

BS 6187:2011



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Code of practice for full and partial demolition

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Contents

Foreword *iii*

Introduction *v*

1	Scope	1
2	Normative references	1
3	Terms and definitions	2
4	Approaches to demolition	8
5	Planning and managing projects (see Figure 3)	14
6	Procurement	26
7	Knowledge of the site (see Figure 5)	29
8	Decommissioning procedures (see Figure 6)	38
9	Identifying structural hazards (see Figure 7)	42
10	Health hazards (see Figure 8)	46
11	Health and safety of people on or off site (see Figure 9)	52
12	Protection of people and the environment (see Figure 10)	65
13	Safe working spaces and exclusion zones (see Figure 11)	75
14	Structural demolition: Principles, mechanisms and hazards (see Figure 20)	88
15	Avoidance of unplanned structural collapses (see Figure 21)	94
16	Temporary structures for stability, support and access (see Figure 22)	98
17	Demolition techniques (see Figure 23)	103
18	Materials handling and processing	116
19	Typical demolition methods for various types of structure (see Figure 25)	121
20	Completion of the works	134

Annexes

Annex A (informative) Training and competencies	136
Annex B (informative) Legislation, statutory regulations, codes of practice and guidance relevant to demolition	137
Annex C (informative) Useful contacts for demolition work	139
Annex D (informative) Heritage	142
Annex E (informative) Demolition waste protocols	144
Annex F (normative) Hazards associated with prestressed materials	146

Bibliography **152**

List of figures

Figure 1 – Outline route map	vi
Figure 2 – Base machine, equipment and attachments	3
Figure 3 – Route map for Clause 5	13
Figure 4 – Flowchart for maintaining structural stability	18
Figure 5 – Route map for Clause 7	29
Figure 6 – Route map for Clause 8	38
Figure 7 – Route map for Clause 9	42
Figure 8 – Route map for Clause 10	46
Figure 9 – Route map for Clause 11	52
Figure 10 – Route map for Clause 12	65
Figure 11 – Route map for Clause 13	75
Figure 12 – Terminology of designed exclusion zone and its constituent parts (typical for controlled explosive demolition)	77
Figure 13 – Example of designed exclusion zone showing practical application (typical for controlled explosive demolition)	78
Figure 14 – Example of designed exclusion zone showing phased and partial demolition (typical for controlled explosive demolition)	79
Figure 15 – Example of reduced exclusion zone by the use of containment (typical for floor-by-floor or top-down demolition)	80

- Figure 16 – Example of safe working space within an exclusion zone (typical for mechanical reduction or top-down demolition employing mechanical plant, etc.) 81
- Figure 17 – Plan of typical progressive demolition sequence, column-to-column maintaining a “square” to provide lateral support 82
- Figure 18 – Elevation: typical multistorey structure demolition sequence working “top down” outwards towards the shear walls (strong points), i.e. lift shafts and stairwells 82
- Figure 19 – Plan of demolition sequence working inwards and outwards towards the structural elements providing stability, such as shear walls 83
- Figure 20 – Route map for Clause 14 87
- Figure 21 – Route map for Clause 15 94
- Figure 22 – Route map for Clause 16 98
- Figure 23 – Route map for Clause 17 102
- Figure 24 – Route map of 17.11 109
- Figure 25 – Route map for Clause 19 119
- Figure 25 – Route map for Clause 19 (continued) 120
- Figure E.1 – The 2008 ICE Demolition Protocol [17] 146

List of tables

- Table 1 – Determining the significance of demolition activities on structural stability 8
- Table 2 – Types of structural refurbishment 12
- Table 3 – Types of survey and levels and information that might be revealed by surveys 30
- Table 4 – Examples of types and purposes of building and structure investigation 35
- Table 5 – Key features to be sampled for potential hazards 36
- Table 6 – Areas of an exclusion zone 76
- Table 7 – Examples of hazards related to the areas of an exclusion zone 85
- Table C.1 – Useful contacts for demolition work 139

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 158, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 31 December 2011. It was prepared by BSI Panel B/513/-/9, under the authority of Technical Committee B/513, *Construction equipment and plant and site safety*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 6187:2011 supersedes BS 6187:2000, which is withdrawn.

Information about this document

This standard has been revised to reflect advances in technology and equipment in the demolition industry, and to give recommendations on the following principal areas.

- a) Project development and management, site assessments, risk assessments, decommissioning procedures, environmental provisions and facade retention.
- b) Deconstruction techniques, including activities for reuse and recycling.
- c) Exclusion zones and safe working spaces, including their design and application.

Recommendations for methods of, and techniques for, demolition and partial demolition, including for structural refurbishment, have been retained, with consideration of specific types of structure, but the text has been significantly updated to reflect current and developing good practices. By being less prescriptive, this edition also allows for innovative techniques and methods to be employed.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard 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 provisions in this standard are presented in roman (i.e. upright) type. Its 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 British Standard cannot confer immunity from legal obligations.

