types of detection system are in use – experts will be able to advise accordingly. Standards are listed in Annex 4.

2.3.7 Protection and siting of key areas and facilities

Particular consideration should be given to the vulnerabilities, siting and protection of key areas and facilities such as plant rooms.

2.3.8 Defending against incidents caused by people entering the building

The preceding sections have addressed physical protection of the site or building from direct attempts to breach the perimeter security. Another area of concern is the hazard presented by people entering the building. These may include members of staff or visitors. When pre-planning for this the first consideration is the safety of the staff and in particular that of security staff.

Visitor/contractor names should be notified in advance wherever possible. Changes from notified names or failures to provide advance notification should be monitored and investigated appropriately.

It is important to ensure that responses to incidents do not leave reception staff isolated and vulnerable.

Personnel – control of security personnel

The *Private Security Industry Act 2001*[17] makes provision for regulation of the private security industry. It introduces the Security Industry Authority (SIA), a statutory body answerable to the Home Secretary, the functions of which are to carry out licensing and approvals conferred on it by the Act. Under the provisions of the Act, people working in designated areas of the security industry will need a licence. The licensing will be phased in over a two-year period planned to start at the end of 2003.

The SIA will also create a public register of approved security firms in its publicly recognised national scheme for the security business.

Employee screening

A minimum requirement is to establish procedures for screening applicants before employment to verify immigration status, work references, addresses and phone numbers supplied on the application form. This should also apply to all seasonal, temporary and contract workers, including caterers. New employees should not work before verification checks have been made. It is useful to have a system for positive employee identification such as photo identification badges. Further information on this subject is available on the Security Services website (www.mi5.gov.uk).

Access control

It is important to:

- control entrance to the facility by employees reporting for work and control the departure of employees leaving the facility during normal working hours;
- institute special controls for employees entering or leaving the facility outside normal hours of work;
- ensure that all the normal routes for personnel entry to or exit from the facility are monitored or controlled. Where feasible and legal, consider reducing the number of

entry and exit points. Maintain the legally required number of emergency exits and ensure that these cannot be used as entry points;
- assess any other possibilities for access, e.g. air ducts, windows, roof openings and vent openings. Seal or provide with locks;
- have procedures in place to restrict access to the facility by ex-employees;
- prevent drivers from entering restricted areas;
- define sensitive or critical areas within the facility where personnel access and movement should be further restricted. These should include chemical storage facilities and access to control rooms for air handling, water systems and storage tanks, electricity and gas supplies. Allow only designated employees to enter. Limit or monitor access to these areas. Ensure that the frequency of monitoring is sufficient to detect any abnormality. Clearly define responsibility for monitoring and controlling the areas;
- limit access only to those areas necessary for the employees work. Consider methods or devices such as colour-coded uniforms or coded badges to make it obvious when employees move to areas of the facility other than those where they normally work;
- restrict access by contractors and their employees to those areas of the building relevant to their work; and
- monitor all incoming and outgoing vehicles for unusual cargo or activity.

Visitors

It is important to note the following issues:

- require positive identification of all visitors, including contract workers. Visitors should be detained at the site perimeter until their credentials and the legitimacy of their visit can be verified with the staff member they are visiting. Any items they have with them should be examined before being allowed on site. Visitor access should be restricted to the areas they need to visit by access controls within the site and they should be accompanied by a staff member at all times if risk levels are considered significant. Provide badges (possibly photo-passes) to visitors and collect them when they leave the site;
- organisations sending contractors having access to the site or building for maintenance purposes should be checked and assurances obtained concerning named personnel being sent to work on the site. Equipment brought on site should be examined. It is important that building or maintenance work does not compromise building security while it is in progress;
- preliminary security checks can be made at the site perimeter, before allowing visitors into vulnerable foyer areas. It may be appropriate to provide some protection (e.g. toughened glass screens) for reception staff. Barriers between foyer areas and the rest of the site/building may also need to be substantial; and

- entry screening of visitors for hazardous items is a two-stage process comprising detection of items and determining if the contents are likely to be hazardous. The first stage involves the use of x-ray systems, metal detectors or a manual search of bags etc. Items to be excluded or further examined are:

  - mobile phones, cameras and recording equipment;
  - knives;
  - aerosol cans or other pressurised containers;
  - manual or electric spray devices;
  - containers of liquids or powders; and
  - bottled gases typically used for repair or maintenance within the building.

The second stage is to examine the items and ensure that they are legitimate. This should be carried out with caution and if necessary expert advice should be sought from the police.

Vestibules, airlocks and revolving doors provide means of controlling access.

Where there is widespread public access to buildings (such as in shopping centres) positive identification and/or screening may not be practical. Other measures that may be considered include security video screening for unusual behaviour.

Isolation of post rooms entry and storage areas

Post rooms and goods inwards areas should be physically isolated from the remainder of the building to prevent penetration of the main building. This is achieved by:

- a separate air handling unit;
- exhaust fans to create a slight negative pressure differential in the area;
- full-height walls surrounding the area;
- an air-lock or vestibule for exterior doors to maintain the pressure differential as people enter and exit (unless entry and exit are infrequent); and
- extract hoods above mail sorting tables and the use of perforated tables for low level extraction.

Isolated zones can be incorporated into both existing and new buildings. These measures can also reduce the potential disruptive effects of hoax letters purported to contain hazardous materials. One system involves the use of modular post rooms that can be removed for decontamination in the event of an incident.

Isolating storage areas is also good practice with respect to normal fire hazards.

It is important to develop systems to enable the prompt detection and management of suspicious items of mail or suspicious deliveries so that any contamination can be minimised. Handlers should be trained to recognise and appropriately handle suspicious pieces of mail.

Considerations regarding items include:

- delivery by a reputable organisation;
- labelling of a reputable organisation;
- suitable accompanying paperwork, delivery note/order number etc; and
- checking addressee is a current employee.

If a package is identified as suspicious it should be isolated and reported to line management. Suitable procedures should be implemented to deal with suspect explosives or contaminants. Expert advice should be sought from the police.

The UK Resilience website[18] has advice on general mail handling and dealing with suspect packages. The Health Protection Agency also provides advice on handing suspect packages[19]. The US Centre for Disease Control (CDC) has provided guidance on mailrooms and goods delivery areas, with an interim recommendation for protecting workers from exposure to *Bacillus anthracis* in work sites where mail is handled or processed[20].

2.3.9 Safety systems and refuges

In addition to isolating post room and goods inwards delivery areas it may be useful to consider degrees of isolation and protection of other key areas of the site or building.

Although security staff need to be located around the site perimeter and building entry points, security control should be sited at points of high vulnerability within the building, such as IT centres and plant rooms. Consideration may be given to the provision of hardened refuge areas with dedicated, High Efficiency Particular Air (HEPA) filtered, positive pressure air supplies and power supplies that can be used by staff when advance warning is available, under the direction of the building manager.

2.3.10 Maintenance of power supplies

Many aspects of protecting buildings against penetration during any incident are dependent on continuity of electrical power. Plans should therefore incorporate the provision of backup power supplies.

It is important to ascertain the impact of a normal power failure not associated with an incident on security measures including access controls, as this can create a temporary vulnerability.

Stand alone telecommunications or a landline plus back up should be provided within refuges.

2.4 PROTECTION OF NATURAL VENTILATION AND HVAC ENGINEERING SYSTEMS

2.4.1 Natural ventilation and local air conditioning

Buildings designed for natural ventilation usually have vents associated with the windows to provide adequate ventilation. These normally provide for a one to two hour rate of air exchange with the outside. Some of these can be sealed to harden the building against penetration by outside releases but minimum ventilation needs to be maintained to serve the building population. Windows can be sealed providing that levels of ventilation remain adequate (as set out in *Approved Document F* of the *Building Regulations*[21]). Arrangements could be made to seal vents and close windows if an incident is expected.

Vestibules, airlocks and revolving doors provide means of controlling air infiltration at main entrances as people enter and exit. This is more pronounced when there are large indoor-outdoor temperature differences. In winter there is a tendency for inward airflow though an open doorway at ground level which may draw in an externally released agent.

2.4.2 Buildings and HVAC services systems

The design and operation of buildings and Heating, Ventilation and Air Conditioning (HVAC) services in response to, or in anticipation of, CBRN events involves two approaches:

- passive protection, where the basic layout and normal operation of the building and HVAC systems provides a degree of protection; and
- active response, in which systems including the HVAC system are controlled or operated to respond to known events or releases either inside or outside buildings.

Primary protection against penetration of a building depends mainly on passive protection, since there may be no warning of an outside release. Active response can be used to provide additional protection when outside contamination is suspected or when special systems are installed to detect and respond to contaminants detected at air intakes.

Passive protection depends on the design, construction, operation and maintenance of the building and systems. Passive protection measures can best be incorporated as part of the design of new buildings, although many can also be incorporated into existing buildings.

For active protection a number of responses involving the operation of HVAC systems are recommended depending primarily on what information is known about the location and nature of the incident. This information, such as whether releases are chemical, biological or radiological, are known to have taken place indoors or outdoors, or are known to be located at specific HVAC inlets, will help determine the appropriate response. The basic steps are intended to ensure that outdoor release is prevented from entering the buildings, and internal release is isolated, diluted and vented to outdoors, as effectively as possible (see Section 3.3). Again, new system design and installation provides the best opportunities to consider and accommodate active response modes but a number of these opportunities may already be available, or could with modification be provided, in some existing buildings.

A number of sources of guidance on pre-planning measures for HVAC systems are available, mostly from organisations in the United States. Principal sources include the US National Institute for Occupational Safety and Health (NIOSH) publications[22, 23], American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)[24] and Lawrence Berkeley National Laboratory, who have established a web-based guidance site[25, 26]. Other guidance on related aspects of HVAC systems is published by the Chartered Institute of Building Services Engineers (CIBSE), This includes minimising pollution at air intakes[27], testing of buildings for air leakage[28] and commissioning codes for air distribution systems, automatic controls and commissioning management[29].

Understanding of systems and controls

The building owner or manager will need to determine the level of risk of contamination of the building HVAC system, and of effects on occupants and business functions. In particular this will involve understanding the zoning of air supply systems, the location of air handling units (AHUs) and the areas they service, and the controls available, including smoke control modes. Such understanding may indicate opportunities to operate the systems to mitigate the risks, with or without modification. Modifications should not be made to systems without understanding the potential effects on occupants during normal operation, and professional help should be sought where these are envisaged.

Some aspects of the resilience of buildings ventilation and air conditioning systems can be better examined using simplified schematic drawings of the building. These show the spaces and treated zones within the building and the main characteristics of the building ventilation and air conditioning system. For new recent buildings constructed to the guidance of *Approved Document L* of the *Building Regulations*[30] that came into effect in April 2002, a suitable schematic may have been provided as part of the *Building Energy Logbook* referred to in the Approved Document. This should generally follow the Chartered Institute of Building Services Engineers (CIBSE)[31] guidance . In Scotland see Part J of the Technical Standards[32].

If simplified schematics are not available among the existing building documentation, the building manager might consider having such drawings prepared by a consultant.

The schematic drawings should indicate the spaces within the building that are supplied with air from each air handler, and the major patterns and directions of airflow into and between the spaces and zones. They should also indicate the paths taken by air that is exhausted from each space or zone, and the general operating instructions of the ventilation and air conditioning system. The description in the logbook should also include the locations of plant rooms and the locations and functions of the major components of ventilation and air conditioning systems such as air handling units, fans and filters.

More information concerning the positions of ventilation inlets and exhausts to and from outdoors, the positioning of supply and exhaust grilles within each space, and the position of access points to ductwork, may need to be determined from the *O&M (Operation and Maintenance) Manuals* or the *H&S (Health and Safety) File* (part of the building hand over documentation) for the building services. The *O&M Manuals* will also explain the operation of the systems and controls, although the detail included in those manuals may be more specialised than is necessary for the building manager and it may be worth having this interpreted more simply by a consultant.

It may be necessary to examine detailed drawings of the air supply and extract systems to determine the precise locations of ducts and dampers, together with details of their construction including the materials used in their construction – hence the internal finishes or roughness involved.

Hand-held smoke puffer tubes might be used to visualise and identify flow directions and paths between spaces, but it could be very time consuming to apply this technique generally in buildings of significant size and complexity.

