PD 7974-8:2012

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Application of fire safety engineering principles to the design of buildings

Part 8: Property protection, business and mission continuity, and resilience

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Foreword

Publishing information

This part of PD 7974 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 August 2012. It was prepared by Technical Committee FSH/24, *Fire safety engineering*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

PD 7974-8 is a new part of the PD 7974 series. The series comprises:

- Part 0: *Guide to design framework and fire safety engineering procedures*;
- Part 1: *Initiation and development of fire within the enclosure of origin (Sub-system 1)*;
- Part 2: *Spread of smoke and toxic gases within and beyond the enclosure of origin (Sub-system 2)*;
- Part 3: *Structural response and fire spread beyond the enclosure of origin (Sub-system 3)*;
- Part 4: *Detection of fire and activation of fire protection systems (Sub-system 4)*;
- Part 5: *Fire service intervention (Sub-system 5)*;
- Part 6: *Human factors – Life safety strategies – Occupant evacuation, behaviour and condition (Sub-system 6)*;
- Part 7: *Probabilistic risk assessment*;
- Part 8: *Property protection, business and mission continuity, and resilience*.

These Published Documents are intended to be used in support of BS 7974.

Information about this document

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Use of this document

As a guide, this part of PD 7974 takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice.

It has been assumed in the preparation of this part of PD 7974 that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The guidance in this part of PD 7974 is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document cannot confer immunity from legal obligations.

0 Introduction

0.1 General

This part of PD 7974 provides guidance on fire safety engineering techniques to support property, business and mission protection objectives.

Frequently, the contents of a building and the work conducted within it are of considerably greater value than the building itself, either intrinsically because of their monetary or historic or cultural value, or indirectly because of the effects of their loss on business or mission continuity, as can be the case for example in computing suites, archives, many industrial plants and also in educational establishments.

National building codes, such as the Building Regulations 2010 [2] in England and Wales [1)], are intended to ensure that a reasonable standard of life safety is provided, in case of fire. The protection of property, including the building itself, often requires additional measures and insurers will, in general, seek their own higher standards before accepting the insurance risk.

For many large complex projects where fire safety engineering is used, the organizations that will own, operate and insure the building or facility are known at the design stage. Schools and hospitals, for example, usually fall into this category. When the owner, operator and/or insurer of a building is known at the design stage, it is possible for fire safety engineering to add further value to the design process by explicitly considering property protection and business continuity as well as life safety. The guidance for considering property protection and business continuity from fire, through business impact analysis (BIA), is presented in the document.

There are also a large number of projects that are developed speculatively where the operator, tenants and insurers are not known at the design stage. Many offices and retail premises are built this way. In the absence of these stakeholders, the fire engineer will not be able to explicitly address business continuity of property protection and they need to make this clear in their fire strategy.

Where the client is able to submit a business impact analysis (BIA), the protection of an organization's resources associated with the built environment that underpin the conduct of business-critical activities may be added to the fire safety objectives suite to inform the qualitative design review (QDR) process, as described in BS 7974 and PD 7974-0.

Where the client is unaware of the role that fire safety engineering can play in meeting their business resilience ambition, this part of PD 7974 will inform the client of areas where, subject to demand, additional design benefit can be delivered.

A BIA identifies a number of potential impacts that the loss of business functions can have. These business impacts may be rated in terms of their potential risk for prioritization purposes. For some potential mitigating measures, a more detailed quantitative assessment of risk and cost-benefit analysis can help evaluate the most cost-effective solution. PD 7974-7 includes data for probabilistic risk assessment and criteria for assessment. The data are based on fire statistics, building characteristics and reliability of fire protection systems. The criteria cover life safety and property protection, both in absolute and comparative terms.

1) Attention is drawn to building regulations in other parts of the UK ([3], [4]), which might not have the same functional requirements as those in England and Wales.

0.2 Common use of fire safety engineering

When developing fire safety engineering solutions for buildings, it has traditionally been common practice for the fire safety engineer to concentrate largely, or even solely, on life safety and evacuation objectives, because these are the elements often mandated by national building regulations. Although life safety is of utmost importance, a building design which focuses exclusively on life safety might not adequately protect property and business continuity resulting in a building, or plant, with diminished resilience to the effects of fire and inflexibility in future use.

0.3 Business resilience, interest, responsibility and drivers

The approach described within this part of PD 7974 is fundamental to ensuring a successful building design that fully meets the needs of the client organization. It is essential for managing the continued viability and success of the client organization.

For example, the role of the Managing Director or Chief Executive of a public company includes the requirement to be accountable for the overall performance of the company and for the day-to-day running and management of the company, under delegated authority from the Board. Their responsibilities include:

- implementing the Executive's policies and strategies;
- managing the day-to-day operations of the organization;
- managing resources efficiently and effectively to achieve the organization's objectives;
- ensuring that appropriate internal audit processes and procedures are in place;
- developing and implementing a risk management plan; and
- ensuring that there is a succession plan in place.

Indeed, it is stated in the Companies Act [5] that a director of a company has a duty to "act in the way he considers, in good faith, would be most likely to promote the success of the company for the benefit of its members as a whole, and in doing so have regard (amongst other matters) to:

a) the likely consequences of any decision in the long term;
b) the interests of the company's employees;
c) the need to foster the company's business relationships with suppliers, customers and others;
d) the impact of the company's operations on the community and the environment;
e) the desirability of the company maintaining a reputation for high standards of business conduct; and
f) the need to act fairly as between members of the company".

The analysis of business vulnerabilities and the appreciation of the benefits of good business continuity planning are at the heart of many of these responsibilities, and as such business continuity initiatives need to start at the top of an organization and promulgate downwards. A business that fails following a major event, such as fire, has demonstrated a fragility that results from poor management.

At the heart of business continuity planning is the identification of critical activities and the resources upon which they depend. Resources are often grouped into categories such as people, plant, premises and infrastructure, and where the built environment is a part of the provision of these resources, there is clearly a need to consider them during the building design phase.

It is essential that, when senior management within the end-user client's organization are known at the design stage of a project, that they are willing and available to provide information and undertake the BIA process.

0.4 Insurer involvement in fire safety engineering design process

Whilst life safety objectives are often mandated by national building regulations, commercial property insurers also champion property and business protection objectives and might have specialist advisers available to help their customers. When available, contact and consultation with the proposed building's or plant's insurers is vitally important and the fire safety engineer is encouraged to make efforts to involve the client's property insurer whenever practicable.

Often, the insurer of a building or plant during its design and build phase will not be the same organization that will finally insure the occupied premises.

It is crucial that the fire safety engineer has a complete a brief as possible from all stakeholders including the end-user client. This might need facilitation by the architect or "design and build" contractor.

1 Scope

This part of PD 7974 provides guidance on fire safety engineering techniques to support property, business and mission protection objectives, in order to address property loss, assist business/mission continuity and/or provide resilience against the effects of fire. It describes a business impact analysis (BIA) process which can be used by the building's or plant's design team in order to inform the qualitative design review (QDR) process, as described in BS 7974 and PD 7974-0. It provides input into the fire engineering objective setting part of the QDR.

NOTE The phrases "mission continuity" and "business continuity" are both used within this part of PD 7974, to indicate that this part of PD 7974 covers all organizations, not just businesses.

It is intended that this part of PD 7974 is applied to the design of new buildings and plant, where appropriate. It can also be applied to the appraisal of existing buildings and plant.

This part of PD 7974 covers all aspects of a building and its contents. It does not cover plant and buildings used for the bulk storage or processing of flammable liquids or explosive materials.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7974, *Application of fire safety engineering principles to the design of buildings – Code of practice*

BS 9999:2008, *Code of practice for fire safety in the design, management and use of buildings*

PD 7974-0, *Application of fire safety engineering principles to the design of buildings – Part 0: Guide to design framework and fire safety engineering procedures*

3 Terms and definitions

For the purposes of this part of PD 7974, the terms and definitions given in BS 7974 and the following apply.