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Introduction

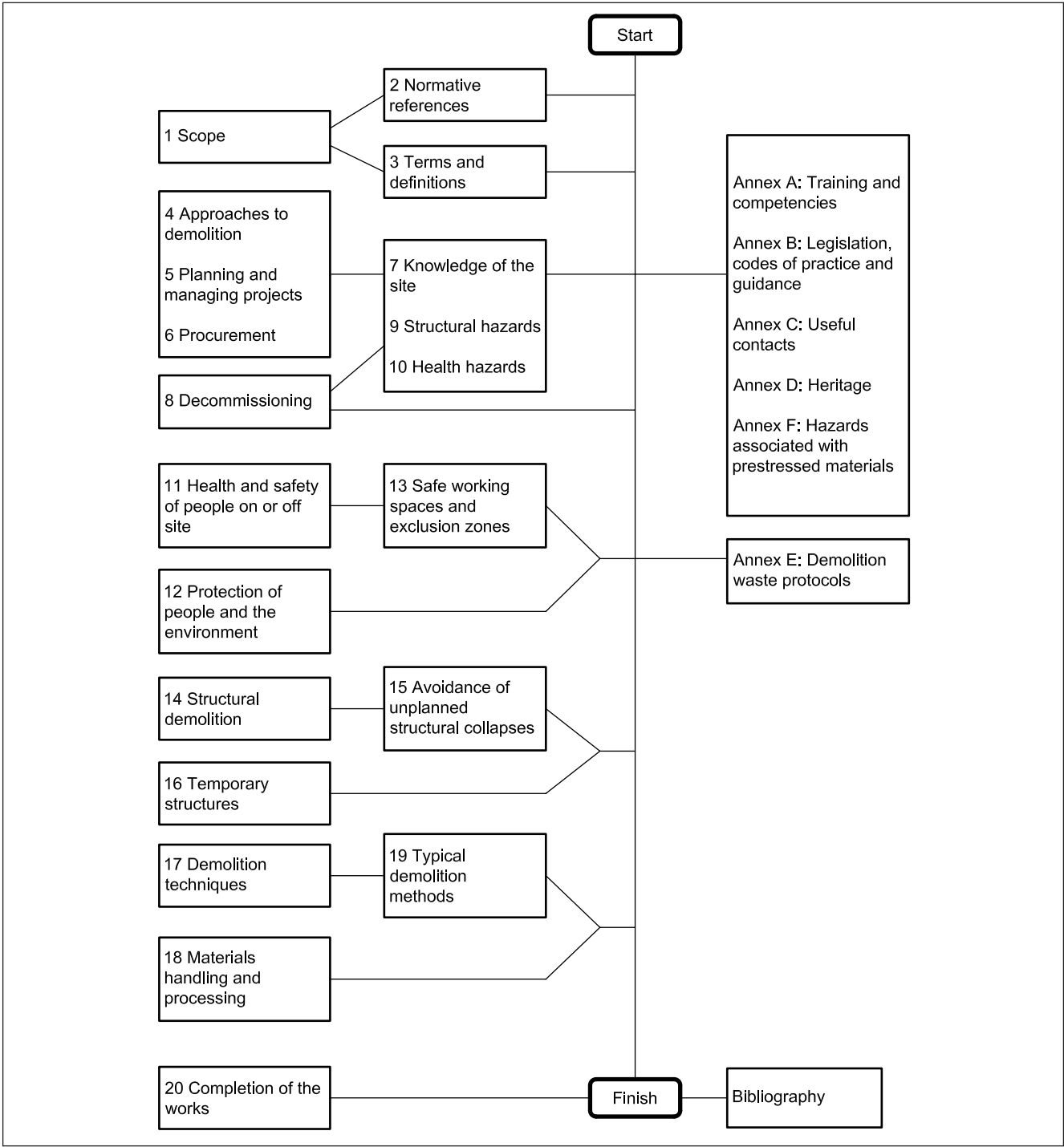
This code of practice concerns the process of demolition, including demolition as part of structural refurbishment, from initial considerations, through planning and design to the execution stages (see Figure 1).

The word “demolition” is often misconstrued to mean “large scale” or to involve the complete removal of a structure or building. However, the removal of a single element or the part removal of a structure or building also constitutes demolition. This standard is therefore intended to be applicable to those involved with all demolition activities, however large or small, including those undertaking partial demolition, which might be for structural refurbishment projects. Trade contractors unfamiliar with the vagaries of demolition activities required for structural refurbishment are advised to seek the advice of a competent practitioner. It is important to note that this standard does not cover all aspects of structural refurbishment; rather it is applicable only to those activities involving partial demolition.

Route maps have been included at the beginning of most clauses. These are not intended to be process flowcharts, but to guide the user through the information in the text. This is particularly in respect of the hierarchy and interdependence of use of the clauses and subclauses, which might not always be obvious because of the complexity of the demolition processes and the wide coverage of this document. Such projects, from inception to completion, include numerous activities, many of which are iterative and which require revisiting. For example, as the project moves through the tender process to contract acceptance and on to site operations, planned methods of work will be developed and augmented further at each stage.

This code of practice has been written on the understanding that the execution of its provisions is entrusted to appropriately qualified and competent people and organizations. Competence is about being able to do the work safely, without endangering others, and meeting the legal health and safety requirements. Clients and procurers of demolition works have a key role and have to take reasonable steps to ensure that those appointed or engaged by them are competent for what they are expected to do. Similarly, those accepting such appointments ought only to do so if they are competent to undertake the demolition or partial demolition activity.

Figure 1 Outline route map



1 Scope

This British Standard gives good practice recommendations for the demolition (both full and partial) of facilities, including buildings and structures. This standard is therefore applicable to demolition activities undertaken as part of structural refurbishment. It also covers decommissioning.

In particular, the standard gives recommendations for:

- a) the proper and effective management of demolition processes, including those forming part of structural refurbishment;
- b) maintaining structural stability, including through the provision of temporary structural support, where necessary;
- c) managing deliberate structural collapse;
- d) identifying and establishing responsibilities during all phases of the demolition processes;
- e) acquiring a knowledge of the site, including its former uses;
- f) managing environmental issues;
- g) managing health and safety hazards;
- h) carrying out risk assessments and planning the work accordingly;
- i) establishing and managing procedures effectively;
- j) determining and managing safe exclusion zones.

The standard takes into account safety, health and issues that affect the protection of the environment.

For the purposes of this standard, demolition activities include, for example, activities that might be known as dismantling, disassembling, demounting, partial demolition, removal, decommissioning, deconstruction and soft stripping, and structural refurbishment, including renovation, rehabilitation, rebuilding, remodelling, reconstruction, redevelopment, restoration, renewal, replanting, development, enlargement, extending, augmenting, conservation, modifications, alterations, structural alterations, upgrading and reroofing.

This standard is not applicable to all structural refurbishment activities; only those involving partial demolition.

It is essential that those carrying out demolition activities possess the necessary levels of competence. Clients or procurers of demolition works need to ensure that all contractors, designers and other team members that they propose to engage or appoint are competent to comply with the health and safety requirements necessary to undertake demolition activities. Annex A gives guidance on the training and competence required for the activities covered by this standard.

2 Normative references

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

BS 5228-1, *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*

BS 5228-2, *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*

BS 5607:1998, *Code of practice for safe use of explosives in the construction industry*

BS 5837, *Trees in relation to construction – Recommendations*

BS 5930:1999+A2:2010, *Code of practice for site investigations*

BS 5975, *Code of practice for temporary works procedures and the permissible stress design of falsework*

BS 6100, *Building and civil engineering – Vocabulary*

BS 6164, *Code of practice for health and safety in tunnelling in the construction industry*

BS 7121-1, *Code of practice for safe use of cranes – Part 1: General*

BS 7121-2, *Code of practice for safe use of cranes – Part 2: Inspection, testing and examination*

BS 7121-3, *Code of practice for safe use of cranes – Part 3: Mobile cranes*

BS 7121-4, *Code of practice for safe use of cranes – Part 4: Lorry loaders*

BS 7121-5, *Code of practice for safe use of cranes – Part 5: Tower cranes*

BS 10175, *Investigation of potentially contaminated sites – Code of practice*

BS EN 1991-1-6, *Eurocode 1 – Actions on structures – Part 1-6: General actions – Actions during execution*

BS EN 12811-1, *Temporary works equipment – Part 1: Scaffolds – Performance requirements and general design*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100 and the following apply.