It would clearly be unsatisfactory if, for example, dampers were closed to isolate a contaminant that had entered a ventilation system and yet the contaminant could still gain access to sensitive spaces through leakage paths in the ductwork itself. Airtightness testing could be considered – particularly for older systems – with a view to locating and remedying leakage points, particularly into or from higher risk or more sensitive areas of the building. Guidance prepared by the HVCA[33] (Heating and Ventilation Contractors' Association) for the manufacture and construction of sheet metal ventilation and extract ductwork systems includes a mandatory pressurisation test. This tests for airtightness for ductwork in relatively high velocity, high pressure, systems. Most building ventilation and air conditioning systems use lower velocities and pressures, where the guidance outlines that the recommended details of construction and assembly should minimise leakage. This will apply mainly to more recent systems that have been constructed using the guidance, and testing is less likely to have been carried out on older systems. It should be noted that the HVCA's concern over leakage is simply that there should not be so much leakage that the performance of the systems is affected. A need to maintain the integrity of ductwork to contain a contaminant may, however, lead to a desire for a higher standard of airtightness.

The NIOSH publication *Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks*[23] details useful guidance including the checklist shown in the box below.

NIOSH Checklist

- what is the mechanical condition of the equipment;
- what filtration systems are in place – what are their efficiencies;
- is all equipment appropriately connected and controlled – are equipment access doors and panels in place and appropriately sealed;
- are all dampers (outdoor air, return air, bypass, fire and smoke) functioning – check to see how well they seal when closed;
- how does the HVAC system respond to manual fire alarm, fire detection, or fire-suppression device activation;
- are all supply and return ducts completely connected to their grilles and registers;
- are the variable air volume (VAV) boxes functioning;
- how is the HVAC system controlled – how quickly does it respond;
- how is the building zoned – where are the air handlers for each zone – is the system designed for smoke control;
- how does air flow through the building – what are the pressure relationships between zones – which building entryways are positively or negatively pressurised – is the building connected to other buildings by tunnels or passageways;
- are utility chases and penetrations, elevator shafts, and fire stairs significant airflow pathways;
- is there obvious air infiltration – is it localised;
- does the system provide adequate ventilation given the building's current occupancy and functions;
- where are the outdoor air vents – are they easily observable – are they or other mechanical equipment accessible to the public; and
- do adjacent structures or landscaping allow access to the building roof.

Passive protection

• The location and protection of HVAC inlets

Contaminants from CBRN releases are most concentrated near the source. Since this is most likely to occur at or near ground level, HVAC inlets should be placed as far away from potential release points as possible. Further away from the source point, contamination is likely to be widespread and diluted, especially in urban areas, but some airborne contamination is likely to be present at several tens of metres above ground level.

However, it is possible to select sites for inlets that are likely to be subject to lowest concentrations, although for any particular building this may vary depending upon the incident release point and the meteorological conditions. Local surveys and modelling can be used to identify preferred inlet locations. For more sophisticated systems it may be possible to use different inlets sited at different points on the building depending on the weather conditions.

Ideally main ventilation inlets should be positioned on building roofs, or in any event elevated at least three metres above ground level, to minimise opportunities for easy access.

Where inlets are located at ground level they may be either protected by enclosure, or by other means of perimeter security and protection, or surrounded with a solid enclosure to a height of at least three metres, with a sloping mesh roof. Extracts located in publicly accessible areas such as entrance lobbies should be positioned in inaccessible locations and/or protected by surveillance.

In the context of inhibiting access to sensitive components, drawings and plans of buildings that indicate details of the location and function of HVAC and other critical services systems should be maintained in secure locations, and access denied to unauthorised persons.

• The location and protection of air handling equipment and ductwork

Rooms in which HVAC plant such as air handling units (AHUs) are located should be secured and access denied to unauthorised persons. Ductwork should be routed and controlled to avoid unauthorised access. It must also be inspected and cleaned on a regular basis as part of its normal operation and use.

Water tanks and water supplied for humidification should be protected from biological contamination.

- **Zoning/pressurisation**

HVAC systems are often used to provide pressures inside buildings that are generally above ambient. This is commonly done to minimise air infiltration that could increase heating loads but, in ensuring that there is a net flow of air outwards from the building, it will generally prevent the ingress of external contaminants through leakage points in the building shell. Where inlet air has been treated to remove any contaminants this will prevent the penetration of outside contamination into the building.

Particular spaces or areas within the building can be set at higher or lower pressures in relation to others to ensure that air always flows into or out of those areas. Ideally these would be served by separate air supply and exhaust systems. Examples could include operating mailrooms, delivery areas and entrance lobbies at lower pressure, to ensure that any contaminants released in those areas do not have access to cross-contaminate adjoining areas.

- **Building fabric airtightness**

Air leakage can be a significant factor in heating and cooling energy requirements. *Approved Document L* of the *Building Regulations*[30] (In Scotland see Technical Standard J10)[32] currently asks for air leakage tests to be carried out on new non-domestic buildings over 1000m^2, and for the achievement of a minimum standard of airtightness, as an energy conservation measure[34].

Leakage through the building fabric also provides routes for the uncontrolled ingress of contaminants, and should be minimised. In normal operation, the building should be pressurised by the HVAC system so that any air leakage flows outwards.

The sealing of filters and dampers is similarly crucial to maintaining the integrity of, and protection provided by, these systems. As building components and seals may deteriorate or move with age, the airtightness of the construction may need to be reviewed at intervals.

- **Filtration**

Various measures can be taken to improve filtration (High Efficiency Particular Air [HEPA] filters or electrostatic dust precipitation), removal of chemical agents (treated activated charcoal filters) and additional neutralisation of microbiological agents through sterilisation (UV or ionising radiation). Activated carbon filters used to remove gases are both expensive and heavy. The combination of HEPA or high efficiency filtration and activated carbon adsorption provides a high degree of filtration of C, B and R agents. The costs of using such systems can be reduced by switching them on only during times of heightened alert – however, the level of passive protection at other times is lower. HEPA filters and electrostatic filters are expensive and very bulky.

Both air brought into the building from outdoors, and air that will be recirculated to augment the fresh air supply, should be filtered. In general, the installation and operating costs, and the pressure loss and associated energy cost, of filters increases with filtration efficiency[35].

There is no consensus to recommend antimicrobial filters, which are usually normal filters onto which an antimicrobial agent has been applied. Dust build up on the face of the filter can inhibit contact between the contaminant and the coating, and there is no evidence that microorganisms are killed downstream within the filter media.

It must be stressed, however, that the effectiveness of filtration or adsorption will be compromised unless adequate means are in place to ensure that all the inlet air flows through the devices. This makes the fit and sealing of the filters in their housings a particularly important design and maintenance consideration. The maintenance and replacement of filters should be given particular attention.

Some measures, particularly improved filtration standards, will be associated with increased costs. Where improved filtration can be incorporated in new design, any additional pressure drop can be minimised by increasing filter areas, to avoid increasing energy consumption and costs. Professional guidance should be sought where high efficiency filtration is needed in retrofit installations, as the increased resistance of filters could reduce flow rates through systems, which could compromise air quality in normal operation, and may require other modifications to compensate for the change. It may also be more difficult to achieve compliance with the guidance of *Approved Document L* of the *Building Regulations*[30] relating to mechanical ventilation or air conditioning efficiency (In Scotland see Technical Standard J10)[32].

• Commissioning

Plant and system commissioning will normally be carried out to the procedures and specifications contained in current published professional guidance. Satisfactory commissioning is included as a provision of *Approved Document L* of the *Building Regulations*[30] (In Scotland see Technical Standard J10)[32]. These procedures are intended to demonstrate that systems operate to the design intended under normal operation. Additional procedures will be needed where particular modes have been specified for emergency operation and additional factors may need to be determined during commissioning. Particular attention will need to be paid to the effective closure and sealing of dampers, and the required pressures and pressure differences between air supply zones.

In the event of a life-threatening incident, the HVAC air distribution system becomes a component of a life safety system. All the planned ‘extraordinary’ operating and shutdown modes should therefore be tested and proven to the building owner’s satisfaction.

- **AHUs and ductwork**

Normal maintenance practice for the health and safety of building occupants, under the normal operation of HVAC systems, recommends regular inspection and cleaning of air distribution systems, and these activities should not be compromised by measures taken to improve robustness to CBRN events. Inspection and cleaning under normal operating conditions is described in the *HVCA Guide To Good Practice*[36] and *in CIBSE Technical Memorandum TM26*[37].

Active protection

Active protection involves systems including the HVAC system being controlled or operated to respond to known events or releases either inside or outside buildings. Although one aspect of this is the prevention of contaminants entering the building, it can be considered mainly as an emergency response to minimise the entry and spread of contamination from exterior or interior releases through the building. It is therefore covered in the next chapter on secondary prevention.

Chapter 3:

Secondary prevention measures:

pre-planning to limit the extent of contamination

3. SECONDARY PREVENTION MEASURES: PRE-PLANNING TO LIMIT THE EXTENT OF CONTAMINATION

This chapter addresses guidance on pre-planning measures that can be taken to limit the extent of contamination once it has entered the building from outside or has been released inside the building.

3.1 GENERAL

Pre-planning to limit the extent of contamination in a building involves:

- ‘passive’ systems that limit the spread of contamination by virtue of the normal operation of the building management and systems; and
- active measures that can be taken in some situations if building management is aware that some form of contamination has entered part of the building from outside or has been released inside the building.

Secondary prevention involves two main issues:

- security and management of occupants; and
- air circulation.

Managers should be prepared with an overall emergency response plan, which will indicate the actions expected of both building management staff and employees/ occupants.

Recommendations are included for containment of contamination and procedures for management of occupants. The possibility of occupants moving through contaminated areas and exacerbating the contamination is discussed in the context of measures that could be adopted to limit the spread of contamination. Measures are also emphasised that can be taken by building managers prior to the arrival of the emergency services, and pre-planning for liaison with the emergency services.

Procedures for identification of the presence of C, B and R agents (odour etc) are discussed, but details of detection systems are not provided (as these are beyond the scope of this document).

3.1.1 Recognising that a CBRN incident has occurred

In some cases, the nature of the incident may be evident, particularly if there has been an explosion. However, other indicators may be individuals seen releasing suspicious materials or identification of unusual packages or substances in a mailroom.

For situations where the initiating event is unobserved, the occurrence of the incident may become apparent over periods from a few minutes to many days, depending on the nature of the agent. The Health Protection Agency web site[38] provides a list of useful links for information on topics such as indicators of possible chemical, biological and radiological incidents. Indicators are also listed in the WHO guidance[39], and in the US CBR Handbook reference[40].

3.1.2 Pre-planning liaison with the emergency services

It is vital that pre-planning involves consultation with the emergency services. They will be able to provide advice to building managers. It is also important that building plans and details of building systems are available to all parties likely to be involved in an incident. These plans and any agreed pre-planned procedures for handling an incident must be available to all relevant parties at all times, by coordinating communication between the relevant parties. The necessary procedures may relate to the building structure, building air circulation systems, building utilities (items such as location of isolation valves) and occupant management. Other important aspects may be the interceptor systems which prevent liquid effluent from entering watercourses and drainage systems, which affect the retention or release of contaminants into the environment beyond the building or site. It may also be useful to position a central shut down and start up point for all building services external to the building.

As part of the pre-planning it may be necessary to obtain expert advice on:

- the building structure;
- building services (air circulation systems); and
- building utilities.

3.2 SECURITY AND MANAGEMENT OF OCCUPANTS

For a number of incident scenarios, several hours or days may elapse before penetration of a building by a contaminant becomes evident. This particularly applies to microbiological contaminants, but also to chemical and radiological contaminants. For such situations, limiting the spread of contamination through the building depends on 'passive' protection through the operation of routine systems. A major method of spread of contamination is by occupants moving around the building – through airborne spread facilitated by movement, door opening etc, contaminated footwear or clothing, or by infected individuals through contact or droplet infection.