3.1 activity
process or set of processes undertaken by an organization (or on its behalf) that produces or supports one or more products or services

NOTE Examples of such processes include accounts, call centre, IT, manufacture, distribution.

[SOURCE: BS 25999-1:2006, **2.1**]

3.2 business continuity
strategic and tactical capability of the organization to plan for and respond to incidents and business disruptions in order to continue business operations at an acceptable pre-defined level

[SOURCE: BS 25999-1:2006, **2.2**]

3.3 business continuity management (BCM)
holistic management process that identifies potential threats to an organization and the impacts to business operations that those threats, if realized, might cause, and which provides a framework for building organizational resilience with the capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value-creating activities

NOTE Business continuity management involves managing the recovery or continuation of business activities in the event of a business disruption, and management of the overall programme through training, exercises and reviews, to ensure the business continuity plan(s) stays current and up-to-date.

[SOURCE: BS 25999-1:2006, **2.3**]

3.4 business continuity management lifecycle
series of business continuity activities which collectively cover all aspects and phases of the business continuity management programme

NOTE The business continuity management lifecycle is illustrated in Figure A.1.

[SOURCE: BS 25999-1:2006, **2.4**]

3.5 business continuity management programme
ongoing management and governance process supported by top management and appropriately resourced to ensure that the necessary steps are taken to identify the impact of potential losses, maintain viable recovery strategies and plans, and ensure continuity of products and services through training, exercising, maintenance and review

[SOURCE: BS 25999-1:2006, **2.5**]

3.6 business continuity plan (BCP)
documented collection of procedures and information that is developed, compiled and maintained in readiness for use in an incident to enable an organization to continue to deliver its critical activities at an acceptable pre-defined level

[SOURCE: BS 25999-1:2006, **2.6**]

3.7 business impact analysis
process of analysing business functions and the effect that a business disruption might have upon them

[SOURCE: BS 25999-1:2006, **2.8**]

3.8 consequence
outcome of an incident that will have an impact on an organization's objectives

NOTE 1 There can be a range of consequences from one incident.

NOTE 2 A consequence can be certain or uncertain and can have positive or negative impact on objectives.

[SOURCE: BS 25999-1:2006, **2.10**]

3.9 cost-benefit analysis
financial technique that measures the cost of implementing a particular solution and compares this with the benefit delivered by that solution

NOTE The benefit may be defined in financial, reputational, service delivery, regulatory or other terms appropriate to the organization.

[SOURCE: BS 25999-1:2006, **2.11**]

3.10 critical activities
those activities which have to be performed in order to deliver the key products and services which enable an organization to meet its most important and time-sensitive objectives

[SOURCE: BS 25999-1:2006, **2.12**]

3.11 disruption
event, whether anticipated (e.g. a labour strike or hurricane) or unanticipated (e.g. a blackout or earthquake), which causes an unplanned, negative deviation from the expected delivery of products or services according to the organization's objectives

[SOURCE: BS 25999-1:2006, **2.13**]

3.12 emergency planning
development and maintenance of agreed procedures to prevent, reduce, control, mitigate and take other actions in the event of a civil emergency

[SOURCE: BS 25999-1:2006, **2.14**]

3.13 exercise
activity in which the business continuity plan(s) is rehearsed in part or in whole to ensure that the plan(s) contains the appropriate information and produces the desired result when put into effect

NOTE An exercise can involve invoking business continuity procedures, but is more likely to involve the simulation of a business continuity incident, announced or unannounced, in which participants role-play in order to assess what issues might arise, prior to a real invocation.

[SOURCE: BS 25999-1:2006, **2.15**]

3.14 impact
evaluated consequence of a particular outcome

[SOURCE: BS 25999-1:2006, **2.17**]

3.15 incident
situation that might be, or could lead to, a business disruption, loss, emergency or crisis

[SOURCE: BS 25999-1:2006, **2.18**]

3.16 likelihood
chance of something happening, whether defined, measured or estimated objectively or subjectively, or in terms of general descriptors (such as rare, unlikely, likely, almost certain), frequencies or mathematical probabilities

NOTE 1 Likelihood can be expressed qualitatively or quantitatively.

NOTE 2 The word "probability" can be used instead of "likelihood" in some non-English languages that have no direct equivalent. Because "probability" is often interpreted more formally in English as a mathematical term, "likelihood" is used throughout this Standard with the intention that it is given the same broad interpretation as "probability".

[SOURCE: BS 25999-1:2006, **2.21**]

3.17 loss
negative consequence

[SOURCE: BS 25999-1:2006, **2.22**]

3.18 maximum tolerable period of disruption
duration after which an organization's viability will be irrevocably threatened if product and service delivery cannot be resumed

[SOURCE: BS 25999-1:2006, **2.23**]

3.19 organization
group of people and facilities with an arrangement of responsibilities, authorities and relationships

EXAMPLE Company, corporation, firm, enterprise, institution, charity, sole trader or association, or parts or combinations thereof.

NOTE The arrangement is generally orderly.

NOTE An organization can be public or private.

[SOURCE: BS EN ISO 9000:2005, **3.3.1**]

3.20 products and services
beneficial outcomes provided by an organization to its customers, recipients and stakeholders, e.g. manufactured items, car insurance, regulatory compliance and community nursing

[SOURCE: BS 25999-1:2006, **2.25**]

3.21 recovery time objective
target time set for:

- resumption of product or service delivery after an incident; or
- resumption of performance of an activity after an incident; or
- recovery of an IT system or application after an incident.

NOTE The recovery time objective has to be less than the maximum tolerable period of disruption.

[SOURCE: BS 25999-1:2006, **2.26**]

3.22 resilience
ability of an organization to resist being affected by an incident

[SOURCE: BS 25999-1:2006, **2.27**]

3.23 risk
something that might happen and its effect(s) on the achievement of objectives

NOTE 1 The word "risk" is used colloquially in various ways, as a noun ("a risk" or, in the plural, "risks"), a verb (to risk [something], or to put at risk), or as an adjective ("risky"). Used as a noun the term "a risk" could relate to either a potential event, its causes, the chance (likelihood) of something happening, or the effects of such events. In risk management (see BS 25999-1:2006, ***6.5****) it is important to make a clear distinction between these various usages of the word "risk".*

NOTE 2 Risk is defined relative to a particular objective; therefore, concern for several objectives implies the possibility of more than one measure of risk with respect to any source of risk.

NOTE 3 Risk is often quantified as an average effect by summing the combined effect of each possible consequence weighted by the associated likelihood of each consequence, to obtain an "expected value". However, probability distributions are needed to quantify perceptions about the range of possible consequences. Alternatively, summary statistics, such as standard deviation, may be used in addition to expected value.

[SOURCE: BS 25999-1:2006, **2.28**]

3.24 risk appetite
total amount of risk that an organization is prepared to accept, tolerate or be exposed to at any point in time

[SOURCE: BS 25999-1:2006, **2.29**]

3.25 risk assessment
overall process of risk identification, analysis and evaluation

[SOURCE: BS 25999-1:2006, **2.30**]

3.26 risk management
structured development and application of management culture, policy, procedures and practices to the tasks of identifying, analysing, evaluating, and controlling responding to risk

[SOURCE: BS 25999-1:2006, **2.31**]

3.27 stakeholders
those with a vested interest in an organization's achievements

NOTE This is a wide-ranging term that includes, but is not limited to, internal and "outsourced" employees, customers, suppliers, partners, employees, distributors, investors, insurers, shareholders, owners, government and regulators.