3.1 adjoining owners

freeholders, owners, lessees, tenants and/or occupiers of a property adjoining the site of work

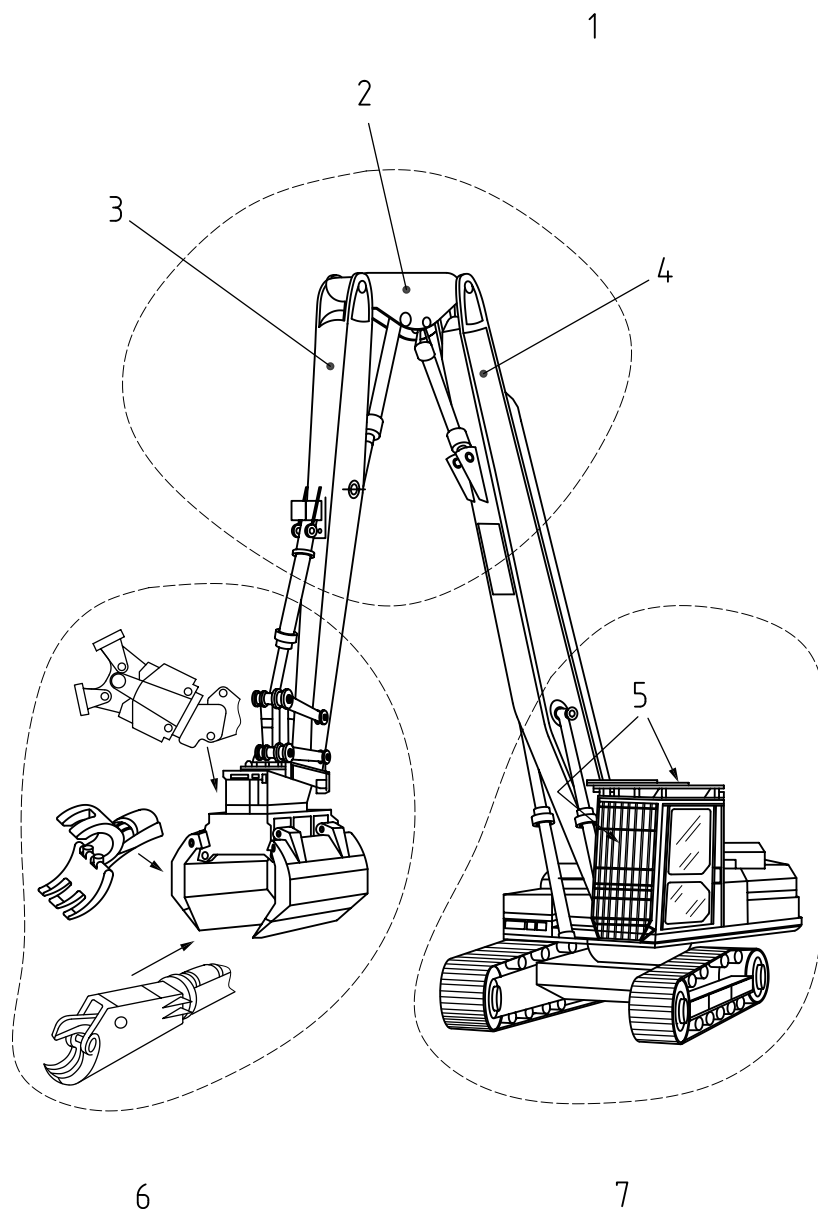
NOTE The term “adjoining owners” has a specific meaning under the Party Wall etc. Act 1996 [1].

3.2 attachment

assembly of components forming the working tool that can be mounted onto the base machine or (optional) equipment for specific use

NOTE See Figure 2.

Figure 2 Base machine, equipment and attachments

**Key**

- | | | | |
|---|--------------------|---|--|
| 1 | Equipment | 5 | Protective cage over and in front of operative's cabin (and to the sides if appropriate) |
| 2 | Optional extension | 6 | Examples of optional attachments |
| 3 | Dipper arm | 7 | Base machine |
| 4 | Boom | | |

NOTE 1 This is an example. The equipment and attachments can differ.

NOTE 2 The protective cage needs to provide a falling object protection structure (FOPS) and a falling object guard screen (FOGS). It might also provide a roll-over protective structure (ROPS).

3.3 base machine

machine without equipment and attachment that includes the mountings necessary to secure equipment, as required

NOTE For example, operator protective structures for demolition. See Figure 2.

3.4 building owner

person or organization having the right to refurbish, demolish or partly demolish a building, including plant or other structure, by virtue of legal ownership or other legal authority

NOTE The term "building owner" has a specific meaning under the Party Wall etc. Act 1996 [1].

3.5 client

initiator of the works for demolition or partial demolition for structural refurbishment

NOTE 1 The client is usually the structure owner, but could also be, for example, a main contractor.

NOTE 2 The term "client" can have a particular meaning in contractual relationships and has a specific meaning under the Construction (Design and Management) Regulations 2007 (CDM Regulations 2007) [2] (see 5.3.1 and 7.2.1).

3.6 cold cutting

method of cutting that generates no incendiary sparks and little or no heat

3.7 competent person

person with sufficient knowledge of the specific tasks to be undertaken and the risks which the work will entail, and with sufficient training, experience and ability to enable them to carry out their duties in relation to the project, to recognize their limitations, and to take appropriate action to prevent harm to those carrying out or affected by the work

(CDM Regulations 2007 [2], modified)

NOTE See Annex A.

3.8 complex structure

structure with unusual or complicated load paths and/or internal forces, which might not be obvious, that requires the planning of safe modes of failure during demolition activities following appropriate structural assessments and analysis

3.9 contaminated site

site which harbours residual health hazards resulting from the presence of physical, biological, ionizing or chemical entities

3.10 decommissioning

process whereby an area is brought from its fully operational status to one where all live or charged systems are rendered dead or inert and reduced to the lowest possible hazard level

NOTE 1 See also 3.23.

NOTE 2 Decommissioning includes decontamination, where appropriate. Some industries, e.g. the nuclear industry, have specific meanings for this term which include dismantling. In practice different hazard levels will apply. For the purposes of this British Standard, decommissioning does not include demolition or dismantling.

3.11 deliberate collapse

controlled removal or weakening of key structural members causing collapse in a planned way of the whole or part of the building or structure being demolished or partially demolished

3.12 deliberate removal

controlled removal of selected members of the structure by dismantling or deconstruction

3.13 equipment

set of components mounted onto the base machine to fulfil the primary design function when an attachment is fitted

NOTE See Figure 2 and 3.24.

3.14 exclusion zone

designated three-dimensional space from which all persons, including the public, are excluded during demolition activities

NOTE 1 One exemption is where an operator in a protected position is authorized to be within the zone to effect a particular demolition activity, such as initiating explosives.

NOTE 2 In certain circumstances, key personnel may remain within the zone for a specific task provided they are adequately protected.

3.15 facade retention

method of maintaining the stability of the outer wall of a building or structure in its original position during and following nearby demolition activities using auxiliary or temporary structures

NOTE See also 3.33.