3.2.1 Pre-planning measures to limit spread by occupants

The main methods for limiting spread around the building are essentially the same as those discussed in Chapter 2. These consist of:

- good security and screening of visitors and staff at reception areas and other entry points;
- screening of post and other items before dispersal around the building;
- restricting access to areas that need to be visited for the conduct of business;
- physical isolation of reception areas, post rooms and goods inwards (and staff working in these areas) from other areas of the building;
- lobbies and airlocks between adjacent zones;
- dispersing different parts of the business around different buildings on a site or on different sites, home working (i.e. restricting physical contact between staff in different areas);
- in some situations it may be relevant to use measures to limit spread of microbiological contaminants (disinfectant trays, overshoes, showering and changing clothing before entering clean or sensitive areas)[12]; and
- Consideration of waste stream management.

Where the presence of contamination is known or suspected, these measures can be enhanced by active measures consisting of further restrictions on access and movement of occupants around the building. If an incident is suspected this should be reported to building security, who should contact the police or other emergency services as appropriate.

An important management aspect is the adoption of measures to protect occupants and limit the spread of contamination. Although occupant protection is beyond the scope of this guide, these measures also have implications for the spread of contamination through a building. Advice is provided by the Cabinet Office on the UK Resilience website[18] and the Health Protection Agency website[19] on actions to be taken and procedures for dealing with exposed persons.

The main aspects related to the limitation of spread are:

- do not touch or move a contaminated item;
- shut windows and doors in the room and leave the room, but keep yourself separate from others and available for medical examination; and
- notify building manager or their nominated deputy.

The building manager or their nominated deputy should:

- notify the police using the 999 system and other emergency services as appropriate;
- switch off the building air conditioning system;
- close all fire doors in the building;
- close all windows in the rest of the building;
- if there has been a suspected biological contamination, ensure that personnel outside the contaminated room are evacuated from the building, as soon as possible, to a previously agreed rendezvous point. Ensure individuals in the contaminated room are evacuated to an adjacent unoccupied, uncontaminated room away from the hazard; and
- if there has been a suspected chemical incident ensure personnel leave the room as quickly as possible. Possible signs that people have been exposed will be streaming eyes, coughs and irritated skin. Seek medical advice.

A basic principle is to keep all persons exposed to the material separate from others and available for medical attention. Other people should assemble at a safe distance from the incident and continue to be guided by the police and the other emergency services.

Further advice on methods for accessing and isolating the affected area (such as setting up a temporary changing booth and airlock at the threshold), for personal protection and decontamination of affected occupants is provided by the Health Protection Agency[38].

Any occupants in the affected area at the time of contamination should remove their shoes and outer clothing if necessary so that these items can be decontaminated. Disposable overshoes should be worn on leaving the area if available.

Where microbiological contamination is suspected, occupants should avoid contact with surfaces and decontaminate their shoes by treading in disinfectant trays before entering uncontaminated parts of the building (although this measure is likely to provide only partial decontamination). Disposable overshoes would also be an advantage. Pre-planning could include the provision of basic equipment such as overshoes and disinfectant trays, depending on a decision by the Building Manager based on a risk assessment.

Occupants must not enter the contaminated area unless it is safe to do so or it is the only means of exit.

3.3 LIMITING THE SPREAD OF AIRBORNE CONTAMINATION WITHIN A BUILDING

Passive containment

The methods of airborne spread of contamination around a building and remedial pre-planning measures to limit spread depend on the air circulation system in the building. Pre-planning measures include passive measures that form part of the normal procedures and systems for building use, and active measures that can be taken once building management become aware that an incident has occurred.

For naturally ventilated buildings, passive measures that can be taken to reduce air circulation between different parts of the building will also reduce the spread of contamination. This can be achieved by separating the building into zones with separate access by occupants (particularly high-risk zones such as reception, post rooms and goods inwards). Where communicating doors exist between zones, these should be maintained closed as far as practicable (or sealed). For new buildings design strategies can be used to ensure that natural ventilation patterns minimise circulation between zones.

For buildings with mechanical ventilation and air conditioning systems, zoning and restrictions on movement of occupants can be enhanced by also dividing the air circulation system into zones. Separation of zones, and ensuring that sensitive zones are maintained at positive pressure with respect to high-risk zones will inhibit the spread of contamination from one part of a building to other parts.

Active response

Passive containment and separation can be enhanced during emergencies by taking active control of air handling units, although this relies on having realistic protocols for known situations. Actions that may enhance protection in some situations may be counterproductive in others so that careful consideration must be taken in the design of such systems and in training staff expected to operate them.

Strategies for reducing spread of contamination through building conditioning systems may include rapidly stopping all Air Handling Unit (AHU) fans and closing all HVAC dampers, including exhaust dampers – or alternatively, maintaining operations and flushing with fresh air to dilute contamination. It is not possible to give simple guidance on this issue, since it depends on the specific systems in place in a particular building and may be affected by the location of the contamination (outside or inside the building). If an active response strategy is under consideration expert advice should be obtained. The following sections outline the issues.

Availability of operational modes

HVAC systems are available that can respond to indoor and external releases of biological, chemical or radiological contaminants. They respond in different ways to limit penetration from the outside and the spread of contamination inside the building. These include system shut-down, operation to provide full fresh air, and operation to maximise air extract. Additional modes may also operate to provide safe escape routes or refuges for occupants, or to contain contamination within particular (more vulnerable) areas using separate air supply and exhaust systems.

The modes of operation will not necessarily be the same as those required for other emergency situations such as fire and smoke removal. For example, it may be decided that the critical nature of stairwells warrants air supply with HEPA filtration both to provide a safe means of escape, and to prevent a critical area from being contaminated, especially by particulate contaminants.

In situations where HVAC system shutdown is recommended, the pressurisation will be lost and the natural pressure distributions within and around the building will expose the fabric to the ingress of contaminants through the air leakage paths. In addition, where individual areas within the building are to be maintained at different pressures, then air leakage paths between such zones should be minimised. Particular attention should be paid to cable conduits and common ceiling voids that may provide leakage paths between zones.

The HVAC system ductwork could in some circumstances be used to remove, or control the spread of, contaminant released in particular spaces in the building. It is therefore important that contaminants then remain in the system, without leakage into occupied spaces. Equally, where systems will be relied on to provide uncontaminated fresh air, it is important that contaminants cannot leak into parts of the ductwork system that may be operating at low pressure. Effective sealing of ductwork construction and joints should be specified and tested.

Dampers that will be used to isolate the HVAC system from outdoor air, or to isolate particular zones, must also be maintained in good working order so that closure and sealing is effective.

Controls

Appropriate design and specification can ensure that the HVAC system and components are able to adopt both normal and ‘extraordinary’ modes of operation, dependent on the circumstances. It is important to consider how the changes in operational mode will be effected by building management staff. Key to the ability to change mode simply and effectively will be issues such as the labelling and co-location of all the relevant controls, or the inclusion of the necessary control sequences in automatic systems such as the Building Management System (BMS). The operation and action of controls should ideally be checked on a routine basis, as part of planned maintenance schedules.

Access to systems and controls

Single control locations are recommended, from which any of the necessary operating modes can be selected. Depending on the simplicity or complexity of the system and the planned response modes, controls may take the form of a single switch that shuts down the HVAC system. Alternatively, controls may be a more comprehensive range of switches to actuate different parts of the system that may have been planned to operate separately in an emergency, or more complex BMS. The control location should be accessible under emergency conditions, and should be located in a zone of the building that is designed to be safe.

Managers should be prepared with an overall emergency response plan, which should include the range of responses that will be required of the HVAC systems, and who will have the responsibility for carrying out those responses.

Training managers and staff

Training and, where appropriate, drills should be carried out periodically to ensure that all those involved are familiar with the responses required of them. This would involve building managers who may need to carry out particular control actions on the HVAC and other services, and occupants of the building.

Managers and staff also need to be trained to respond to an emergency by implementing the appropriate pre-planned response strategy in relation to actions such as taking refuge or evacuation as appropriate and avoiding the spread of contamination. Where members of the public may be present, staff need to be trained to manage the emergency response of occupants. Suitable warning systems (such as personal address systems) and warning protocols need to be developed for different potential incidents. The warning protocols need to include provision for risk communication and reassurance as appropriate. Further advice can be found on the National Steering Committee on Warning and Informing the Public (NSCWIP) website (www.nscwip.info).

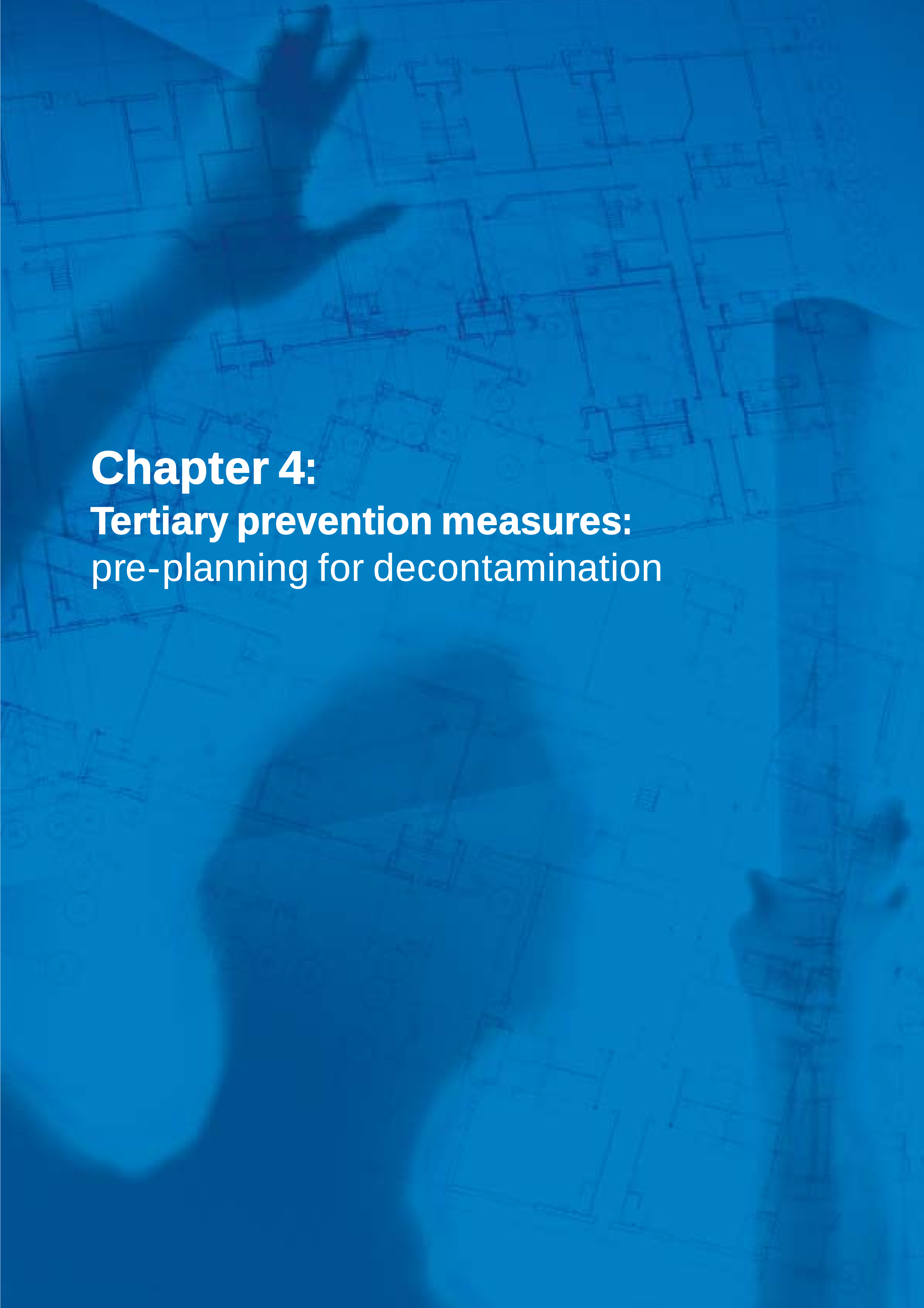
First responders

First responders to incidents (including the 'blue light' emergency services) should, where appropriate, have building plans available beforehand or be otherwise informed concerning the ways in which the building is zoned. This is in terms of the isolation of particular areas through the pressure differentials maintained by the HVAC system, the control actions that can be achieved by the HVAC systems in response to emergency situations, and the emergency response plans. The simple advice presented on a number of UK websites (UK Resilience[18], Health Protection Agency[19] and Thames Valley Police[41]) is to switch off the building air conditioning if an incident occurs, whether it is inside or outside the building. Such immediate action will straightaway provide a reduction in the penetration rate of any outside contamination into the building and the rate of spread of any contamination circulating within the building. However, depending on the design or the system in place in any specific building, switching off the entire building air conditioning system may not necessarily be the most effective response. This is because the integrity of zoning maintained by differential pressures in the system and the positive pressure maintained with respect to the outside will be lost. This enables passive air movement and any airborne contamination into and around the building via leakage paths. It is therefore recommended that the appropriate course of action for any specific building should be pre-planned depending on the air circulation system in place.