[SOURCE: BS 25999-1:2006, **2.32**]

3.28 top management

person or group of people who direct and control an organization at the highest level

NOTE Top management, especially in a large multinational organization, might not be directly involved; however, top management accountability through the chain of command is manifest. In a small organization, top management might be the owner or sole proprietor.

[SOURCE: BS EN ISO 9000:2005, **3.2.7**, and BS 25999-1:2006, **2.24**]

4 Setting design objectives

4.1 General

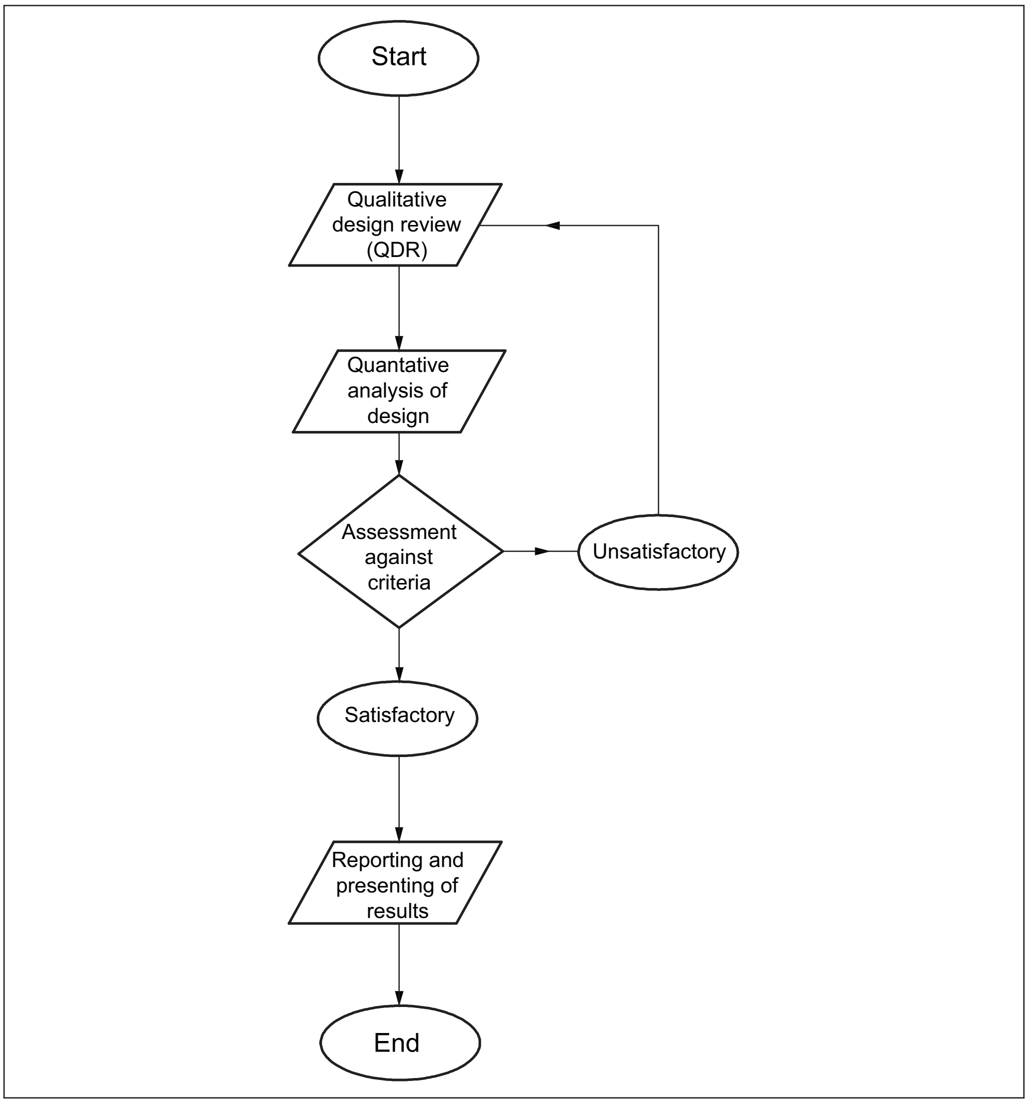
A framework for fire safety engineering design is described in BS 7974 and PD 7974-0, and is illustrated in Figure 1. The framework is divided into three stages:

a) QDR, where the scope and the objectives of the fire safety design are defined, and where performance criteria are established and acceptance criteria set;

b) quantitative analysis, where engineering methods are used to evaluate potential solutions; and

c) assessment against criteria, where the results of the quantitative analysis are compared against the acceptance criteria.

Figure 1 **Basic fire engineering process**



4.2 Qualitative design review (QDR)

The interaction of fire, buildings and people gives rise to an almost infinite number of possible scenarios, and it is not feasible to evaluate every conceivable case. BS 7974 and PD 7974-0 describe the QDR as a qualitative process that draws upon the experience and knowledge of the fire safety engineer and a team of others involved in the design and operation of the building, in order to identify the significant fire hazards and simplify the problem before attempting to carry out a detailed quantified study.

PD 7974-0 then continues to describe how the QDR should be conducted. A QDR is a structured technique that allows the team to think of the possible ways in which a fire hazard might arise, and to establish a range of strategies to maintain the risk at an acceptable level. The fire safety design can then be evaluated quantitatively or qualitatively against the objectives and criteria set by the team. The QDR should be conducted in a systematic way to reduce the chance of a relevant item being missed.

Whilst the QDR is essentially a qualitative process, it can often be useful to review the evidence, fire statistics or carry out quick calculations to resolve a difference of opinion between team members or to establish the most significant scenarios for detailed quantification.

The main stages in the QDR are defined as:

a) review the architectural design and occupant characteristics;

b) establish fire safety objectives;

c) identify fire hazards and possible consequences;

d) establish trial fire safety designs;

e) identify acceptance criteria and methods of analysis;

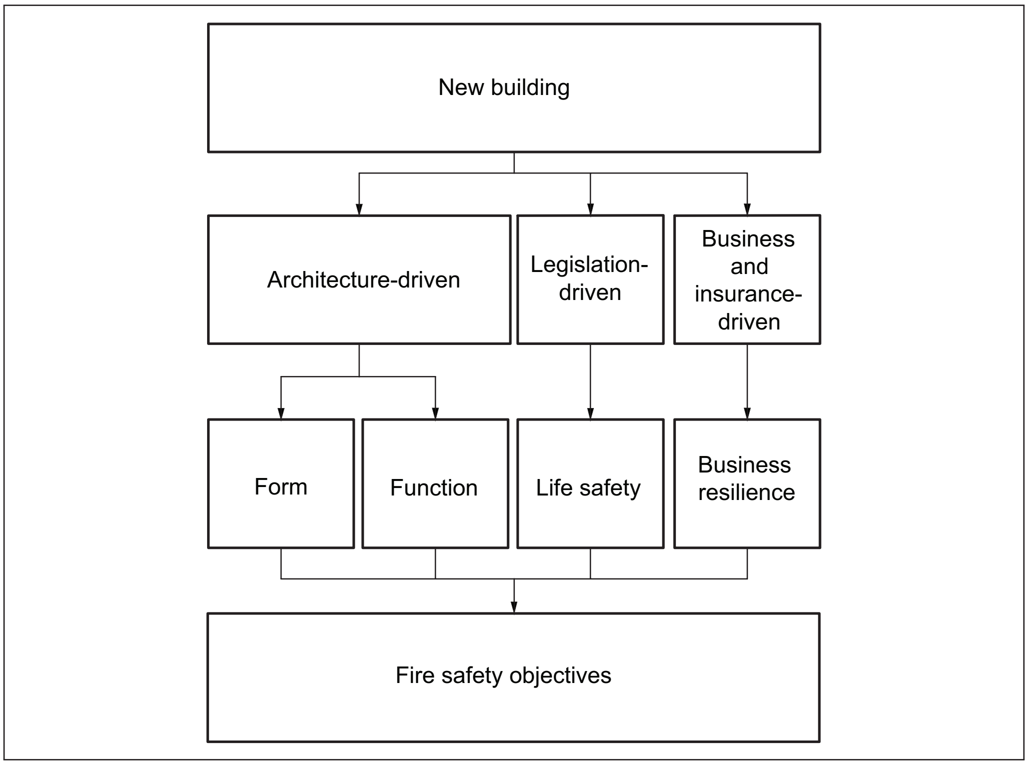
f) establish fire scenarios for analysis.