3.16 fan

temporary platform at height used solely to contain any debris or other materials unintentionally dropped in the demolition process and prevent this from being a danger to persons or property below

NOTE 1 A fan is usually formed in scaffolding projecting from a building or structure at an inclined angle. See also 3.17.

NOTE 2 Fans are not intended to be used for access, storage of materials, accumulation of demolition debris or as working platforms.

3.17 gantry

designed temporary structure providing a covered way that protects people from unplanned falls of materials and/or a structure that protrudes from the building facade to facilitate the removal of debris and materials

3.18 hand-held equipment

powered portable equipment or manual tools held in and operated by hand

3.19 high-pressure water jetting

cutting, removal or cleaning of material using high-pressure water

3.20 hot cutting

method of cutting where heat is applied (e.g. by flame) or is generated

NOTE With this method there is potential for producing incendiary sparks.

3.21 materials recycling

action of reprocessing materials which have previously been processed for inclusion in a product

NOTE For example, concrete and bricks recovered through a reprocessing activity can be crushed, screened and sold as an aggregate.

3.22 mobile demolition machine

self-propelled machine made, or adapted for use, for demolition activities, which comprises a base machine (3.3), equipment (3.13), optional equipment (3.24) and attachments (3.2), as appropriate

NOTE See Figure 2.

3.23 mothballing

process of decommissioning and then preserving buildings, plant or structures in such a way that they can be readily brought back into service if required

NOTE See also 3.10.

3.24 optional equipment

optional items of equipment mounted onto the base machine to increase, for example, capacity, flexibility, comfort and/or safety

NOTE See Figure 2 and 3.13.

3.25 permit to work procedure

procedure which sets out the agreed work to be undertaken on identified equipment, or in an identified area, and the precautions to be taken and to be managed as part of a safe system of work

NOTE This is an additional level of management control provided specifically to ensure that risks arising during high-hazard activities are appropriately controlled. See 11.7.

3.26 prestressing

process whereby compressive stresses are built into the parent material by, for example, tensioning wires or bars to give added strength prior to working loads being imposed

3.27 prestressed elements**3.27.1 post-tensioned prestressed element**

structural element in which the wires or bars are, for example, tensioned after the material to be compressed (e.g. concrete) is in place and has reached a suitable strength

3.27.2 pretensioned prestressed element

structural element in which the wires or bars are tensioned prior to the placing of the material to be compressed (e.g. before concrete is poured) and then released after the material has reached a suitable strength

3.28 pretreatment

process of changing the physical, chemical or biological properties of material to facilitate its handling, recovery and disposal

NOTE Pretreatment can include sorting and segregation, provided this involves an element of recycling. All wastes are required to be pretreated prior to disposal.

3.29 pre-weakening

deliberate weakening of part of a structure as part of an efficient controlled design collapse mechanism to be effected a short time afterwards, while ensuring sufficient residual stability until deliberate collapse is initiated

NOTE See also 3.36.

3.30 product reuse

repeated use of products taken from buildings or infrastructure, in their original form, for the same or a similar application

3.31 progressive demolition

controlled removal of parts of a structure whilst maintaining the stability of the remainder as demolition activities progress through the facility

3.32 recovery

operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

(Waste Framework Directive [3])

3.33 shoring (including propping)

system of auxiliary supports which provide a load path to maintain stability during temporary states of the structure

NOTE See also 3.15.

3.34 site waste management plan (SWMP)

systematic identification of expected and actual waste arisings together with an appraisal and implementation of management options in line with environmental legislation and the principles of the waste hierarchy

NOTE 1 There are financial threshold values above which the Site Waste Management Plans Regulations 2008 [4] require an SWMP to be prepared.

NOTE 2 There are statutory variations in some parts of the UK. There is guidance particular to different areas.

3.35 structural refurbishment

alteration to an existing retained building or structure that involves removal or modification of structural elements or members, which might or might not cause instability

NOTE This includes removal or addition of structural elements, dismantling and partial demolition of the existing structure.

3.36 weakening

deliberate removal of parts of a structure that can reduce its ability to resist loadings, including imposed loadings and its own self weight

NOTE Weakening may be undertaken to create openings (e.g. in walls and floors) for removal of materials, for example, but excludes deliberate structural pre-weakening (see 3.29).

3.37 waste

substance or object which the holder discards or intends to discard or is required to discard

(Waste Framework Directive [3])

NOTE Any material no longer required by the original owner and, in the case of demolition, any material that leaves the site boundary, is legally classified as “controlled waste” and is subject to the provisions of the Environmental Protection Act 1990 [5]. Under case law [R (Save Britain’s Heritage) v. SSCLG 2010], any material no longer required by the original owner is classified as waste, regardless of whether it is sent for recycling or recovery, whether it has a commercial value and an end market, and whether or not it poses an environmental threat. This is important because demolition materials left on site for a period of time might need a permit to remain on site until a market is found. As a general rule, further use needs to be a certainty, not a possibility.

4 Approaches to demolition

4.1 Options assessment

Demolition, including demolition as part of structural refurbishment, may be just one option considered in a broader assessment, especially within an asset management context. A base assessment, e.g. options assessment, should therefore be carried out to ascertain the most appropriate options.

4.2 Assessment of approaches

On the basis of the results of the options assessment, one, or a combination of, the following approaches should be selected.

- a) Complete demolition with potential reuse of site (possibly by others).
- b) Complete demolition and rebuild.
- c) Partial demolition and building some new replacement facilities.
- d) Structural refurbishment (see Table 1).
- e) Structural refurbishment whilst not in use.
- f) Structural refurbishment whilst in use.

NOTE See also CIRIA C621 Good practice guidance for refurbishing occupied buildings [6] and also CIRIA C638 Climate change risks in building - an introduction [7].

Table 1 Determining the significance of demolition activities on structural stability

	Effect on fabric of facility	Effect on integrity of structure	Examples	Competence required
Structural refurbishment	Non-invasive		Shop fittings such as counters	
	Invasive	Non-structural	Non load-bearing walls	Ability to assess whether this is so; a structural engineer might be required
		Structural	Load-bearing walls	Structural engineer

4.3 Intervention principles

The extent and effect of any particular planned process or physical intervention should be assessed. A decision should be taken about which activities would be most appropriate.

When considering the activities and the possible methods to be adopted, the various hazards and thus potential risks should be assessed, for example, where materials are to be removed and where structural instability might be possible, whether planned or unplanned. The amount of materials to be removed is not necessarily the key criterion as the effect of their removal should be considered together with the proposed methods of removal, including the structural instability that could be caused. The need for auxiliary (or temporary) or permanent works to provide interim (or replacement permanent) support should be assessed and, if necessary, planned. The design should ensure that the structure is taken down in a planned and controlled manner, thus avoiding any unplanned structural instability or collapse.

4.4 Selection of the approach

When selecting an approach to demolition activities, a number of factors should be taken into account, including the following.