HVAC response to CBRN incidents, and possible control sequences, has been described in the guidance prepared by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Responses depend generally on whether the source of contamination is indoors, outdoors, or unknown, whether the contaminant is known, and on the abilities of the HVAC air systems. A summary of actions that can be carried out is provided in the ASHRAE *Special Report Guidance for Building Security*[42].

More detailed discussion of particular HVAC control actions, and the reasons for recommending such actions, that may be performed under the various contamination scenarios is provided in a Lawrence Berkeley National Laboratory report *Protecting Buildings From a Biological or Chemical Attack: Actions to Take Before or During a Release*[26].

The Federation of Environmental Trade Associations (FETA) is the recognised UK body which represents the interests of manufacturers, suppliers, installers and contractors within the heating, ventilating, refrigeration & air conditioning industry. The FETA has provided practical guidance on HVAC systems. Further information is available on their website (www.FETA.co.uk).



Chapter 4:

Tertiary prevention measures: pre-planning for decontamination

4. TERTIARY PREVENTION MEASURES: PRE-PLANNING FOR DECONTAMINATION

This chapter is concerned with strategic pre-planning for measures which may be adopted to improve the effectiveness of decontamination procedures should a CBRN incident occur. It does not cover actual decontamination methods.

4.1 GENERAL

In this aspect of the guidance strategic pre-planning is discussed for measures which may be adopted to improve the effectiveness of decontamination procedures should a CBRN incident occur. The emphasis is therefore on actions which can be taken to prepare existing buildings or influence the design of new buildings in order to optimise any decontamination processes required in the event of a CBRN incident. Guidance is also given on obtaining advice on reducing vulnerability to decontamination costs and pre-arranging decontamination services.

There is a range of practical pre-planning actions that can be considered. The actions in many cases apply to both the fabric and contents of the building and are aimed at making the restoration/decontamination process more efficient and effective in order to ensure that as much of the agent as possible is removed. It is not within the scope of 'tertiary prevention measures' to provide technical information on the decontamination/restoration methods themselves.

There are two main aspects to decontamination pre-planning:

- examination of the building and contents to identify likely sites for contamination to be deposited; and
- remedial measures to minimise deposition, protection of surfaces to facilitate decontamination, and removal or enclosure of items that are difficult to clean or are of particular importance.

4.1.1 Typical types of substances involved in CBRN incidents

To prepare a building and optimise decontamination/restoration processes following a CBRN event an important aspect is the physical form (gas, solid or liquid) and chemical properties of the agent. In general, relatively non-reactive gases and highly volatile liquids such as carbon monoxide, hydrogen cyanide and anaesthetic gases can be removed simply by ventilating the building. Before venting, consideration may need to be given to possible environmental hazards. Acid gases such as hydrogen chloride or chlorine can also be removed by venting, but react with metallic and alkaline surfaces. This may cause some superficial building damage, but does not generally represent a health hazard. They may also damage electronic and other equipment. Less volatile organic vapours and liquids tend to be absorbed by building contents and some building surfaces. They can present long-term health hazards and therefore require decontamination. Sooty deposits from fires carry adsorbed organic substances and acid gases, also requiring decontamination. Dusts containing toxic chemicals, microbiological particles or radiochemicals also require decontamination. Some can be absorbed or may react chemically with surfaces so that decontamination requires removal of the surface. Microbiological deposits may require fumigation.

4.2 PRE-PLANNING MEASURES FOR THE BUILDING FABRIC AND CONTENTS

4.2.1 Interior surfaces

Any C, B and R agent that comes into contact with the building fabric could potentially permeate through building surfaces. Clearly surfaces such as plasterboard, masonry, and various porous surface finishes have the potential to adsorb gases and liquids and fine particulates. Depending upon the situation it is possible to adopt either of two alternative strategies. Non-porous surfaces and coatings can be adopted which are less susceptible to contamination and are easier to clean. Alternatively, materials with highly porous surfaces can be introduced in some locations that will absorb free liquid and reduce immediate contact with vapour hazards. These should be designed for ease of removal after a contamination incident. Clearly the applicability of any such treatments will depend upon the practical, functional and other considerations (such as for example limitations presented by historic buildings). Where reduced vulnerability to contamination is required the following remedies are proposed:

Suggested remedies:

- all internal surfaces that are easily accessible to be treated with a non-porous coating. This can be a low porosity paint film but an 'anti-graffiti' type of paint system has the additional merit of providing an impermeable surface that is easy to clean. 'Permanent' attachments to walls should be kept to a minimum. Apply disposable adhesive membranes;
- floors should ideally be constructed with an impermeable surface (e.g. sealed with a proprietary coating). If carpeting is necessary, use easily removable carpet tiles instead of wall-to-wall carpet;

- ceiling fittings (e.g. lighting diffusers) should be flush mounted and sealed; and
- soft fabric furniture and furnishings should be avoided, particularly ‘permanent’ fixtures. Consider impervious fabric upholstery (e.g. PVC based). Where absorbent soft furnishings have been exposed, disposal rather than decontamination is recommended.

4.2.2 Building voids and interstices

All buildings contain both intentional and unintentional voids throughout the structure. Many buildings for example have suspended floors and ceilings and vertical cavities, purposely designed to provide a route for building services such as HVAC and cabling (both electricity supply and data). Unintentional voids arise in a multitude of ways including poorly fitting joints, installation of fixings, mechanical damage, movement and general wear and tear. Such voids are vulnerable to contamination from agents released inside and outside a building as solids, liquids and gases. As with porous surfaces partial removal may result in continued slow release of contamination.

Suggested remedies:

- seal gaps as comprehensively as possible;
- reduce the size and number of ‘interstices’ to a minimum within practical and economic limits;
- treatment for absorbent surfaces will have some effect but detailed attention to sealing gaps and openings is probably needed in most cases; and
- check the airtightness of a room (or building) to check the efficiency of any such remedial measures.

4.2.3 Heating and ventilating ducting

Contamination of an HVAC system will generally be difficult to remove completely and it may be necessary to strip out the old system and replace with new. Some pre-planning measures can be taken at the design stage to reduce deposition.

Forms and materials of construction

The details of bends, changes of shape and cross section, and other internal details of air supply ductwork systems may act either to trap small particles or to ease their transport through the system. Particular contaminants will deposit preferentially in regions of lowest velocity, or where flow separates from duct surfaces – higher concentrations of contaminant may be expected in such locations, e.g. sharp bends. Deposition is generally minimised where changes of direction and shape occur smoothly. Similar considerations apply to energy efficiency where rapid, angular turns and changes of shape may be associated with higher pressure loss coefficients, hence higher energy requirements.

Duct surface finish is an additional factor, where rougher surfaces are associated with higher pressure losses, higher energy requirements, and potentially higher rates of deposition of dusts. Cleaning operations are generally more difficult where surfaces are not smooth, or are absorbent. Particular difficulty would be experienced in decontaminating concrete or brick/block work ducts, and consideration might be given to applying smooth liners to such duct forms.

Note also that for energy efficiency in providing heating or cooling, some forms of air supply system are routed through hollow concrete floor and ceiling panels to make use of the high thermal mass of these components of construction. Professional advice should be sought where such forms are encountered and lining considered, in order to avoid compromising the effectiveness of the heating and cooling systems.

Suggested remedies:

- provide easy access to all the duct interior surfaces by providing inspection hatches;
- minimise the length of horizontal runs in the ducting;
- minimise the number of gasket sealed joints in the system;
- avoid rough or porous surfaces – coat if necessary; and
- minimise sharp bends and points where flow velocity changes suddenly.

It is difficult to quantify the benefits of remedial measures because little is known about the fate of C, B and R substances on common building materials.

4.2.4 Lack of core utilities following a CBRN incident

Electricity supplies, water supplies and drainage systems will be vulnerable in a CBRN incident. Considering decontamination/restoration activities, availability of these services is likely to prove crucial in determining both the speed of operations and their effectiveness. This may be considered an aspect of generic business continuity management.

Suggested remedy:

- consider providing skeleton utility backup systems that have a high degree of isolation from the areas likely to be contaminated. Naturally this will depend largely on the time scale economics of restoring function of the building.

4.2.5 Lack of security arrangements

Anecdotal evidence suggests that following an emergency incident the obvious need to secure the building against unauthorised entry is not always achieved. Looting, such as that following the Bishopsgate bombing, would have obvious implications in many areas of building decontamination/restoration and in the spread of contaminants. This too may be considered an aspect of generic business continuity management.

Suggested remedy:

- ensure strict security over personnel allowed at the incident (through liaison with the emergency services).

4.3 PRE-PLANNING WITH CONTRACTORS

As part of the decontamination pre-planning process, it is recommended that expert advice is sought on decontamination issues and decontamination contractors are consulted with respect to specific buildings. The Government is actively considering the establishment of a national decontamination and recovery service. Such a service would provide further advice and assistance on specialist contractors and decontamination techniques. Decontamination contractors often only have a vague impression of the structure, contents and facilities available in a building when called to action. It is clearly essential for any contractor to be informed of these features if called to a CBRN event. It is important that such details are maintained in a secure location. In the case of CBRN materials highly experienced and well-trained contractors/operatives will be required.

The following areas should be addressed:

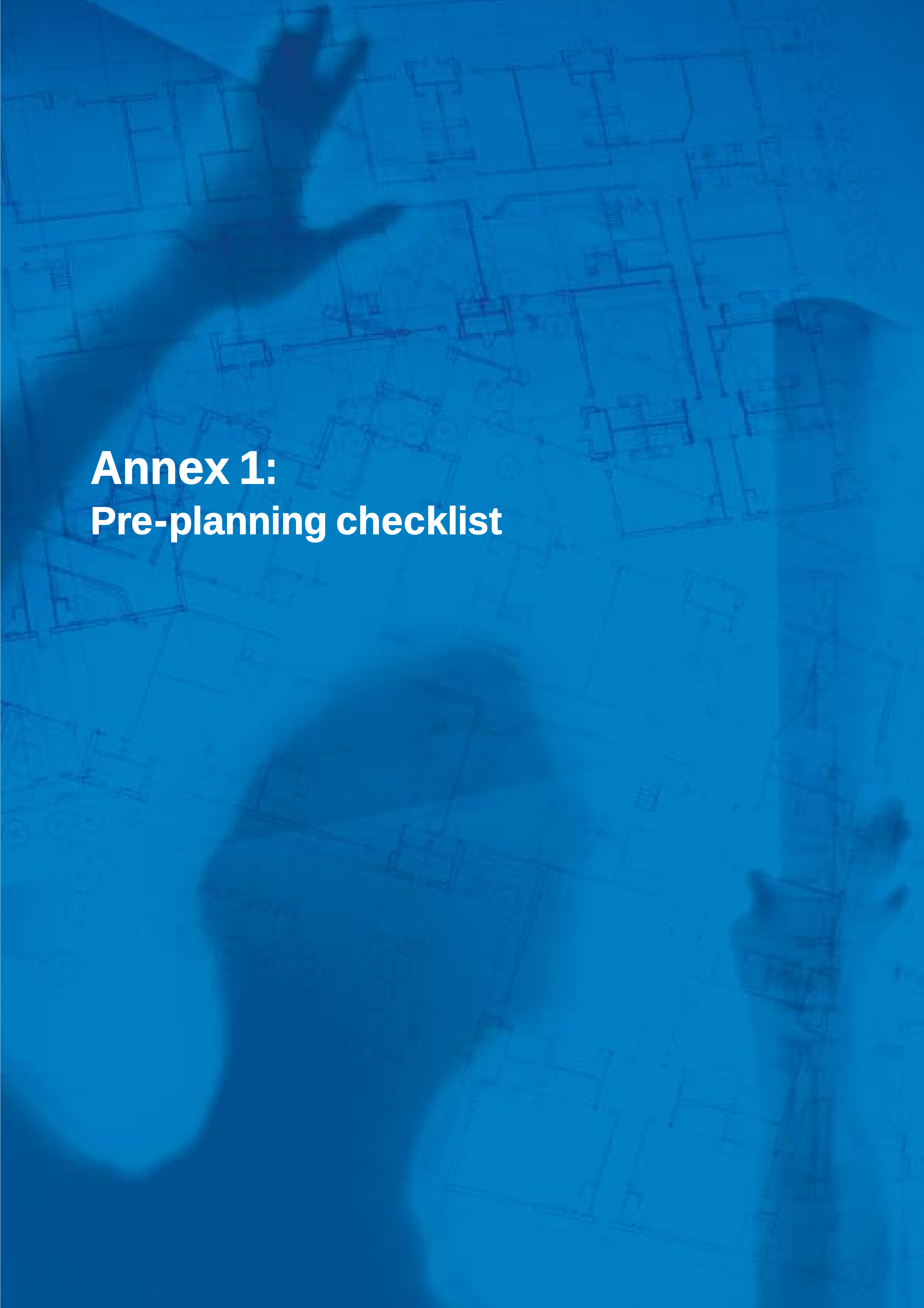
- carry out a survey of the building, its systems and contents in order to identify areas and items that are vulnerable to contamination and difficult or expensive to decontaminate;
- identify remedial actions to reduce vulnerabilities and remove or protect important items;
- ensure up-to-date plans of the building, layouts, services, decor and positions of protected core utilities are lodged with the decontamination contractors. Seek assurance that these will be kept in a secure location and seen only by authorised personnel;