It can be desirable to protect those parts of an organization’s resources, associated with the built environment, that underpin the conduct of business-critical activities.

Where the end-user client is able to submit a business impact analysis (BIA), this information should be added to the fire safety objectives suite to inform the QDR process. Where the client is unaware of the role that fire safety engineering can play in meeting their business resilience requirements, an additional stage should be incorporated into the QDR process to determine and document the impact of a disruption from a fire event, as illustrated in Figure 2, in order to provide input into the fire engineering objective setting part of the QDR, with example objectives including elements such as:

- three out of five manufacturing lines should be available at any given time;
- following a fire, full or x% capability should be retrieved within 14 days;
- a single seat of fire should never jeopardize more than x% of held stock;
- a single fire should never jeopardize x% of transport vehicle capability; etc.

Figure 2 **Drivers for fire safety objectives**



4.3 Objectives setting team

Figure 2 demonstrates that input from a diverse range of individuals is required.

The team needed to undertake the pre-design analysis will require representation from (where available):

a) end-user client: a manager with sufficient seniority to understand the organization's priorities in a holistic way, plus a manager with responsibility for business continuity management such as the risk manager, etc.;

b) the client's insurer; possibly a risk surveyor from the insurer, with business interruption competencies relating to the industry and/or operations undertaken by the client;

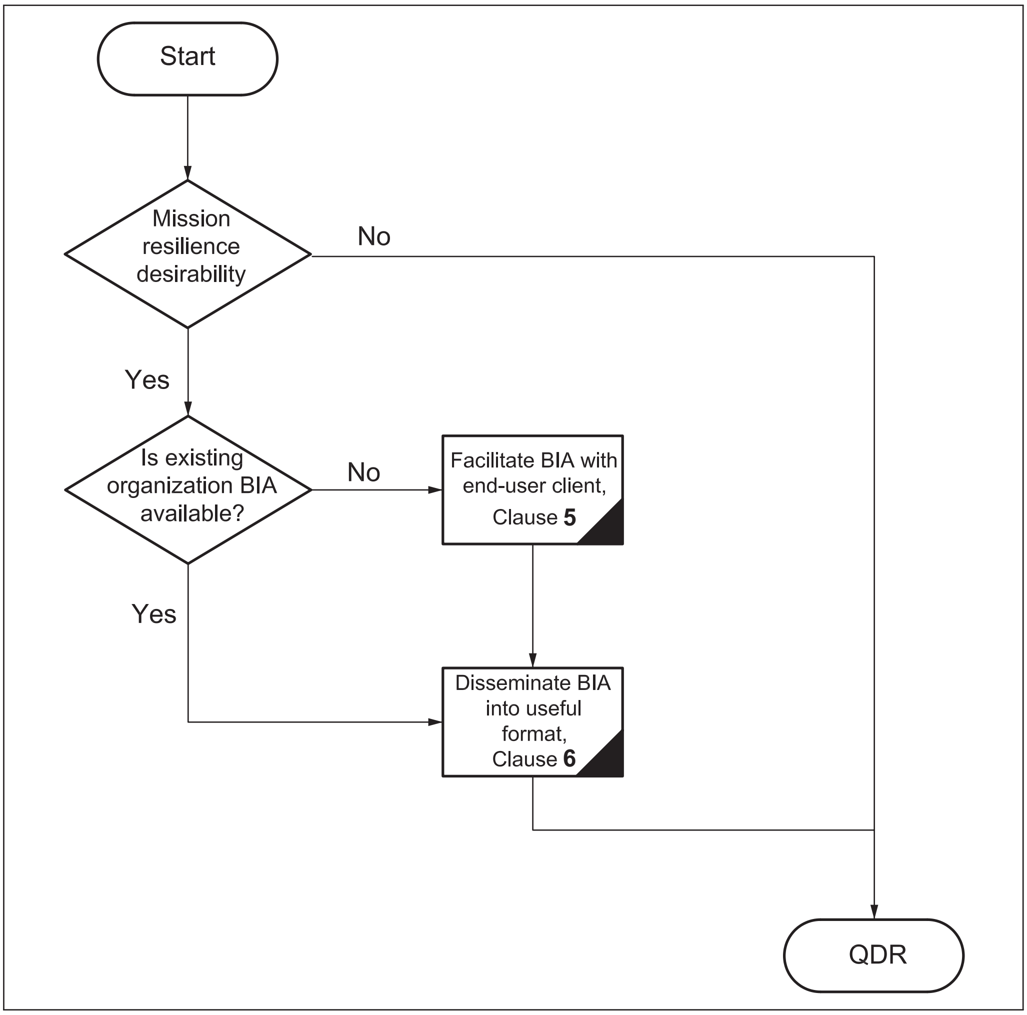
c) building design team, including the conceptual architects;

d) fire safety engineer.

4.4 Objectives setting process

With many high-profile construction projects, the architectural design team and their engineering consultants have a good dialogue with, and understanding of, their client's objectives. In many other cases, however, this is not necessarily the case, and then it is recommended that a process such as that outlined in Figure 3 is adopted.

Figure 3 **Resilience objectives setting process**



The initial element of the process involves the high-level strategic design team determining the end-user client's appetite for exploring resilience objectives within the building design. Essentially, this will be determined by the architectural team, but it is important that the topic is pursued to an appropriate degree, explaining the potential business advantage that can be gained from sensible investment in resilient design. If the conclusion of these initial discussions is that the client does not want to follow this process, then the fire safety engineer should follow the QDR process as defined in BS 7974 and PD 7974-0. If the conclusion is positive, and the client does want to pursue this process, then it should be established whether the organization has already completed a BIA as part of their business continuity management planning.

NOTE Guidance on business continuity management is given in Annex A.

Where a BIA is not already available, the fire safety engineer should communicate to the end-user client organization the need to produce a BIA, and facilitate its production as outlined in Clause **5**. This process requires input from the architectural design team and insurer.

BIA, as described in Clause **5**, is a well established process within business continuity management, so it is most likely that an organization that employs business continuity management practices will have a current BIA. Where a BIA is available, the fire safety engineer should disseminate and interpret the information contained within it, to assist with fire safety engineering objective setting, as described in Clause **6**.

5 Business impact analysis (BIA)

5.1 Understanding an organization

The fire safety engineer, architectural design team and insurer should endeavour to fully understand the end-user client's organization in terms of its objectives, stakeholder obligations, statutory duties and the environment in which the organization operates. The data gathered will be used to inform the organization's continuity and recovery strategy, identify mission-critical activities, their dependent resources, and the timeframe within which they need to be recovered (the maximum tolerable outage, or recovery time objective), and as a means to establish dependencies and relationships between business processes and supporting infrastructures.

5.2 BIA process

5.2.1 Precursors

The approach outlined within this part of PD 7974 might not be applicable to all building or plant design projects involving elements of fire safety engineering. There is little purpose in undertaking a BIA unless the management of the end-user client's organization understand the requirement for undertaking such an activity and are willing to act on the findings. For a BIA to be undertaken successfully, its purpose should be appreciated and supported by senior management in advance of the process commencing. Before a BIA is undertaken, a clearly stated commitment to the wider goals and objectives of business continuity management should be sought from senior management within the client's organization. This commitment should include the organization's willingness to invest in the solutions that evolve following use of a BIA to help define the requirement.