- a) The information given in relevant guidance documents.
- b) Health, safety and environmental requirements.
- c) The needs of the client, the users and the workforce.
- d) The type, age, condition, use and business activity (if appropriate) of the facility and local conditions and constraints (e.g. access, existing services, party walls).
- e) The need to avoid disruption to business continuity, the community and nearby structures.
- f) Legislative requirements (see 5.1.3).
- g) Party wall constraints.
- h) Cost and commercial benefits:
 - 1) cost of work; and
 - 2) existing and new revenue.

4.5 Choosing the methodology

To ensure a successful outcome, the decision about which of the following methodologies to adopt should take account of such factors as sustainability, waste strategies, client issues, risk management issues, e.g. increased risk of accident or injury, the potential for statutory nuisance, prohibition and prosecution, and insurance issues.

- a) Hand working (manually).
- b) Mechanical working (machine use).
- c) A combination of hand working and mechanical working.

EXAMPLE

A building contains a large amount of "soft strip" material. If the building is detached and there is adequate space around the structure, the decision may be taken to manually strip out all of the material to assist in a clean reduction of the remaining structure. However, if the same building is located in a heavily populated or dense area, such as a city or town centre, the best option might be to reduce the structure with all materials *in situ* and transport this elsewhere for segregation and processing.

4.6 Demolition activities in structural refurbishment

4.6.1 General

Because demolition activities as part of structural refurbishment can alter the load-bearing parts of the structure, the following issues should be assessed.

- a) The load-bearing requirements and the necessary temporary support system.
- b) The potential for unplanned collapse of structure (e.g. often due to lack of understanding of traditional building construction).
- c) Fire safety (e.g. fire loading, means of escape, protection).
- d) All services, including electricity and gas (e.g. isolation and disconnection of services, especially where properties either remain in occupation or are the subject of phased handover, leading to work being carried out with live services).
- e) Health issues [e.g. noise and vibration, the presence of asbestos, lead, silica, polychlorinated biphenyls (PCBs) or zoonoses carriers, the need to provide welfare facilities].
- f) Client issues (e.g. raising awareness, wide variation of client experience, provision of relevant information).

Competent advisors should be involved early in the process. When gathering information, the design team should identify and understand the concerns and needs of:

- 1) the client;
- 2) the occupier of the building (who might not be the client, but could be living in the building while the work is done);
- 3) the contractor; and
- 4) any third parties (e.g. members of the public, adjoining owners, emergency services, environmental matters).

The team should also identify the need during the project for emergency procedures in the event, for example, of fire, power loss and security incidents.

NOTE See also CIRIA C579 Retention of masonry facades - best practice guide [8] and C589 Retention of masonry facades - best practice site handbook [9].

4.6.2 Extent and effects of demolition activities in structural refurbishment

The degree to which demolition in structural refurbishment might be invasive and affect the structure should be assessed both before and during the work (see Table 1). This assessment should be undertaken for each element of work and then encompassed into the demolition plan.

4.6.3 Types of work involving partial structural demolition and structural supports

The type of instability created in a structure should be assessed before and after such work as the following is carried out.

- a) Removal of floors.
- b) Removal of walls.
- c) Chimney breast/stack removal.
- d) Alterations to traditional building structures.
- e) Forming new openings.

- f) Excavation/removal of foundations, etc., for basement construction under existing buildings and garden areas.
- g) Loft conversions.
- h) Facade retention.
- i) Cutting back floors to upgrade insulation/create mezzanine/two storey height areas in the building interior.
- j) Extensions.
- k) Construction of additional floors at roof level of existing buildings.
- l) Conversion of office buildings into residential/hotel accommodation.
- m) Structural refurbishment, such as:
 - 1) modernization, e.g. upgrading a facility where the same use is to be retained;
 - 2) change of use, including subdivision; and
 - 3) significant rebuild, e.g. undertaking major structural works but reusing the existing foundations and retaining the facade.

NOTE 1 Activities not generally described as structural refurbishment include maintenance jobs, such as painting, gutter cleaning and window cleaning.

NOTE 2 Table 2 gives examples of possible changes of use arising from structural refurbishment activities as a guide for broader risks, establishing the management criteria of the demolition work and the competencies required, particularly where there could still be occupation of the facility.

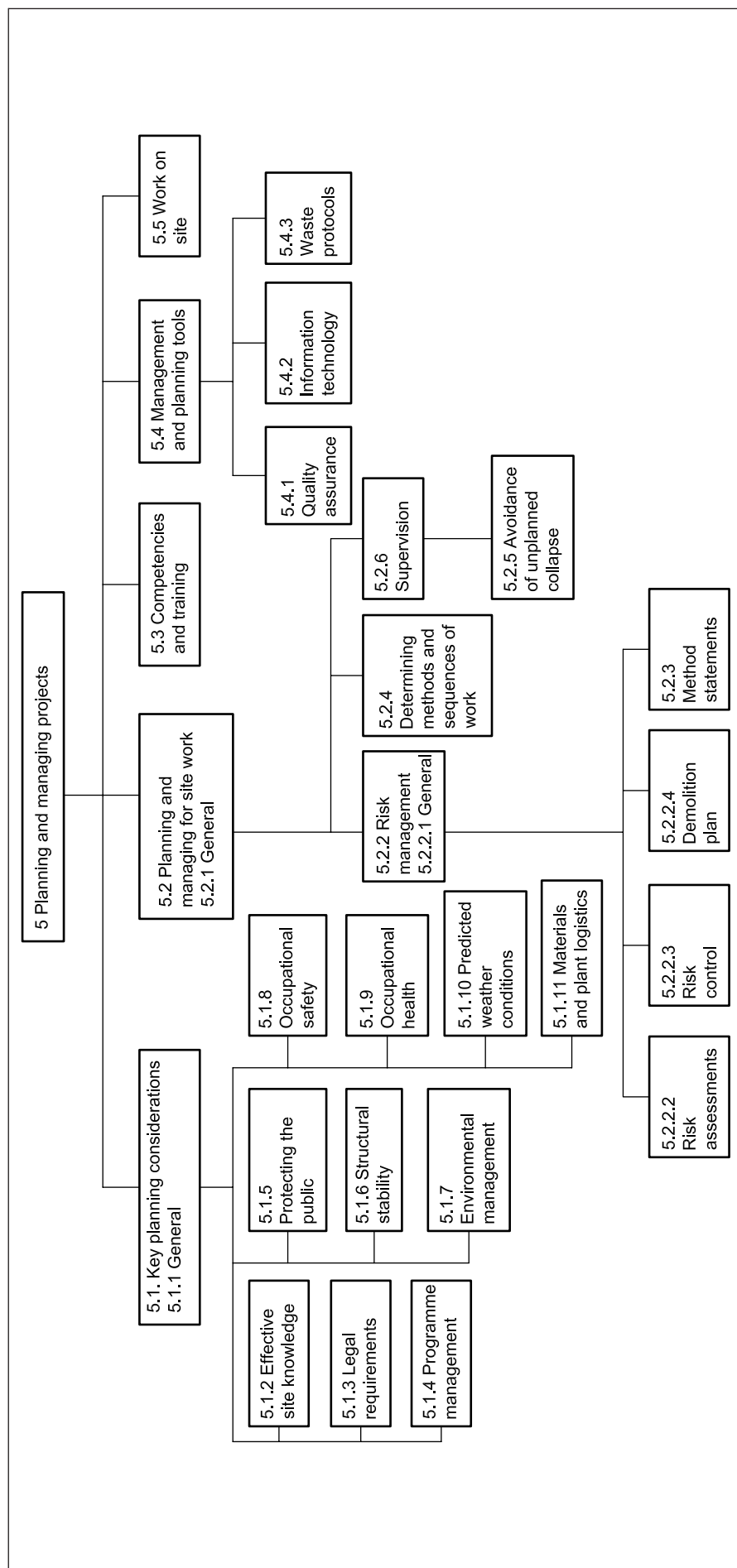
Table 2 Types of structural refurbishment