- explore decontamination options and methods. (It should be noted that some decontamination techniques may cause damage to some surfaces and materials. Techniques will vary in their effectiveness in removing contamination from the surface concerned);
- draw up inventories of equipment, valuable items and so on to determine which require particular protection (or removal off-site) and items that can be disposed of rather than decontaminated; and
- consider staging a scenario-based CBRN exercise that includes the decontamination contractors.

4.4 DISPOSAL OF CONTAMINATED WASTE

Following an incident a building may be contaminated by gaseous contaminants and/or liquid or solid deposits. Decontamination may involve venting of gases and the production of contaminated liquid or solid waste as well as contaminated building materials and contents. Consideration of waste disposal is beyond the scope of this document, but issues of disposal and potential environmental contamination will need to be addressed following an incident (by competent agencies), as well as the fact that the building itself may be classified as a hazardous site[43].

Annex 1:
Pre-planning checklist



ANNEX 1: PRE-PLANNING CHECKLIST

1. RISK ASSESSMENT

The basis of a building CBRN risk assessment is similar to that of a fire or health and safety risk assessment. Risks should be identified and avoided as far as possible, and methods should be implemented to minimise hazards. The first step is to consider the probabilities that the building or infrastructure may be subject to CBRN events of different magnitudes ranging from minor accidental or deliberate chemical releases or criminal acts to major CBRN incidents. Refer to published guidance[1-3] and consult police or other agencies if appropriate.

For any considered remedial measures it is important to weigh up the level of protection in relation to the level of risk, the costs (both financial and social) of implementation and the incremental benefits obtained.

2. GENERAL VULNERABILITY ASSESSMENT

A recommended procedure is to conduct a review of the building, its systems, procedures and occupants. This is aided by a ‘walk round’ survey of the site or building to identify vulnerable points.

The following issues should be considered:

VULNERABILITIES TO PENETRATION FROM OUTSIDE:	✓
• site perimeter, fences, gates, perimeter security manning, CCTV, security lighting, movement detectors and so on;	
• building envelope and approaches;	
• physical barriers at building perimeter;	
• vulnerability of building envelope to penetration;	
• vulnerability of ground floor windows and glazing;	
• vulnerability and siting of building entrances including car parks, external doors and main entrance, loading bays and so on;	
• CCTV and other systems providing intelligence of persons or vehicles approaching the building;	
• accessibility to the building roof from adjacent structures or landscaping;	
• vulnerability and siting of external air inlets to the building;	
• vulnerability to interruption of utilities; and	
• site and building entrance security personnel.	

VULNERABILITIES INSIDE THE BUILDING:	✓
• vulnerability of building foyer/reception areas or concourses;	
• extent to which foyer, post room, goods reception areas are isolated from the rest of the site or building;	
• extent of provisions for identification and handling of suspect packages and for containing releases in post rooms and goods reception areas;	
• determine if security screening procedures are in place to prevent hazardous materials from being brought into the building;	
• vulnerability to contamination of water or food consumed within the building;	
• vulnerability to release of contamination by visitors, contractors and staff;	
• vulnerability to spread of contamination within the building by air circulation or by circulation of building occupants (on footwear, clothing, by contagion or droplet infection);	
• vulnerability to contamination that would be difficult to remove (i.e. any absorbent or chemically reactive surface); and	
• vulnerability of precious items or key business items such as archives.	
VULNERABILITIES AND SYSTEMS RELATED TO MANAGEMENT OF OCCUPANTS:	✓
• vulnerabilities of staff, visitors and contractors;	
• vulnerability of procedures and features pertinent to protective actions. Examine procedures and features relative to protective actions with regard to effectiveness against different types of incidents, such as sheltering, evacuation, isolation of different groups of occupants or parts of the building;	
• vulnerability of emergency communications. Examine methods for raising an alarm, communication systems and protocols. Determine whether the building has a public address system. If so, record the locations of the broadcast microphone and controls;	

• determine communication protocols used by building security personnel and record locations of alarm call points. Is there a specific method for raising a CBRN alert? How does this relate to fire alarms and warning procedures? and	
• vulnerabilities of occupants in relation to means of escape or taking refuge. Obtain a copy of the evacuation routes posted for a fire emergency and fire emergency procedures. Determine if there are interior rooms suitable as sheltering refuge areas or protected refuges.	
VULNERABILITIES TO BUSINESS INTERRUPTION AND RELATED ISSUES:	✓
• vulnerability to business interruption by a CBRN event; and	
• vulnerability to contractual liabilities: tenant, owner, insurance, customers, suppliers, financial stakeholders, other agencies.	

3. SPECIFIC VULNERABILITIES OF THE BUILDING AIR CIRCULATION SYSTEM

SPECIFIC VULNERABILITIES OF THE BUILDING AIR CIRCULATION SYSTEM	✓
• determine the building's type of ventilation system – natural ventilation, unit ventilators (through the wall units in each room) or a duct system with air handling units;	
• if passively ventilated, check 'leakiness' of building (pressure test if necessary), window closures and other vents;	
• if there is an HVAC system consider the above, plus siting and protection of air inlets;	
• if the building has a duct system, record the number of different zones and air handling units, and the location of controls for each;	
• if the building has mechanical ventilation with a duct system, record the location of all fresh air intakes that are at ground level and accessible to the public;	
• list the locations of plant rooms having air handlers, whether each plant room is kept locked and which have outside entrances;	

• determine whether the lobby, public access areas of the building, mailrooms or receiving areas share an air-handling unit with office areas;	
• establish the air circulation patterns and zones within the building;	
• how does the HVAC system respond to manual fire alarm, fire detection, or fire-suppression device activation?	
• are all supply and return ducts completely connected to their grilles?	
• are the variable air volume (VAV) boxes functioning?	
• how is the HVAC system controlled? How quickly does it respond?	
• how is the building zoned? Where are the air handlers for each zone? Is the system designed for smoke control?	
• how does air flow through the building? What are the pressure relationships between zones? Which building entryways are positively or negatively pressurised? Is the building connected to other buildings by tunnels or passageways?	
• are utility chases and penetrations, lift shafts, and fire stairs significant airflow pathways?	
• is there obvious air infiltration? Is it localised?	
• does the system provide adequate ventilation given the building's current occupancy and functions?	
• where are the outdoor air louvres? Are they easily seen? Are they or other mechanical equipment accessible to the public?	
• determine if the building has smoke purge fans and whether the intakes of the smoke purge fans are at ground level or elevated;	
• record the locations and identification of switches for the smoke purge fans;	
• determine if the building has automatic dampers in working condition on outside-air fans and air handlers;	
• list all exhaust fans and the location and identification of the control for each; and	
• determine if stairwells are protected from smoke (external and isolated).	

4. CONSIDER IMPLEMENTATION OF BASIC REMEDIAL PRE-PLANNING MEASURES TO REDUCE VULNERABILITIES

DEFENDING THE SITE, ITS PERIMETER AND INDIVIDUAL BUILDINGS:	✓
• implement an integrated security system by improving physical security of perimeter and building envelope to improve protection against penetration by explosion, vehicles, people (measures such as protective ditches and ramparts, improved fencing, bollards, barriers, improved detection and surveillance, protection of glazing, doors and exterior ducts); and	
• review provision of CCTV, security lighting and intruder alarms.	
DEFENDING AGAINST INCIDENTS CAUSED BY PEOPLE ENTERING THE BUILDING:	✓
• review security screening procedures: implement procedures for checking bona fides of visitors. Carry out security checks into background of staff (especially security staff) and of organisations and their staff supplying services (such as catering, maintenance etc);	
• consider setting up a preliminary security screen for visitors and perhaps staff outside the building;	
• improve physical protection and isolation of foyer/reception areas. Consider placing reception at first floor level;	
• implement bag search procedures (with X-ray and metal detection) for visitors. Implement detailed checks on contractors, maintenance workers and other external site services in terms of personnel and equipment coming onto the site or into the building;	
• develop procedures, to confirm nature and take action, for situations where suspect objects are found;	
• install procedures and equipment to prevent release and spread of contamination from post or goods. Consider having mail screened offsite or in a dedicated building on-site;	
• implement physical and personnel zoning of building;	
• pre-plan to limit accidental or deliberate spread of contamination throughout building by staff or visitors;	

• train emergency response team and staff with respect to CBRN incidents, ensure that appropriate communication systems and emergency protocols are in place;	
• review security of food and water supplies and catering;	
• pre-plan for working with the emergency services during an incident; and	
• consider strategies for limitation of business interruption.	

5. CONSIDER IMPROVEMENTS TO HVAC SYSTEM AND EMERGENCY ACTION PROCEDURES

IMPROVEMENTS TO HVAC SYSTEM AND EMERGENCY ACTION PROCEDURES	✓
• ensure that the building logbook is in place and kept up-to-date with specific aspects of building systems, such as differential pressures between different building zones;	
• train staff in any emergency procedures considered appropriate. For known outside releases this may include closing windows and doors and shutting off individual room air conditioning units, personal computers and generally minimising air circulation. For known inside releases the opposite strategy may be adopted;	
• consider additional protection of air intakes and extracts or re-siting to prevent unauthorised access;	
• review access controls on plant rooms and other important areas;	
• consider improved filtering and sterilisation systems of HVAC inlets and recirculation points;	
• consider re-siting HVAC inlets or physical protection (such as 3m high towers over ground level inlets);	
• consider re-arrangement of HVAC zones and provision of protected (hardened) areas with dedicated filtered air supplies; and	
• consider implementation of evacuation, sheltering or purging options and how these might be implemented using the existing HVAC system, during an incident.	