5.2.2 Definition of scope

The next step in the BIA process is to address the scope of the analysis. This will largely be influenced by the scope of the building or plant being designed. However, a new facility being constructed within an existing site might require a BIA which analyses the entire site, in order to fully understand the influences and dependencies within the new facility, and indeed any other sites out of which the organization operates.

As a fire safety engineering tool, and within the scope of this part of PD 7974, the BIA may be restricted to fire-related disruptions. However, the end-user client might wish to conduct a holistic BIA which includes the consideration of non-fire-related disruptions at the same time. Therefore, the fire safety engineer and architectural design team should be aware of their individual contribution to the process and be cognisant of the data they require to inform the subsequent steps in the QDR.

5.2.3 Data collection

The second step involves data collection and requires a collaborative approach to be taken, but it is essential that the end-user client is responsible for undertaking the analysis. The client's insurer, or insurance broker, will often have a good understanding of the organization, the hazards, and business interruption consequences; however, it is only the end-user client who can convey the full picture. The senior management team should be asked to assess the organization as a whole, and to provide a ranking for key products or services and the point at which the maximum tolerable period of disruption (MTPD) occurs. This team should also set the timescale for resumption within the MTPD, which is called the recovery time objective (RTO). The outcome of this data collection is to determine the critical activities across the organization that are needed to deliver these products and services.

5.2.4 Moderation

The third element of the BIA is to subject the findings to a moderation process, rather than simply accepting the findings at face value. Moderation is best conducted by senior managers within the client's organization so they can give the global perspective, but other various methods to moderate the BIA data include:

- comparison of output with findings of earlier reviews, or across other divisions, or with internal expectations;
- use of peer review with other business continuity management experts;
- use of a senior figure within the client organization (or panel) to assess the initial findings.

5.2.5 Report

Once the BIA has been completed, the process undertaken and the findings should be documented in such a way that it:

- provides a meaningful input into the fire engineering objective setting within the QDR;
- feeds back into the wider client organization's business continuity management plan;
- provides sufficient evidence of the process to satisfy a later audit.

The incorporation of a BIA, or the interpretation of the end-user client organization's BIA, into the QDR and objective setting process, as described in Clause **6**, will allow the fire engineer to establish scenarios for quantitative analysis utilizing appropriate fire protection tactics, resulting in resilient building designs.

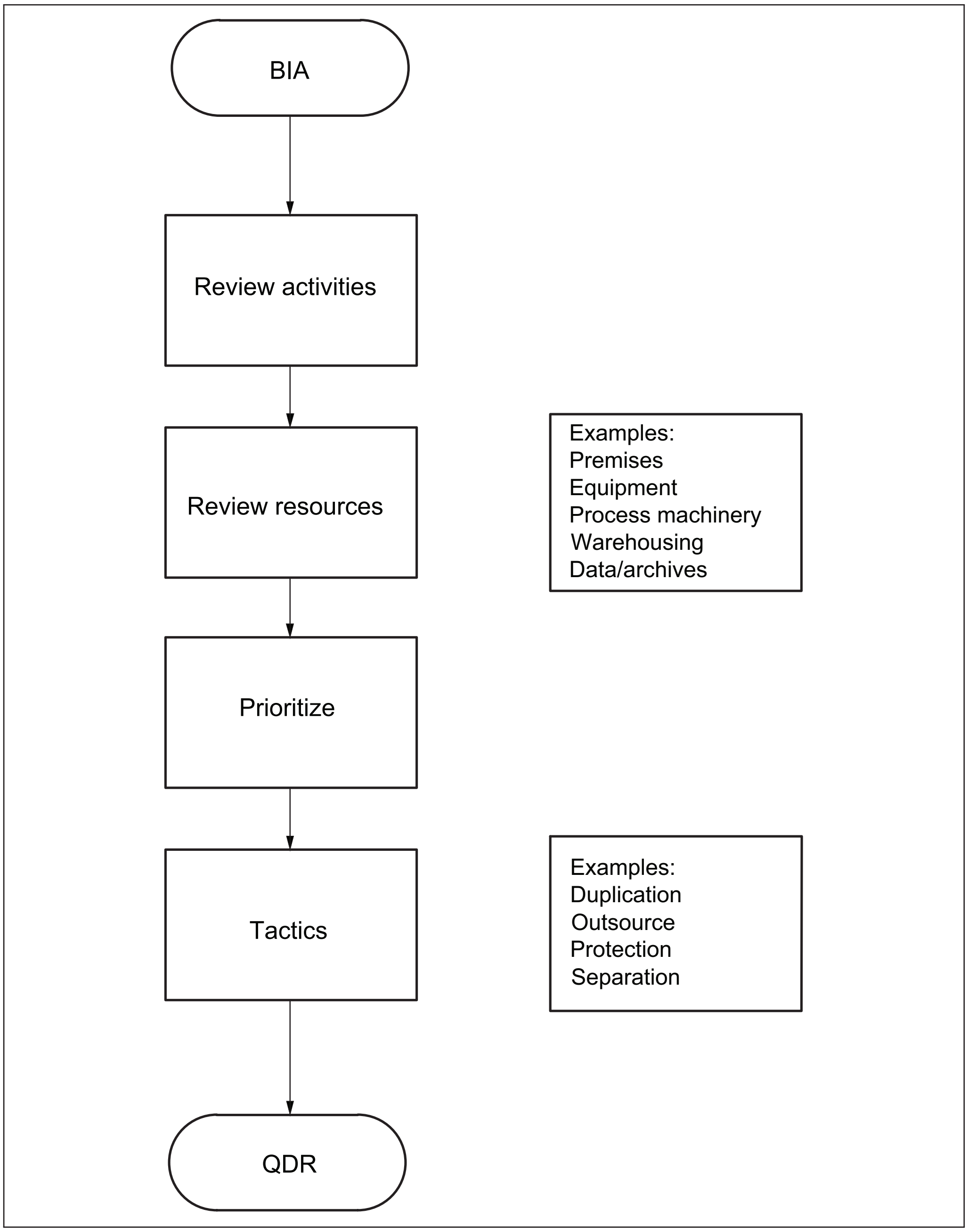
6 Interpreting BIA for fire safety engineering

6.1 Understanding the BIA report

Numerous templates and organization-specific formats have been developed and are used to record the output of a BIA. One example is shown in Annex B.

The BIA report will have reviewed all activities undertaken within the client's organization. As shown in Figure 4, the resources required to complete these critical activities will also have been identified. By undertaking the moderation exercise, the prioritization of these activities and supporting resources will have been documented. This then allows the building design team and the fire engineer to analyse and identify which resources would benefit from protection from fire and combustion products, and select the appropriate tactics for further analysis.

Figure 4 **BIA to QDR process**



6.2 Establishing fire safety engineering objectives

*NOTE Property and business protection objectives are dealt with separately, in **6.2.1** and **6.2.2** respectively. The guidance in these subclauses is based on guidance given in PAS 911.*

6.2.1 Property protection objectives

The building might or might not be seen as a crucial part of the resources supporting critical activities. Conceivably, if all persons have been safely evacuated from the building, then the consequential collapse of the building might be acceptable. However, in many cases, controlling a fire to prevent the destruction of the building is seen as an objective. In such cases, in order to define fire safety objectives, the BIA should be used to ascertain answers to such questions as:

- What parts of the building are most vulnerable to a fire incident?
- What parts of the building need special consideration to support the business continuity plan?
- How big will a fire need to be to constitute a threat to the building?
- What aspects of the building might cause a fire to spread throughout the building?
- What parts of the building are most critical for protection and what parts are secondary?