Category	Existing use	Possible change of use	Issues	Building type and occupancy (BS EN 1991-1-7: 2006, Table A.1 ^{A)}
Commercial	Office premises, car parking	Residential use, health or educational facilities	Structural alterations, new service ducts, asbestos	2A, 2B, 3
Industrial	Factory buildings, mills, warehousing and storage	Residential use, offices, restaurants and other entertainment	Proximity to other buildings, hazardous substances	2A, 2B, 3
Residential	Detached, semi-detached, terraced houses, flats	Residential, retail, offices, work space, catering	Requirement to carry out works while building/parts thereof in use	1, 2A, 2B, 3
Health	Hospitals, doctors' surgeries, other health facilities	—	Prevention of infectious diseases	2A, 2B, 3
Education	Schools, universities	Community facilities	Requirement to carry out works while building/parts thereof in use	2A, 2B, 3
Retail	Shops, shopping malls, warehousing	Residential, workshops	Structural alterations, new service ducts, asbestos	2A, 2B
Infrastructure	Bridges, power stations, waste water treatment works	Art gallery, residential, new technology	Structural alterations, new service ducts, asbestos	3

NOTE Attention is drawn to the Building Regulations [10, 11, 12].

^{A)} The classifications in this column relate to design requirements to ensure the ability of buildings to sustain localized damage without a disproportionate level of collapse.

Figure 3 Route map for Clause 5



5 Planning and managing projects (see Figure 3)

5.1 Key planning considerations

5.1.1 General

The issues in 5.1.2 to 5.1.11 should be addressed, as appropriate, when planning demolition projects. Sufficient lead-in time should be allocated for completion of these activities.

NOTE The key considerations listed in the following subclauses are relevant at many stages of work, from scheme concept and development, through tender development, tendering procedure and contract awarding procedures to contract management and work on site.

5.1.2 Effective site knowledge (see Clauses 7 and 8)

An assessment and survey of the site should be planned to identify the following, as far as possible.

- a) The extent of decommissioning.
- b) Details of the isolation or removal of services and details of temporary supplies.
- c) Knowledge and history of the structure, including form, materials of construction, structural interactions and location.
- d) Isolation and protection measures for adjacent structures.
- e) Hazardous materials.
- f) Previous uses of the site.

5.1.3 Complying with legal requirements (see Clause 11 and Clause 12)

5.1.3.1 Legislation

Arrangements should be put in place to ensure compliance with legislation in a number of different related fields, including the following.

- a) Waste management.
- b) Reuse and recycling.
- c) Control and minimization of nuisances to the site's neighbours, including:
 - 1) dust;
 - 2) noise;
 - 3) vibration;
 - 4) smoke; and
 - 5) traffic movements and management.
- d) Air overpressure.
- e) Environmental protection, including prevention of pollution.
- f) Occupational health and safety.
- g) Planning (including listed buildings and party wall constraints).
- h) Building regulations.
- i) Highways and roads.

NOTE A list of relevant legislation and official guidance is given in Annex B. Legislation can vary nationally or under local authorities. Information and advice can be obtained from regulating authorities, such as the Health and Safety Executive (HSE), the Environment Agency and local authorities. Further advice can be sought from the relevant professional bodies and industry associations. See Annex C.

5.1.3.2 Permissions, consents and licenses

5.1.3.2.1 General

Early consideration should be given as to whether any permissions, consents or permits/licences are required for the works and whether any special measures need to be put in place, particularly for works on dangerous structures or special (e.g. nuclear) sites and for works which could:

- a) affect a public or private road or highway, e.g. works which necessitate:
 - 1) the partial or total closure of the road or highway;
 - 2) the erection of temporary structures (e.g. scaffolds, fans, screens, hoardings and supports) on or over the road or highway;
 - 3) the use of plant or equipment on or over the road or highway; and
 - 4) the storage of site vehicles on the road or highway;
- b) affect features outside the curtilage of the site (e.g. footway lights, vaults and other voids under a highway);
- c) affect access routes, for example, to:
 - 1) an adjoining property; or
 - 2) utilities;
- d) involve scaffolding or a crane jib passing over an adjoining property; or
- e) involve the burning of waste in the open on site.

NOTE 1 Discussions might need to be undertaken with a number of parties, including regulating authorities (e.g. the local authority or Highways Agency), utilities providers, public transport operators, property owners or emergency services. All demolition activity in England and Wales requires planning permission.

NOTE 2 Special measures might include, for example, the provision of temporary diversions for both pedestrian and vehicular traffic in the event of a road closure.

5.1.3.2.2 Heritage site activities

The relevant local planning authority (LPA) should be consulted in good time for advice as to:

- a) whether consent is required for:
 - 1) demolition or partial demolition of a building or other structure that is a designated heritage asset ¹⁾ or is otherwise considered to have heritage significance meriting consideration in planning decisions; and
 - 2) work involving disturbance of the ground (such as removal of soil, foundations or buried services) in an area that is considered to be of archaeological significance;

¹⁾ The consent is generally incorporated in the necessary planning permission for the development. In the case of a building or other structure that is listed, a Listed Building Consent is also required; in the case of a building or other structure in a conservation area, a Conservation Area Consent is also required. Applications for planning permission, Listed Building Consent and Conservation Area Consent are usually published by the LPA for public consultation, comments from which are taken into account by the LPA in making its decision.

- b) what information will be required in any application; and
- c) whether the LPA intends to:
 - 1) place restrictions on the work, such as prohibiting alteration or demolition of certain parts of the structure, or require the use of non-contemporary materials or techniques, all of which could have cost and time implications; or
 - 2) require consultation with specialist bodies, which could again have a significant influence on project timing.

Consents should be applied for and obtained before demolition activities commence.