6. CONSIDER MAJOR REMEDIAL AND PROTECTION MEASURES

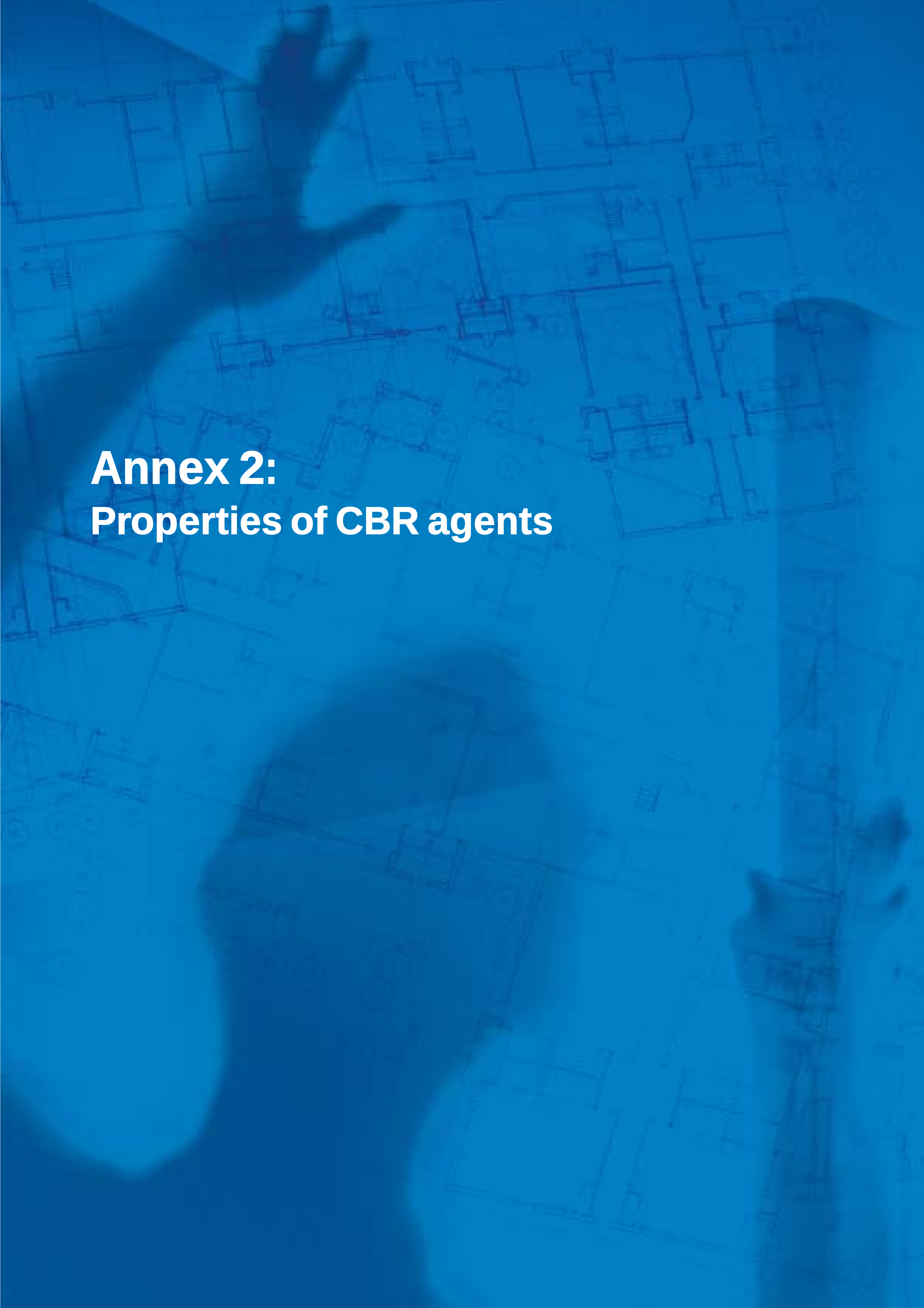
MAJOR REMEDIAL AND PROTECTION MEASURES	✓
• relocation to a better protected site, dispersal of activities over several sites;	
• installation of protected refuges hardened against major CBRN incidents;	
• installation of advanced air filtration systems with different air inlets used according to the wind conditions;	
• render surfaces in post room resistant to contamination (or easy to decontaminate); and	
• pre-plan for sources of advice and decontamination services if an incident occurs.	

7. STAFF TRAINING AND EMERGENCY PLANNING

STAFF TRAINING AND EMERGENCY PLANNING	✓
• train staff in procedures required to maintain normal security and operation of protective building systems;	
• establish contact with emergency services and liaison procedures to be adopted in the event of an incident;	
• train staff in how to recognise that a CBRN event has occurred;	
• train staff in active procedures needed in the event of different CBRN scenarios (exterior or interior releases) with respect to security actions, occupant management and any emergency procedures needed with respect to air circulation systems; and	
• develop staff training programme requirements with respect to content, duration, frequency and audit process.	

8. PRE-PLANNING FOR DECONTAMINATION

PRE-PLANNING FOR DECONTAMINATION	✓
• obtain expert advice on vulnerabilities to contamination and remedial measures for building, building systems and contents;	
• pre-arrange for sources of advice and decontamination services in case an incident occurs. Identify preferred decontamination contractors and review possible requirements. Provide plans and inventories of the building to the contractors;	
• pre-arrange contractors to sample and identify contaminants, advise on decontamination requirements and provide services to assist in establishing whether decontamination is achievable or has been achieved to a satisfactory health and safety standard;	
• render surfaces in post rooms and other vulnerable areas resistant to contamination (or easy to decontaminate);	
• protect important items, identify items for disposal and for decontamination in case of an incident; and	
• plan for continuity of utilities during and after an incident.	



Annex 2:
Properties of CBR agents

ANNEX 2: PROPERTIES OF CBR AGENTS

CHEMICAL AGENTS

For inhaled substances, dosage is expressed as the product of concentration and exposure time, which is often expressed in terms of the dosage required to cause a defined toxic response, such as incapacitation or death.

For some chemicals the dosage required to produce a given toxic response is approximately constant, so that a short exposure to a high concentration has a similar effect as a longer exposure to a lower concentration. For some substances, their toxic effects are more closely related to the concentration to which a subject is exposed[44, 45].

In general, toxic gases or highly volatile liquids are more easily dispersed in the vapour phase. They are also likely to clear rapidly from a building and therefore present minimal decontamination problems beyond ventilating the building for a limited period. However, depending on the agent, environmental hazards may result from venting, which may need to be considered. The time taken to vent a building would be dependent on a number of factors, including the nature of the chemical itself and also the temperature and airflow. Absorption of the chemical into different surfaces would also affect the venting time. There is a lack of knowledge in this area and the fate of different chemicals in different materials is largely unknown, so it is not certain that venting alone would be sufficient to decontaminate all volatile liquids. Decontamination would need to be confirmed by relevant investigations.

Less volatile toxic liquids or solids are likely to cause persistent contamination of a building that will require active decontamination. They are likely to cause longer term health hazards to building occupants following prolonged exposure if the building is inadequately decontaminated. The general problem is that building occupants are likely to be exposed to low concentrations of the agent released into the air in the building or to low level dermal absorption or ingestion through contact with contaminated materials.

The category of lower vapour pressure (i.e. slowly evaporating) liquids and solids includes a wide range of toxic chemical compounds. Some of these are highly toxic and can be acutely dangerous if small amounts are inhaled, ingested or absorbed through the skin. Building occupants might be alerted by an odour or may not notice anything unusual. For non-odorous substances the contamination may remain unnoticed for some time. Contamination could present a serious acute health problem to building occupants, but is more likely to present a long-term health hazard. Consequently, a building may be rendered unusable after a CBRN incident without active decontamination, assuming this is possible.

The main categories of toxic gases and vapours in terms of their effects on people are:

- asphyxiants and narcotics/anaesthetics – substances causing collapse and loss of consciousness when a sufficient dose is inhaled (e.g. carbon monoxide, hydrogen cyanide, diethyl ether). Subjects are often unaware of exposure until incapacitation occurs;
- substances that produce strong and unpleasant odours at low concentrations, resulting in discomfort and distress (e.g. mercaptans). The severity of the effects depends on the concentration;
- sensory and pulmonary irritants – substances causing painful irritation of the eyes, nose, throat and lungs, with breathing difficulties (e.g. CS riot control agent, hydrogen chloride, chlorine, phosgene, formaldehyde, and blistering agents). Severity depends on exposure concentration ranging from mild eye irritation at low concentrations to collapse at high concentrations. Many of these substances cause lung damage (which can be fatal) if a sufficient dose is inhaled;
- organophosphorus warfare agents. These affect the nervous system, causing tightness of the chest and dimming of vision at low doses followed by cramps, giddiness and collapse at high doses. The effects depend on the dosage inhaled (or by skin absorption or ingestion). For more volatile compounds (e.g. sarin) inhalation exposure is a major hazard;
- blistering agents. These attack the eyes, skin and respiratory tract. They can cause temporary blindness and painful blistering of the skin. Many of these substances can also cause lung damage, which can be fatal if a sufficient dose is inhaled; and
- plant, animal and mycotoxins. These are toxins derived from animals, plants or fungi. They are not infectious agents and constitute a chemical hazard. Some toxins (e.g. ricin, tetrodotoxin, nicotine and aflatoxin) are very potent poisons that can cause serious injury or death from skin contact, inhalation or ingestion.

The main categories of toxic dusts and low volatility liquids are:

- toxic dusts causing health hazards by inhalation or ingestion;
- toxic deposits on building surfaces;
- substances releasing unpleasant odours (or mild sensory irritation) over a long period (e.g. many organic low vapour pressure liquids). Some of these, such as mercaptans and irritants such as formaldehyde, have long term health implications; and
- substances releasing low concentrations of toxic vapours (e.g. many organic low vapour pressure liquids and some solids).

CHEMICAL AGENTS DAMAGING BUILDINGS AND BUILDING SYSTEMS

In addition to presenting health hazards to building occupants some agents can also damage the building and its systems. Acid gases such as hydrogen chloride can attack metals in buildings damaging structural components and equipment. Carbon fibre dust can disable a building by shorting out electrical supplies and electrical or electronic apparatus. Although the health hazard may be relatively minor, the effect on building systems can be serious.

BIOLOGICAL AGENTS

A range of toxins or infectious biological agents could be used in an incident. These include waterborne diseases such as typhoid (*Salmonella typhi*) and cholera (*Vibrio cholerae*), as well as more traditional biological warfare agents.

Biological agents are classified as:

- bacteria that causes disease, such as anthrax and plague;
- viruses such as smallpox and viral haemorragic fevers, e.g. Ebola;
- fungi such as that causing Valley fever and Histoplasmosis; and
- biological toxins such as botulinum.

The threat of attack by these agents is considered serious because:

- they cause disease in man or animals;
- the diseases have a high mortality rate;
- in some cases, infections may spread from person to person; and
- the reputation of these diseases is such that they can induce public anxiety and disrupt everyday life in the population.

Bacteria and viruses are spread by a variety of mechanisms including direct contact with an infected person via air, water or food; by contact with contaminated surfaces; or by means of vectors such as biting insects. Transmission between people is mainly by the inhalation of particles containing bacteria or virus or by contact with body fluids from an infected individual.

Bacteria need nutrients and appropriate conditions to grow and multiply. Live bacteria can contaminate any building but their survival within the building will depend on the presence of a suitable environment, such as *Legionella* in water supplies. Some bacteria have evolved mechanisms to help them survive in hostile conditions. For example, *Bacillus anthracis*, which causes anthrax, forms spores that are resistant to desiccation, heat, and, to some degree, chemicals.

Spores are small, easily dispersed and persistent, and if they contaminate a building produce a continued source of infection. If a person inhales or ingests enough spores they can develop the disease. The greatest risk to human health following a release of spores occurs whilst they are airborne. However, once deposited they are easily re-suspended by, for example, movement of people around a building. The spores will remain a hazard as long as they remain viable, which varies from species to species.

Most viruses are vulnerable outside living host tissue. They are spread by mechanisms similar to those described above for live bacteria. However, some viruses can survive outside the body for some time and therefore could contaminate a building.

Microbiological contamination can be removed or destroyed by a variety of methods including:

- filtration of air supplies using high efficiency (HEPA) filters;
- fumigation using reactive chemicals;
- disinfection of surfaces or water supplies; and
- sterilisation using heat, ultraviolet light or gamma radiation.

However, the effectiveness of microbiological decontamination methods may not have been tested against a wide range of biological agents and the processes themselves could be somewhat destructive (i.e. involve damage to or removal of building surfaces).

RADIOLOGICAL AGENTS

The harmful effects of radiological agents (i.e. radionuclides) result from exposure to the radiation they emit when they undergo radioactive decay. They give rise to two types of hazard: from external exposure to radiation; and internal exposure through absorption of radioactive material into the body. Exposure to radiation can produce both short- and long-term damage to health.