The loss of the building fabric, i.e. the walls, doors, floors, ceilings and divisions, and their decorations and fittings, might be acceptable, as the rebuild costs might not be of primary importance when weighed against the cost of their protection. For buildings of historical importance or where special building materials and fabrics have been introduced, the fabric might be viewed as important as the building itself. Considerations might include:

- What parts of the building fabric are most vulnerable to a fire incident?
- What forms of damage are unacceptable (e.g. damage from toxic gases, smoke, from convected heat from a fire, water, etc.)?
- How much of the building fabric is seen as an “acceptable loss”?
- What parts of the building fabric are most critical for protection and what parts are secondary?

Fixtures and fittings might be furnishings, equipment, machinery and plant within the building that cannot be easily moved, especially in the event of a fire incident. IT equipment and data might be of particular importance. The importance of the fixtures and fittings in terms of value is often a subjective decision, and might be determined by the insurers, management or special interest parties. Considerations might include:

- What fixtures and fittings are deemed to be a priority for protection and what are secondary?
- What forms of damage are unacceptable (e.g. damage from toxic gases, smoke, from heat from a fire, water, etc.)?
- How easily can the fixtures or fittings be replaced?
- What forms of protection are most appropriate?
- What parts of the building are most critical for protection and what parts are secondary?

- What special requirements are there for fire-fighters (e.g. providing specific facilities and/or equipment other than those suggested by building regulations)?
- What salvage processes are appropriate to full equipment reinstatement and/or replacement?

Moveable items might be small furnishings, computer equipment, works of art, tools and test equipment, which are housed within the building but can be moved out of the building in the event of a fire incident. The importance of the moveable items, as with fixtures and fittings, in terms of value, is often a subjective decision and might be determined by the insurers, management or special interest parties. Considerations might include:

- What moveable items are deemed as a priority for protection and what are secondary?
- What forms of damage are unacceptable (e.g. damage from toxic gases, smoke, from heat from a fire, etc.)?
- What areas can be designated as places of safety for moveable items?
- What procedures are required to move the items to a place of safety?
- What fire and security protection is required for the designated location of the moveable items?
- How easily can the moveable items be replaced?
- What forms of protection are most appropriate?
- What salvage processes are appropriate for full item reinstatement/replacement?

6.2.2 Business/mission continuity objectives

When dealing with issues relating to the direct and indirect consequences of a fire, there are four main objectives to be separately reviewed.

a) **Short-term operations**. This is the assessment of how a fire will have an immediate and near immediate impact on the business. Considerations might include:
   - In what ways will a fire affect the running of the business on a day-to-day basis?
   - What are the most critical short-term aspects of the business that require special attention?
   - What are the short-term contingency arrangements that can be put into place following a partial and/or total fire?
   - What would be the acceptable downtime following a fire?

b) **Long-term operations**. This is the assessment of how a fire will have a longer-term impact on the business. Considerations might include:
   - In what ways will a fire affect the running of the business in the long term?
   - What are the most critical long-term issues of the business that require special attention?
   - What are the long-term contingency arrangements that can be put into place?
   - What changes to the business processes can be implemented if the business cannot continue in its present form following a fire?

c) **Confidence**. This is the assessment of how a fire will have an impact on the confidence of stakeholders. Considerations might include:

- How will a fire affect the confidence of employees?
- What changes in working arrangements would need to be implemented as a consequence of a fire?
- How will a fire impact on the confidence of customers, suppliers and shareholders in the business and its ability to continue to operate?
- How will a fire affect its relationship with the local community and/or the wider society?

d) **Mission**. This is the assessment of how a fire will have an impact on the ability of the organization to follow its objectives. Considerations might include:

- How will the fire impact on the core mission and values of the organization?
- What impact will a fire have on the viability of the organization?
- How will the organization be perceived over the longer term?
- What are the legal, commercial and logistical implications of a fire and how will they manifest themselves?

7 Fire protection tactics for improving resilience

Once the required objectives have been determined (see Clause **6**), all available fire protection tactics should be assessed, to develop an appropriate fire safety strategy to provide the required degree of resilience of a building or plant in fire. The obvious should not be ignored. Possibilities include the following.

a) **Minimizing ignition sources**. Wherever possible, all processes conducted within a building or plant should be designed to reduce the likelihood of ignition. It is appreciated that frequently little can be done in this area at the design stage, but often some improvement can be made. For example, water-based central heating is far less likely to provide an ignition source than electric heaters.

b) **Minimizing combustibles**. Using non-combustible materials both in the structure of the building and in its contents will reduce the likelihood of a serious fire and hamper fire spread. Wherever practicable, flammable and combustible substances and materials used in a business should be substituted by non-combustibles. Although the design process might have little influence on the contents of a building, some improvements can be made. For example, fire-resisting hydraulic oils can be substituted for mineral oil, and air-cooled switchgear substituted for oil-filled switchgear. Water-based solvents can be substituted for flammable solvents. Even when no practical non-combustible materials are available or their use is constrained by cost or other considerations, fire severity can be reduced by selecting materials with improved reaction-to-fire properties. Examples include the use of composite structural panels using materials with improved fire performance, the use of flame retardant as opposed to standard cables, and the use of silicone-based transformer fluids instead of oil-based.

c) **Fire detection**. Early detection can give time to allow a fire to be tackled in its early stages before it is too large to be effectively dealt with. High-sensitivity detection can allow incipient fire to be spotted before flaming combustion occurs, and can allow for fire to be effectively eliminated (e.g. by powering down equipment) before it can develop.

For detection to be effective, it should raise an alarm in a manned area from which early fire attack can be organized.

d) **Manual fire-fighting**. There is evidence that approximately two-thirds of fires are extinguished by the use of manual fire extinguishers. Availability of ample and appropriate fire extinguishers provides the means for this to occur. However, for this to be most effective, employees should be given practical, hands-on training in the use of extinguishers.

The provision of an on-site fire team or fire and rescue service will further enhance the capability to tackle fires in the early stages and to minimize loss.

The provision of enhanced facilities for the fire and rescue service, such as hydrant systems, risers, fire-fighting shafts and improved vehicular and pedestrian access can all also help to improve the chance of successful early fire-fighting to minimize losses. Fire ventilation can also be provided to allow safe fire attack.

When designing measures to assist the fire and rescue service, discussions should always be held with the appropriate service to ensure that expectations are likely to be met in practice.

e) **Fire suppression**. Both manual and automatic fire suppression systems should be considered. Further advice is given in BS 5306-0. It should be noted that some fire suppression systems are designed to support life safety objectives and others for business and property protection. Sometimes the most effective life safety and property protection/business continuity fire strategies are able to harness the life safety and property protection/business continuity benefits from a single sprinkler system.

f) **Ventilation**. Smoke ventilation can limit damage from smoke and hot gases. It can also improve the fire and rescue service's ability to successfully tackle a fire, by providing a safe clear layer for fire and rescue service operations or safe access routes (pressurization techniques). It should be noted that ventilation systems can also hamper the effectiveness of sprinkler systems performance, therefore coherent design is required.

g) **Passive fire protection and compartmentation**. Reducing fire size by effective fire-resisting compartmentation can limit fire spread and potential loss. Compartmentation can also be used to protect particularly vulnerable equipment. Periods of fire resistance given in guidance to building regulations (e.g. Approved Document B [6]) might not necessarily provide a level of protection to survive a burn-out of contents, if not a higher level of structural fire resistance should be used if structural integrity to survive a worst-case fire is required or desirable.

h) **Back-up and redundancy**. Business and mission continuity can be assured by having back-up equipment available (or a contingency plan in place to ensure that the equipment can be quickly obtained). Backing up computer data to a remote server can be especially effective in protecting valuable records.

i) **Training and management**. Both the likelihood of a fire incident and the severity of an incident can be minimized by good training of employees in fire prevention and in what to do in the event of fire. Good management to ensure good housekeeping and regular maintenance of possible ignition sources and fire protection equipment is also key to preventing losses and should be in accordance with good practice guidance such as BS 9999:2008, Section **4**. However, it should be noted that since people cause fires, passive, installed, automatic protection is preferred to complex management procedures in most instances.