The timetable for applications and consents should also be established with the LPA, and taken into account in the programme for work on site.

NOTE Annex D gives details of the common sorts of Conditions that might be applied to a consent relating to heritage matters.

5.1.3.2.3 Other activities

The following activities should be carried out, where appropriate.

- a) Obtaining permissions from, and liaison with, for example, the police, roads and highways and local authorities, utilities, rail and waterways companies, and others as necessary.
- b) Prior agreement with the local environmental health departments about environmental noise.
- c) Application to the local authorities for licensing of crusher or screening plant.
- d) Possible permission from the local authorities and environmental regulator for on-site burning of waste materials.
- e) Prior consents or other agreements with the relevant regulator for the disposal of ground water or waste water and other fluid discharges.
- f) Waste management, including waste disposal.

NOTE 1 Attention is drawn to the Environmental Protection (Duty of Care) Regulations 1991 [13] and Waste Management – The Duty of Care – A Code of Practice [14], and the Landfill Regulations [15].

- g) Allocating site waste management plan responsibilities and requirements.

NOTE 2 Attention is drawn to the Site Waste Management Plan Regulations 2008 [4].

5.1.4 Programme management (see Clause 6)

A detailed programme and timetable of events, as appropriate, should be prepared, detailing the following.

- a) The scheme, sequence and method of proposed demolition.
- b) The plant required and its usage.
- c) Traffic management, the plan for controlling traffic to, from and within the site (see HS(G) 144 [16]).
- d) The management of arisings, including likely types and amounts, removal and temporary storage on site, and options for reuse, recycling, recovery, disposal, etc., where appropriate.
- e) Contingency arrangements, e.g. for partial collapses or misfires when explosives are used.

- f) The agreed start and completion dates.
- g) Any limitations, e.g. tidal, nightworks, seasonal.

5.1.5 Protecting the public (see Clauses 11, 12 and 13)

Arrangements for protecting members of the public should include the following.

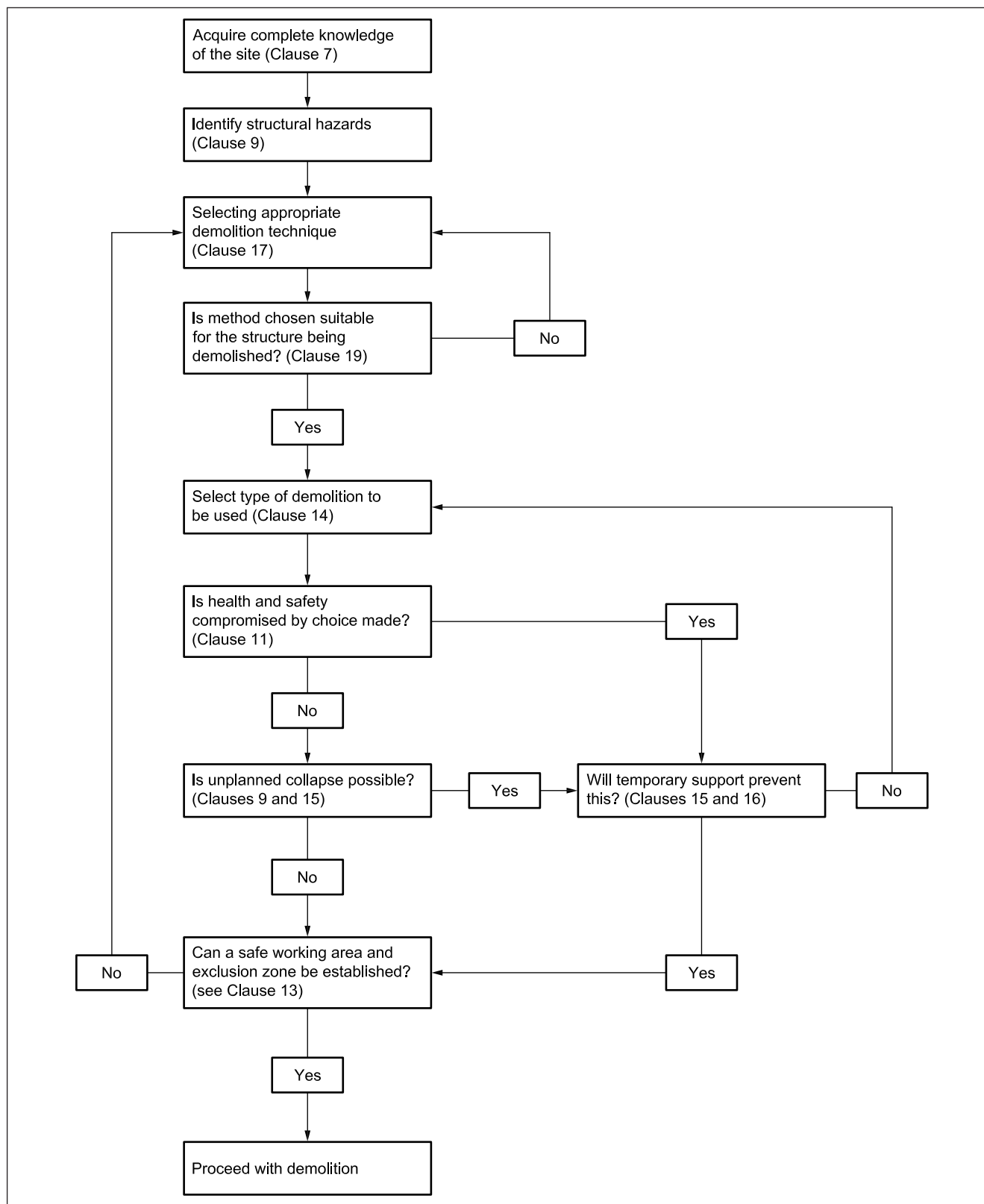
- a) Site security, including the provision of, for example, suitable fencing and/or barriers.
- b) The control of spectators and/or site visitors.
- c) Exclusion zones outside the site boundaries during critical aspects of the work, when appropriate.
- d) Containment of demolition materials.

5.1.6 Structural stability (see Figure 4 and Clauses 9, 14, 15 and 16)

The process for maintaining structural stability should be in accordance with Figure 4, taking the following into consideration.

- a) Avoidance of unplanned, including premature, collapses and maintenance of residual structural stability.
- b) Details of any pre-weakening and knowledge of the remaining structural stability designed by a competent engineer, including the sequence of the operation.
- c) Details of any auxiliary or temporary works to provide support designed by a competent engineer, taking into account adjacent structures.
- d) Previous collapse history relating to the form of the structure, e.g. large panel precast concrete construction (see 19.2.3) and lift-slab concrete structures (see Forensic Engineering ICE Conference proceedings).

Figure 4 Flowchart for maintaining structural stability



5.1.7 Environmental management (see 5.4.3 and Clause 12)

The need for the following should be assessed during the planning process.