The short-term health effects of radiation are directly related to the dosage received. There is a threshold below which no effects are observed. Above the threshold the severity of effects increases in proportion to the dosage received. In contrast the severity of long-term health effects are independent of the dosage received. Instead, the probability of developing a particular condition is related to the dosage received. In addition, there is no safe level of exposure. If a particular condition, such as a cancer, develops the patient will develop the full blown disease.

The form of the radiation is important in determining the hazard. There are four main types of radiation: alpha, beta, gamma and neutrons. Each has a differing ability to penetrate matter.

- Alpha particles are helium nuclei and can generally be absorbed by a sheet of paper or by several centimetres of air. They can scarcely penetrate the dead, outer layer of human skin and are, therefore, not hazardous unless they are taken into the body through inhalation, ingestion or a skin wound;

- Beta particles are electrons and are more penetrating than alpha particles. They can penetrate the outer layers of skin and may penetrate a centimetre or so of tissue, depending on their energy. Radionuclides that emit beta particles are therefore hazardous to superficial tissues of the body (skin and eyes) but not to internal organs unless they are taken into the body (e.g. through inhalation or ingestion). In general, beta particles can be absorbed by up to a few metres of air, depending on their energy, or by a thin layer of plastic or glass. However they can emit secondary (gamma) radiation when absorbed;
- Neutrons are emitted during nuclear fission. They are deeply penetrating, but can be blocked by several centimetres of concrete or water; and
- Gamma rays are highly energetic and can pass through the body – so radionuclides that emit them may be hazardous whether inside or outside the body. Gamma rays can penetrate most materials and require a substantial thickness of earth, lead, concrete or water to provide an effective barrier.

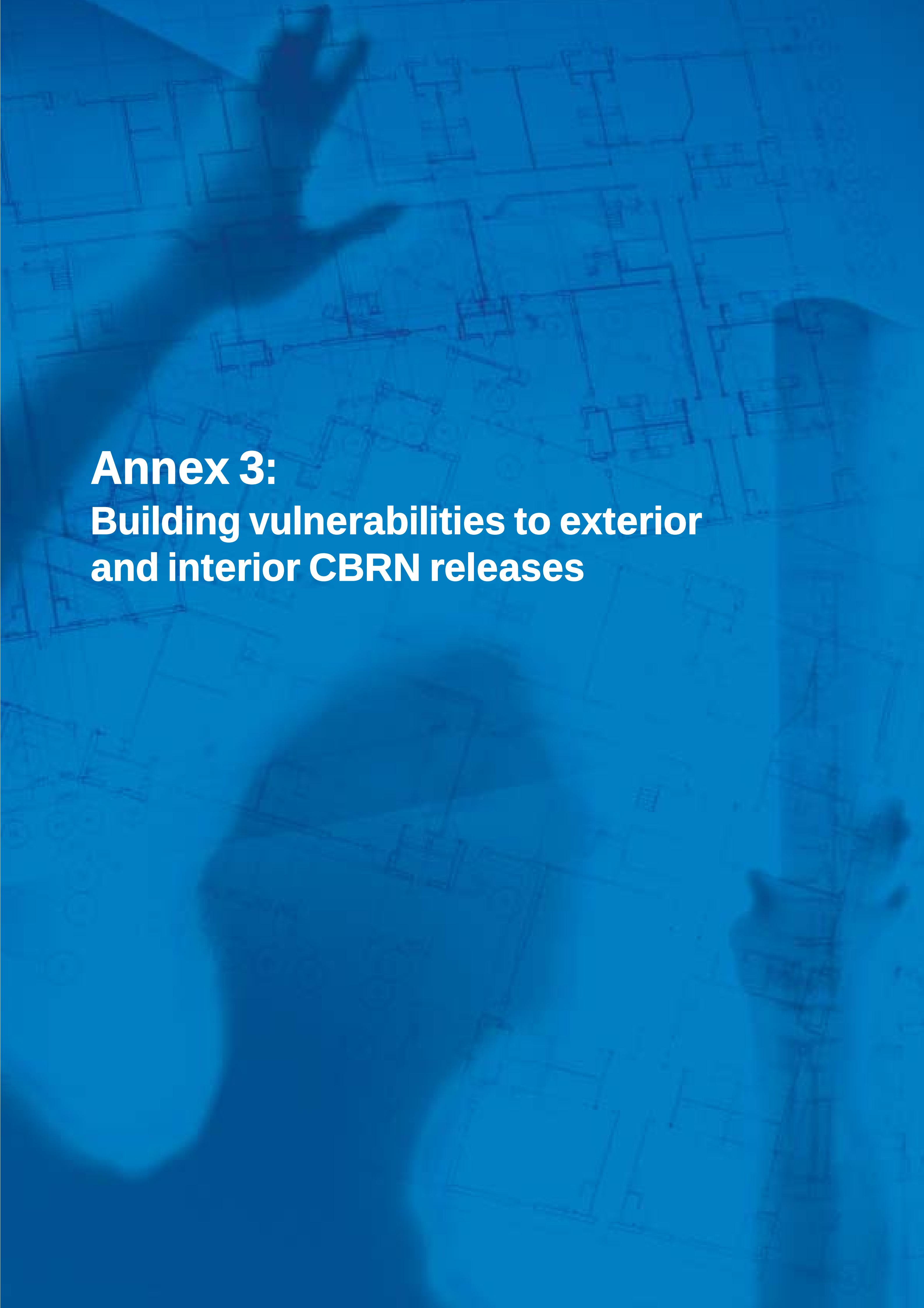
The exposure of the body to radiation from a point source reduces approximately with the square of the distance from the source. For example, the dose rate at 2m from a contaminated small object will be four times lower than it is at 1m from the object

HALF LIFE

Levels of radioactivity decrease with time, so that the extent of contamination by any radioactive material decreases. The half life is the time required for the level of radioactivity to decrease by half. This may vary from many thousands of years to a few seconds depending on which radionuclide is present.

The half-life is important in terms of building contamination because if a contaminating radionuclide has a very short half life the level of radioactivity, although intense at first, may return to general background levels within a few days. In such cases the building may need to be closed for a period, but could be occupied without the need for decontamination once the level of radioactivity declines to a tolerable risk level. However, for longer-lived isotopes, such as caesium-137, it may take many years for activity to decline to safe levels and decontamination will need to be considered.

Where contamination is attached to the building fabric or systems in a form that remains in place, the hazard to building occupants depends on their proximity to the radiation source and the extent of shielding by building materials. In such cases it may be possible to occupy the building provided it can be operated without access to contaminated areas. However, if the contamination is in a form that could disperse and contaminate a large area or be ingested or inhaled by the building occupants (such as a radioactive dust), then the hazard to occupants could be more significant.



Annex 3:

Building vulnerabilities to exterior and interior CBRN releases

ANNEX 3: BUILDING VULNERABILITIES TO EXTERIOR AND INTERIOR CBRN RELEASES

The perceived hazard and extent of disruption from an incident may not be directly related to the actual hazards. There have been many incidents (both accidental and deliberate) in which very minor contamination giving rise to noxious odours has caused major concern and disruption. In some cases these have resulted from transient releases of small amounts of fumes outside or within buildings. In other cases persistent low levels of contamination have resulted in ‘sick’ buildings. This has occurred on a number of occasions following inadequate decontamination after fires. Low volatility organic contaminants can off-gas over many years, producing odours and health hazards.

In a general security context organisations should consider information that, if publicly available, might render them more vulnerable. For example, drawings and plans of buildings that indicate details of the location and function of HVAC and other critical services systems.

EXTERIOR RELEASES

Exterior releases of chemical, biological or radiological agents are likely to be dispersed over a wide area. The direction of spread and the degree of dilution depends on the size and nature of the source, the wind and air pressure conditions and the landscape – for example, whether the building at risk stands alone on a flat plane, is in a steeply sided valley, or is one of many buildings of various sizes in a city landscape. The main hazard to buildings is from airborne contaminants. If the source is a solid (such as asbestos dust or *Bacillus anthracis* spores) or low volatility liquid, then dispersal will be slow and inefficient unless a rapid dispersal mechanism such as a bomb or fire is used (although these are likely to have a destructive effect on some chemical and most biological agents).

If winds are strong, an agent is likely to be widely dispersed, but heavily diluted at any particular location. When gases or aerosols are released at ground level, they tend to remain near ground level under stable conditions, which normally occur at night, dusk and dawn on overcast days[46]. On sunny days, when the ground is hotter than the air above, plumes tend to spread upwards and are diluted and dispersed as they rise. Plumes are diverted upwards as they pass buildings, on the front face and also on the downwind side. In general a plume will take the shortest path around a building. If the width of the building is more than twice the height, the shortest path is over the building. Fires cause buoyant rising plumes.

The hazards in the area surrounding a building will depend on the nature of the agent, the amount released and the extent of the dispersal. The hazards inside a building will depend on the extent to which the agent penetrates the building. In some situations, although a building is itself unaffected, it may be surrounded by outside contamination so that access is affected.

BUILDING VULNERABILITY TO EXTERIOR RELEASES OF C, B AND R AGENTS

In general, the further the target building is from the point of release the more dilute the plume of the agent and the less the hazard of significant contamination of the building interior. Where buildings are on a protected site, the fact that a release is likely to occur outside the site perimeter and therefore some tens or hundreds of metres from the target building decreases potential hazards. For city buildings opening onto the street, the hazard depends on how the local conditions affect dispersal and the ease of penetration of contaminated air into the building. In cities, the high density of building and interactions with wind tend to cause rapid upwards dispersion and mixing of ground level releases. The advantage of this is that contamination entering a building at any point is likely to be considerably diluted compared to the concentrations near the source. The disadvantage is that the contamination is spread over a wide area, and high level air inlets are not immune from contamination. For a modern ‘sealed’ or ‘tight’ building the rates of air exchange between outside and inside are generally low, as should be the rate of penetration of outside contaminants. For an older or more ‘leaky’ building they are higher. The ‘leakiness’ of a building can be established by a building pressurisation test (and from calculations of HVAC circulation rates). For the majority of large buildings (whether passively or actively ventilated), the rate of air exchange time is around one to two hours under normal use conditions. This can be reduced if windows are closed and air conditioning systems shut down. Chemical releases may be detected by odour but radiological or biological releases are not readily detectable at the time of release, unless the act of release is observed or reported.

In general, for exterior releases of all kinds, building occupants may be less likely to receive a significant exposure if they remain inside until the agent has dispersed (providing the building is closed and any air inlets are remote from the source). It is also likely that in many situations an exterior airborne release may not result in very extensive or serious indoor contamination of an enclosed building, especially if air exchange between the outside and inside is minimised for a period after the incident (i.e. doors and windows shut and air circulation shut down – unless it is filtered to remove fine dust and chemical vapours). When such an incident occurs it is therefore very important to establish as quickly as possible whether a chemical has been released outside or inside the building. If a large breach in the building envelope is created by an explosion or other means then externally released chemicals or other agents could cause significant interior contamination.

Air-conditioned buildings may be vulnerable to significant contamination of indoor air if the agent is released close to HVAC intakes. HVAC filters will remove only a proportion of dusts and microbiological agents, providing they are well fitted and in good condition. Removal of toxic gases requires the use of appropriate carbon filters.

Various measures can be taken to improve filtration (HEPA filters, electrostatic dust precipitation), removal of chemical agents (treated activated charcoal filters) and additional neutralisation of microbiological agents though sterilisation (UV or ionising radiation).

Leakage through the building fabric also provides routes for the uncontrolled ingress of contaminants. In normal operation, the building should be pressurised by the HVAC system so that any air leakage flows outwards. However, in situations where HVAC system shutdown is recommended, the pressurisation will be lost and the natural pressure distributions within and around the building will expose the fabric to the ingress of contaminants through the air leakage paths.

Passively ventilated buildings are more vulnerable if windows are open. In passively ventilated buildings, serious long-term contamination of a building following an external release is less likely to occur if doors and windows are closed. Once the external contaminant has dispersed and the building has been thoroughly ventilated for a sufficient time significant amounts of contamination may not remain in the building.

In addition to airborne dispersal, contaminants may be dispersed by vehicles (especially on tyres) or on clothing (especially footwear).

INTERIOR RELEASES

Release of a contaminating agent inside a building constitutes a serious hazard because the first line of defence (the building envelope) has been breached and because the agent is dispersed into a restricted area, and likely to be close to building occupants.