8 Financial justification

For some potential mitigating measures, a more detailed quantitative assessment of risk and cost-benefit analysis can help evaluate the most cost-effective solution. PD 7974-7 includes data for probabilistic risk assessment and criteria for assessment. The data included are based on fire statistics, building characteristics and reliability of fire protection systems. The criteria included cover life safety and property protection, in both absolute and comparative terms.

9 Examples

NOTE This clause contains a number of simplified examples of the outcome of the processes described in Clauses ***4*** *to* ***8****. It is not intended to describe a complete design solution for the examples given.*

9.1 School

A school building is being designed in England. The intention is to design a light and open space that creates a stimulating environment for learning. The central core of the building is to be a two-storey atrium (open spatial planning). Classrooms will open onto a balcony at first floor level. Much of the ground floor will be an open space incorporating moveable partitions that will enable the space to be used for a variety of purposes. Additionally, as a private finance initiative (PFI) procured school, what is being designed is not only a building, but a teaching capability for several hundred children. The building is therefore critically linked to business continuity objectives and recovery speed is "next day" (or 3 days at best if a fire happens on a Friday).

In England, for a new school, the guidance of Building Bulletin 100 (BB 100) [1] can be followed to meet the functional requirements of the Building Regulations 2010 [2], which apply in England and Wales. [2)]

BB 100 states:

> *"A degree of property protection is an implicit consequence of the measures necessary to protect life. However, property protection measures that will satisfy insurers will generally be more onerous in some aspects.*
>
> *It is the intention of this guide to address both the life safety needs and the property protection needs at the same time. This dual approach will allow designers to tailor their strategy to the location, use, and risks identified."* [3)]

BB 100 is not the only way to meet the functional requirements of the Building Regulations 2010; it recognizes the use of fire engineering as an alternative, and in accepting fire engineering as an alternative, BB 100 states:

> *"The onus is on the designer to demonstrate that the design results in an appropriate safety level, as good or better than that achieved by following the detailed design guidance here."* [3)]

2) Attention is drawn to building regulations in other parts of the UK ([3], [4]), which might not have the same functional requirements as those in England and Wales.

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In this situation, then, the minimum criterion that a fire engineered solution would have to meet would be that it delivered a level of occupant safety as good as that delivered by the prescriptive guidance in BB 100. Property protection might not be an implicit consequence of delivering that level of occupant safety through fire engineering.

BB 100 highlights the economic and social costs of school fires. These issues include:

- the hire of temporary accommodation during the rebuild, which can last for up to 5 years;
- additional costs if pupils need to be transported to another school site;
- general disruption, including children's education;
- loss of teaching aids;
- loss of coursework, which will have to be redone by the pupils;
- loss of personal items owned by pupils and staff;
- loss of facilities for the community, e.g. for Scouts, Guides, football and other sports, evening classes, polling stations, council meetings, centres for emergency accommodation;
- additional costs from insurers, requiring more security to prevent repeat incidents;
- high levels of stress, particularly for senior staff;
- loss of reputation, with implications for recruitment and retention of staff as well as pupil applications.

Whilst the safety of occupants is paramount, a principal objective of the fire safety design should be to take into account the effect that fire would have on contents and buildings. In this case, even if means of escape are suitable, the fire engineer could incorporate sprinklers and smoke extraction to limit fire growth and smoke damage. The fire engineer might also recommend introducing a degree of cellular design on the ground floor to protect areas of high monetary or educational value.

9.2 Food manufacturing plant

An established small-scale snack food producer is planning to expand production capabilities to meet a significant increase in sales and plans to develop an export market. The compact site comprises an office building, a production building and a storage building. The storage building can house up to 7 days' worth of product, so essentially the business operates a "just in time" manufacturing philosophy. The production building is a converted farm building which houses frying ranges, protected with automatic fire suppression local to the ranges. The ranges are provided with a single feed from the bulk oil storage tank.

The client and their team originally chose the most cost-effective option of expanding the original production building by building a simple extension, thereby providing the space to locate additional frying ranges, etc.

However, the following business resilience issues were taken into account in order to adjust the fire safety objectives.

- With fruition of successful business development, loss of production for more than 2 days is unacceptable.
- The original expanded building designs represents a large "single and communicating risk", which would be considered by insurers as an estimated maximum loss (EML) of 100%. For many insurers, this EML would be too high to cover and would require reinsurance, increasing costs for the client.

- The client is the largest employer in the surrounding rural area and therefore the loss to the community resulting from a disruptive fire is large.
- The business is largely owned by a venture capital fund, which is keen to look after its investment and acts as a vocal Board member.
- Having identified these issues, to proceed as planned would mean the MD would be falling short of their responsibilities

After discussions with their insurer, the client chose to convert the existing warehouse into a new production facility, separated by more than 20 m from the original production building. A new warehouse is planned which will be sprinklered. The client will now have two separate production lines operating in parallel, both protected by high-pressure fog fire suppression giving protection of production operations, with a new sprinkler protected warehouse giving additional business resilience. The new arrangements might attract a discount from their insurers.

9.3 Nuclear process plant

A plant is being designed to process nuclear material. This processing is basically a wet process but will be conducted within concrete cells to contain radioactivity. However, these cells need to be ventilated and cooled to remove heat generated by the process even when the process is shut down. The building also contains a services area containing a control room, offices to house administration staff, changing rooms, and canteen and welfare facilities.

As part of the general nuclear safety design, all critical fans and pumps involved in the ventilation and cooling have redundancy, i.e. they are duplicated, as are services to these fans and pumps (i.e. power and instrumentation and control).

The principal objective of the fire safety design is to ensure that fire does not result in a radioactive release. A secondary objective is to maintain tenability within the control room, so that the plant can be shut down safely in the event of a fire and maintained in a safe state. To ensure this objective the following strategy is chosen.

a) All radioactive inventory is to be enclosed by a fire-resisting structure able to withstand a burn-out of all combustibles within the plant.

   NOTE 1 This is easily achieved by the concrete cells, but penetrations into these cells need to be protected.

b) Combustibles are to be minimized. The structure is to be concrete with a steel frame; cladding is to be non-combustible. Cables are to be flame-retardant in accordance with BS EN 50266-2-2.

c) The services area is to be separated from the main plant by fire-resisting structure. The fire resistance of the separating wall is designed to withstand a burn-out of all contents, such that fire within these areas cannot spread to the active part of the facility.

   NOTE 2 This fire resistance is greater than that prescribed to meet the guidance in Approved Document B [6]. 90 min is chosen in this case.

d) Because of the need to maintain tenability within the control room, this room is also compartmented from the rest of the services area by 90 min fire resistance. It is also sited on the ground storey with direct access to the outside. In addition, despite 24 h staffing, high-sensitivity detection and in-cabinet fire suppression systems are installed in critical control and instrumentation cabinets, to ensure that fires within such cabinets do not result in spurious information to control staff or the incorrect operation of plant.

e) The rest of the services area is designed following Approved Document B [6].

f) The load-bearing structure within the active area is designed to withstand burn-out. Because of the low fire loads, 60 min fire resistance is calculated to be sufficient.

NOTE 3 This is less than that proscribed by Approved Document B [6], which calls for 90 min fire resistance for an industrial building of this height.

g) All redundant services (e.g. duplicated power cables and instrumentation and control cables) are separated from the alternative system by compartmentation and careful routing of services, such that a single fire cannot disable both redundancies. In addition, critical control and instrument cabling is 60 min fire-resisting.

h) Fire detection is provided throughout to give early warning of a fire.

i) Vehicular access is provided around the complete perimeter of the building, and fire-fighting shafts are provided to allow easy and safe fire and rescue service intervention.

NOTE 4 Because of the remote location of the site, there is an on-site fire and rescue service.

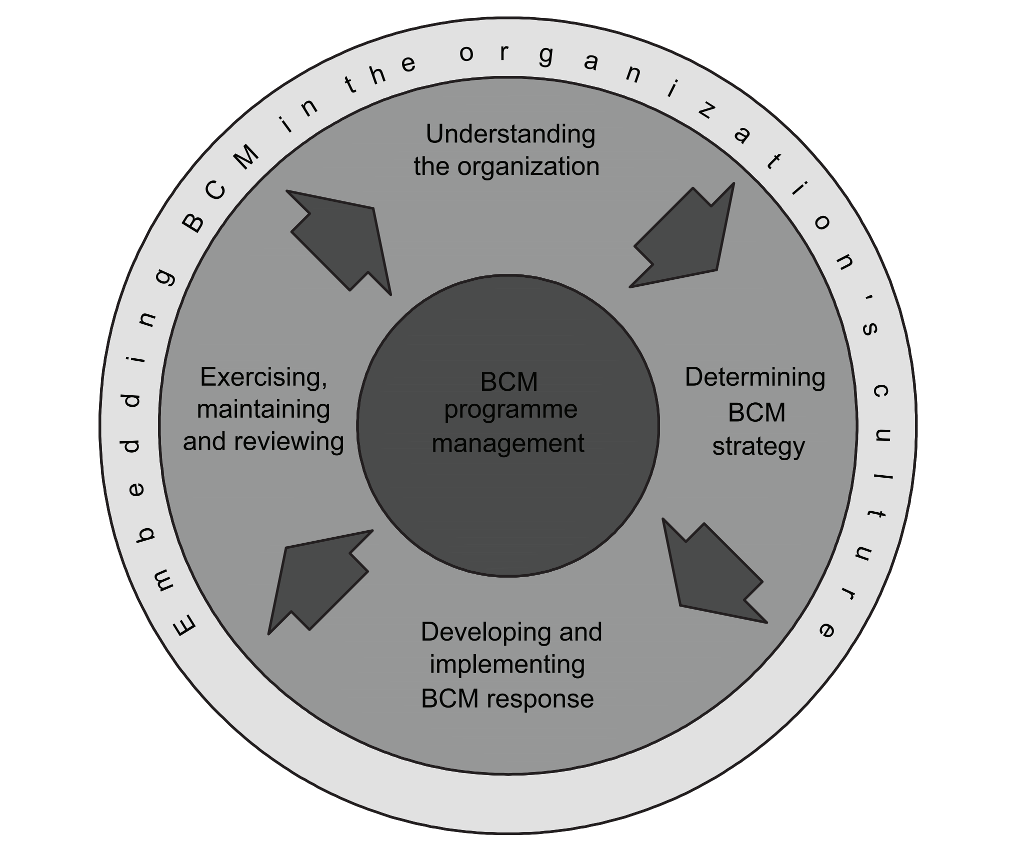
Annex A (informative) Business continuity management

A.1 What is business continuity management?

As outlined in BS 25999-1, business continuity management is a business-driven process that establishes a strategic framework to improve an organization's resilience against the disruption of its ability to achieve its key objectives; provides a rehearsed method of restoring an organization's ability to supply its key products and services to an agreed level within an agreed timescale after a disruption; and delivers a proven capability to manage a business disruption, protecting the organization's reputation and brand.

Business continuity management requires the process to be planned, implemented and improved on a regular basis, and BS 25999-1 introduces a business continuity management lifecycle, as illustrated in Figure A.1.

Figure A.1 **Business continuity management lifecycle**



A.2 What are the benefits?

Business continuity management forms an important element of good business management. All business activity is subject to disruptions, such as technology failure, denial of access and fire. Business continuity management provides the capability to adequately react to operational disruptions while protecting welfare and safety. Some of the benefits of an effective business continuity management programme, as identified in BS 25999-1, are that the organization:

- is able to proactively identify impacts of an operational disruption;
- has in place an effective response to disruptions which minimizes the impact on the organization;
- maintains the ability to manage uninsurable risks.

A.3 What are typical solutions to identified business continuity issues?

Whilst protection of resources underpinning critical activities with suppression systems goes some way to reducing the likelihood of critical damage from fire, no system is infallible, and as such no contribution is made in ensuring critical activity availability when such systems fail. Business continuity solutions ensure that there is always adequate availability of critical activities, irrespective of the type of event behind the loss of resource and, within reason, the scale of the event.

As such, solutions relevant to the built environment upon which fire safety engineering tools may be used include:

- duplication of assets;
- splitting and separation of assets;
- protection of assets;
- early detection of threat.

A.4 How does it apply to fire safety engineering design?

The effects of fire are only some of the disruptions that would be identified and managed within a holistic business continuity plan. However, by identifying these fire-related disruptions and potential consequences at the design stage of a building or plant, it is possible to incorporate features designed to reduce property loss, assist in ensuring business continuity and provide resilience against the effects of fire. For the fire safety engineer, the BIA process will:

- identify those activities critical to the end-user client's organization;
- identify the resources needed to support the activities;
- identify the fire safety objectives necessary to protect the resources.

A.5 What new fire safety objectives might be introduced?

The BIA describes:

- the importance of business activities to the organization in delivering its strategic plan;
- the timescales upon which the activity has to be recovered before the organization sustains critical damage;
- the resources upon which the activity depends;
- the tolerable loss of resource, as a percentage.

Using this information to augment life safety mandated objectives, the fire safety objectives suite for consideration could contain activity-specific requirements such as:

- fire has to be detected and extinguished before reaching *x* kW in size;
- compartment/equipment has to be recovered in 7 days;
- business stream has to be operational in 14 days.

Whilst fire safety engineering alone will be unable to achieve these aims, or might not be the most appropriate means of doing so, some building elements could be instrumental in meeting these goals.

Annex B (informative) Business impact analyses

BIAs are presented in numerous ways, tailored to the individual organization, or to their insurer's requirements, or to a preferred format developed by their specialist consultant.

A BIA spreadsheet could include the following columns:

- business function name;
- business function definition;
- business unit;
- outage durations:
  - one: from 0 h to 12 h;
  - two: from 12 h to 24 h;
  - three: from 24 h to 72 h;
  - four: from 72 h to 1 week;
  - five: over 1 week;
- financial impact (low, medium or high for each level of outage duration);
- operational impact (low, medium or high for each level of outage duration);
- regulatory or legal impact (low, medium or high for each level of outage duration);
- recovery time objective (RTO);
- maximum tolerable period of disruption (MTPD);
- dependencies;
- whether the RTO can be met.

An example of a BIA spreadsheet is shown in Figure B.1.

Figure B.1 **Example of BIA spreadsheet**

Name of person completing form		**Business area**		**Location of business function**	
Contact telephone number(s)		**Equipment, facilities, services supporting business area**		**Number of business function staff at location (and if relevant notation as to whether the location is open to the public)**	
Business function covered by form			**Key objectives of business function**		
Period (see notes 1 and 2)	**Narrative description of impact of unavailability on business operations of business function**	**1 to 10 rating and category/ categories**	**Critical assets (people, IT, voice, other non-IT – including collections/ collection items) needed to support business function**	**Other business functions and/or organizations that the business function is dependent on and the nature of the dependency**	**Other business functions and/or organizations dependent on the business function and the nature of the dependency**
1					
2					
3					
4					
5					
Any other relevant information					
Notes (1) Insert agreed time periods before using the form. (2) If it is decided to use more time periods than 5, add in additional rows.					

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