Vulnerability to interior releases, especially smaller-scale, is essentially a security issue. The most vulnerable buildings are those subject to uncontrolled entry by large numbers of the public, such as railway stations, airports and shopping malls. Such buildings usually have a combination of areas with uncontrolled and controlled access. Controlled access areas provide varying degrees of opportunity to screen occupants. One aspect of vulnerability is the extent to which visitor access to different parts of the operation can be restricted. Another aspect is the extent to which the organisation is able or willing to apply security screening of visitors and staff.

The degree of compartmentalisation of the building and its air circulation systems affects vulnerability in terms of the extent of spread of an agent from the point of release.

Fires

Fires constitute the most common form of chemical incident in buildings. For this reason buildings are designed to withstand fires in order to protect occupants. Building envelopes are designed to prevent external fire spread. There are also requirements for the fire resistant construction of buildings, so that larger buildings are constructed as a set of fire-resisting compartments. The basic concept is that a fire in any one compartment should not be able to spread to adjoining compartments within a reasonable time (see Approved Document B [England and Wales] and [Part D (Scotland])[32]. This does not necessarily mean that the toxic fire effluent (smoke) cannot spread beyond the compartment boundaries, although measures in place should limit the rate of contamination in compartments such as protected corridors and stairs. Within any one enclosure the escape route provision should be sufficient for the maximum anticipated population to evacuate into a protected escape route within approximately two and a half minutes[47].

The building regulations also contain requirements for means of providing warnings and means of escape during fires, which can also be used for interior CBRN incidents or where fires are used in conjunction with C, B and R agents.

HVAC systems are designed either to shut down or to go into exhaust mode in case of fire, depending on the system. This usually operates via the electronic fire detection system, but sometimes local heat-operated 'fusible link' systems are used to isolate affected areas.

Some systems are designed to pressurise stairs in case of fire. This is to maintain a smoke-free escape route for occupants. Some systems (particularly in London) have a rapid exhaust mode for floors (rooms and corridors) which increases the extract rate of the normal ventilation. In some buildings there is a manually switched purge system based on the normal HVAC system, which is intended to purge a building of smoke after a fire. Atrium buildings and shopping malls have either passive (buoyancy-driven) or active (fan-driven) extract in case of fire. It is possible that some of these systems might be useful either during or after a C, B and R release in specific buildings depending on the system in place. Careful consideration should be given to situations where the fire safety systems are helpful or counterproductive in different interior C, B and R scenarios. Consideration may also be given to potential environmental hazards arising from venting the fire effluent.

Annex 4:
British Standards applicable to security measures

ANNEX 4: BRITISH STANDARDS APPLICABLE TO SECURITY MEASURES

Fencing standards:

BS 1722-1:1999 *Fences. Specification for chain link fences*.

BS 1722-2:2000 *Fences. Specification for strained wire and wire mesh netting fences.*

BS 1722-8:1997 *Fences. Specification for mild steel (low carbon steel) continuous bar fences and hurdles.*

BS 1722-9:2000 *Fences. Specification for mild steel (low carbon steel) fences with round or square verticals and flat horizontals.*

BS 1722-10:1999 *Fences. Specification for anti-intruder fences in chain link and welded mesh.*

BS1722-12:1999 *Fences. Specification for steel palisade fences.*

BS 1722-14:2001 *Fences. Specification for open mesh steel panel fences.*

Security lighting standards and other aspects of security:

BS 8220-2:1995 *Guide for security of buildings against crime. Offices and shops.*

BS 8220-3:1990 *Guide for security of buildings against crime. Warehouses and distribution units.*

CCTV standards:

BS EN 50132-2-1:1998 *Alarm systems. CCTV surveillance systems for use in security applications. Black and white cameras.*

BS EN 50132-4-1:2001 *Alarm systems. CCTV surveillance systems for use in security applications. Black and white monitors.*

BS EN 50132-5:2001 *Alarm systems. CCTV surveillance systems for use in security applications. Video transmission.*

BS EN 50132-7:1996 *Alarm systems. CCTV surveillance systems for use in security applications. Application guidelines.*

BS 7958:1999 *Closed-circuit television (CCTV). Management and operation. Code of practice.*

BS 8418: 2003 *Installation and remote monitoring of detector activated CCTV systems. Code of practice.*

Intruder alarm standards:

BS 4737-4.2:1986 *Intruder alarm systems in buildings. Codes of practice. Code of practice for maintenance and records.*

BS 7042:1988 *Specification for high security intruder alarm systems in buildings.*

DD 243:2002 *Installation and configuration of intruder alarm systems designed to generate confirmed alarm conditions. Code of practice.*

DD 244:1998 *Code of practice for wire-free interconnections within intruder.*

EN standards on intruder alarm systems come into force from March 2004.

Annex 5:
List of useful contacts

ANNEX 5: LIST OF USEFUL CONTACTS

For advice on buildings, contact:

Glass and Glazing Federation
44–48 Borough High Street
London SE1 1XB
Tel: 0870 042 4255
www.ggf.org.uk

Institution of Civil Engineers
Library and Information Services
1–7 Great George Street
London SW1P 3AA
Tel: 020 7222 7722
www.ice.org.uk

Institution of Structural Engineers
11 Upper Belgrave Street
London SW1X 8BH
Tel: 020 7235 4535
www.istructe.org.uk

Laminated Glass Information Centre
299 Oxford Street
London W1C 2DZ
Tel: 020 7499 1720
www.aecportico.co.uk/Directory/LGIC.shtm

These organisations produce guidance notes relating to their fields of interest:

British Council for Offices (BCO)
38 Lombard Street
London EC3V 9BS
Tel: 020 7283 4588
www.bco.org.uk

British Council of Shopping Centres (BCSC)
1 Queen Anne's Gate
Westminster
London SW1H 9BT
Tel: 020 7222 1122
www.bcsc.org.uk/index.asp

National Terrorist Crime Prevention Unit
PO Box 849
London SW1P 1XD
Tel: 020 7931 7142

These organisations can provide information on a wide range of relevant issues

Emergency Planning Society
The Emergency Planning Society
The Media Centre
Culverhouse Cross
Cardiff CF5 6XJ
Tel: 0845 600 9587
www.emergplansoc.org.uk

Royal Institute of Chartered Surveyors
RICS
12 Great George Street
Parliament Square
London SW1P 3AD
United Kingdom
Tel: 0870 333 1600
www.rics.org

Federation of Environmental Trade Associations
The Federation of Environmental Trade Associations
Henley Road
Medmenham
Marlow
Buckinghamshire SL7 2EZ
Tel: 01491 578674
www.feta.co.uk

English Heritage
English Heritage
Customer Services Department
PO Box 569
Swindon SN2 2YP
England
Tel: 0870 333 1181
www.english-heritage.org.uk/default.asp

Association of British Insurers
51 Gresham Street
London EC2V 7HQ
Tel: 020 7600 3333
www.abi.org.uk

Association of Insurance and Risk Managers
AIRMIC Secretariat
6 Lloyd's Avenue
London EC3N 3AX
Tel: 020 7480 7610
www.airmic.com

National Forum for Risk Management in the Public Sector (ALARM)
Oakridge House
Wellington Road
High Wycombe
Bucks HP12 3PR
01494 522556
www.alarm-uk.com

Business Continuity Institute
PO Box 4474
Worcester WR6 5YA
United Kingdom
Tel: 0870 603 8783
www.thebci.org

Chartered Institution of Building Services Engineers
The Chartered Institution of Building Services Engineers
222 Balham High Road
Balham
London SW12 9BS
Tel: 020 8675 5211
www.cibse.org

Chartered Institute of Loss Adjusters
Peninsular House
36 Monument Street
London EC3R 8LJ
Tel: 020 7337 9960
www.cila.co.uk

Health & Safety Executive
HSE Infoline
Caerphilly Business Park
Caerphilly CF83 3GG
Tel: 0870 154 5500
www.hse.gov.uk

Police Scientific Development Branch
Woodcock Hill,
Sandridge,
St. Albans,
Hertfordshire AL4 9HQ
Tel. 01727 865051
www.homeoffice.gov.uk

Royal Institute of British Architects
Royal Institute of British Architects
66 Portland Place
London W1B 1AD
Tel: 020 7580 5533
www.riba.org/go/riba/Home.html

Statutory and Regulatory Authorities

English Heritage Government Historic Buildings Advisory Unit
23 Saville Row,
London W1S 2ET
Tel: 020 7973 3000
www.english-heritage.org.uk

For scheduled ancient monuments in England & Wales:

Department for Culture Media and Sport
2–4 Cockspur Street,
London, SW1Y 5DH
Tel: 020 7211 6200
www.culture.gov.uk

For historic monuments in Wales:

Welsh Historic Monuments
CADW
Welsh Assembly Government
Cathays Park
Cardiff, CF10 3NQ
029 2050 0200
www.cadw.wales.gov.uk

Useful Government websites

Health Protection Agency;
www.hpa.org.uk

Civil Contingencies Secretariat, Cabinet Office;
www.ukresilience.info

Home Office;
www.homeoffice.gov.uk

Security Services;
www.mi5.gov.uk

National Steering Committee on Warning and Informing the Public;
www.nscwip.info

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[15] Performance Testing of CCTV Perimeter Surveillance Systems. J. Aldridge and C. Gilbert. Police Scientific Development Branch Publication No. 14/95 (1996).

[16] Human Rights Act 1998. The Stationery Office ISBN 0 10 544298 4

[17] Private Security Industry Act 2001. The Stationery Office ISBN 0 10 5412015

[18] *Biological/Chemical Threats by Post.* UK Resilience. http://www.ukresilience.info/terrorism.htm.

[19] Advice and documents relevant to C, B, R and N issues are available on the Health Protection Agency Web site: http://www.hpa.org A specific document on mail handling (*General Handling of Mail and Identification of Suspect Mail*) is available at http://www.hpa.org.uk/infections/topics_az/deliberate_release/menu.htm.

[20] *CDC Interim* Recommendations for Protecting Workers from Exposure to Bacillus anthracis in Work Sites where Mail is Handled or Processed* (*updated from CDC health advisory 45 issued 10/24/01) http://www.cdc.gov/niosh/unp-mailrecs1.html

[21] *The Building Regulations Approved Document F (1995) amended 2000.*

[22] *Guidance for Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks of May, 2002* (available at http://www.cdc.gov/niosh/bldvent/2002-139.html)

[23] *Guidance for Filtration and Air-Cleaning Systems to Protect Building Environments from Airborne Chemical, Biological, or Radiological Attacks* April, 2003. http://www.cdc.gov/niosh/docs/2003-136/2003-136.html

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[25] *Advice for Safeguarding Buildings Against Chemical or Biological Attack for emergency personnel and building operators* http://securebuildings.lbl.gov/secure.html

[26] *Protecting Buildings From a Biological or Chemical Attack: Actions to Take Before or During a Release* LBNL/PUB-51959, January 10, 2003 http://www-library.lbl.gov/docs/LBNL/

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[41] *Advice to business on chemical or biological attack.* Thames Valley Police http://www.thamesvalley.police.uk/crime-reduction/ad_bus.htm

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This publication provides guidance on pre-planning measures to minimise the effects of a Chemical, Biological, Radiological or Nuclear (CBRN) incident. It complements the Strategic National Guidance on decontamination of buildings and infrastructure exposed to CBRN material.

Guidance is provided on:

- CBRN hazards
- Risk and vulnerability assessment
- Primary prevention: pre-planning measures to prevent contamination
- Secondary prevention: pre-planning measures to limit the extent of any contamination that does occur
- Tertiary prevention: pre-planning measures in relation to decontamination.

Risks and vulnerabilities of buildings and infrastructure and mechanisms of penetration are described. Guidance is provided on methods for prevention and limitation of spread of contamination in terms of physical and operational security. The protection of air inlets to heating and ventilation air circulation systems and the use of systems to limit internal spread of contamination are described. References are made to sources of further information.

It will be of particular interest to building owners; managers; tenants; insurers; local authorities; decontamination contractors; business continuity practitioners and emergency planners.

ISBN 1-851126-93-7
9 781851 126934 >

ISBN 1 85112 693 7

Price £15.00