- a) Control of noise at the site boundaries.
- b) Control of dust emissions.

- c) Waste management, including reduction, reuse and recycling.
- d) Minimization of materials haulage.
- e) Bunding arrangements for storage and dispensing of fuel oils.
- f) Wheel washing plant and road-cleaning arrangements, where required.
- g) Skip or truck sheeting arrangements.
- h) Arrangements for dealing with hazardous materials, e.g. flammable materials, gases, hazardous liquids and asbestos.
- i) Anticipated values of air overpressure and ground vibration.
- j) Areas of conservation, including flora and fauna.
- k) Minimizing landfill.
- l) Carbon consumption/agenda.

Clients and contractors should consider waste minimization and recycling in accordance with the waste hierarchy during the planning stages, and implement systems to prevent downstream breaches in environmental legislation, such as the duty of care, and illegal deposit of waste.

Priority should be given to minimization before construction, for example, through designs, layout and other decisions, with preference given to on-site reuse and recycling, followed by off-site reuse and recycling, recovery and disposal.

NOTE 1 European and national waste strategies and plans refer to the waste hierarchy.

NOTE 2 Waste protocols, such as the ICE Demolition Protocol [17] and the WRAP Quality Protocol for the Production of Aggregates from Inert Waste [18] (see Annex E), describe what is meant by the waste hierarchy in the context of demolition. The principles of the waste hierarchy are embedded in the Site Waste Management Plans Regulations [4] and Code of Practice [19], and other good practice guidance [20].

NOTE 3 All waste is required to be pretreated prior to landfill disposal.

NOTE 4 The Site Waste Management Plan Regulations 2008 [4] provide a formal framework to help contractors both comply with waste management law and incorporate resource efficiency into construction processes. While the regulations currently only apply in England for projects greater than a certain financial threshold, the site waste management plan approach provides a useful methodology which can help contractors achieve best practice for any size project. Contractors involved with smaller projects may prefer to use the Site Waste Management Plans Code of Practice 2004 [19] as a guide.

It is the responsibility of the client to ensure a SWMP is written before construction work commences, and during construction and afterwards the responsibility passes to the principal contractors.

NOTE 5 Further advice is available from www.envirowise.gov.uk/construction and www.wrap.org.uk/business/construction.html

The amount of space available on site for processing materials should be identified, e.g. where on-site processing is impractical, it might be more productive to send the waste to a materials recycling facility (MRF, also known as a "transfer station").

NOTE 6 Many of these waste disposal facilities are ideally placed to handle a large variety and volume of mixed materials direct from the demolition site. Because of the large volume of waste accepted at these facilities, separation of all types and grades of waste material makes for a cost-effective process and produces a high rate of resource efficiency, whilst reducing to an absolute minimum any waste destined for landfill. Although there is invariably a gate charge to dispose of the waste, the contractor generally saves that which would be payable through the landfill tax scheme.

During planning, advice should be obtained from local enforcement authorities as to what will be allowed for the burning of materials, both by open fire or incineration, as these activities are subject to local and national restrictions.

NOTE 7 The control of the burning of materials on site is generally subject to Section 80 (Nuisance provisions) of the Environmental Protection Act 1990 [5] and the Clean Air Act 1993 [21]. Burning waste in the open on a demolition site might require an environmental permit (England and Wales) or a waste management licence (Northern Ireland and Scotland) or registered exemption.

NOTE 8 Subject to certain exemptions, all companies undertaking demolition have to register with their local authority or waste regulatory authority for a certificate of registration before they undertake the work (see 5.3 and Annex A).

5.1.8 Occupational safety of the workforce (see Clauses 11, 13 and 16)

Measures for the following should be put in place.

- a) Obtaining details of personnel access and working platforms, including the procedure for their maintenance and subsequent removal as the structure is reduced.
- b) Establishing appropriate working spaces and exclusion zones.
- c) Protecting the workforce, including reference to any permit to work procedures.
- d) Providing effective communications, including warning signs and signals.

5.1.9 Occupational health of the workforce (see Clauses 10 and 11)

Processes for the following should be put in place.

- a) Hazard recognition, risk assessments and control measures for:
 - 1) substances potentially hazardous to health, e.g. from heavy metals or other toxic substances, including when working with materials which can be reused or recycled; and
 - 2) exposures to harmful substances such as asbestos and radioactivity.
- b) Assessments and control measures for noise on sites.
- c) Identification of deleterious atmospheres, such as oxygen deficiency in confined spaces.
- d) Hazard recognition and risk assessments for the need for, and the provision of, appropriate personal protective equipment (PPE).
- e) Appropriate welfare arrangements, including for when the work involves exposure to contaminated materials or dirty work.
- f) Health monitoring of all staff.

5.1.10 Predicted weather conditions

Arrangements should be made where appropriate for liaison with, for example, the Meteorological Office to obtain forecasts of sudden and severe weather changes, such as strong winds, lightning, snow and heavy rain, and indications of how these can affect the planned works and programme.

5.1.11 Materials and plant logistics

As materials and plant will be incoming and outgoing, the logistics for delivery, storage and movement, for example, should be planned effectively. The need for temporary, auxiliary and permanent items should be assessed, taking account of the need to manage the waste streams from the site.

NOTE This might be particularly relevant for phased operations and where partial demolition is being undertaken on premises that are still occupied.

5.2 Planning and managing for site work

5.2.1 General

Demolition works should be planned in such a way that it is undertaken using systems of work that take into consideration safety, health, the environment, and efficiency.

All those involved from concept through tender to contract execution should ensure effective planning and communication, and the provision of sufficient time to allow the execution of a successful and efficient project.

The timescales required for the acquisition of any licences or permits should be allowed for in the programming of works.

After the contract has been awarded, and before work commences, the contractor should determine the proposed safe sequence of operations on the basis of an assessment of the comparative risks, related specifically to the site and conditions. This sequence should be used to assess and expand the construction phase plan (CPP) for the tender and proposed programme of works. The expanded plan for the tender should form the basis of the CCP (demolition plan) for the demolition. SWMPs may also be considered.

The methods of work should allow for demolition activities and site clearance as stipulated by the contract, taking account of any constraints imposed by the client.

Adequate time should be allowed for setting up the site prior to work commencing and for executing the works.

5.2.2 Risk management

5.2.2.1 General

Tenderers/contractors should look for the hazards in the project, including how and where the work could be done and the equipment and materials used.

When planning methods and sequences of work, a suitable and sufficient risk assessment should be carried out in accordance with 5.2.2.2 and recorded. This should include selecting methods, materials and equipment to remove or minimize risk from work.

5.2.2.2 Risk assessment

The following principles of risk assessment should be followed when determining methods and sequences of work.

- a) Identify the hazards associated with the proposed work.
- b) Consider who might be harmed and how, including workers, site visitors, members of the public and anyone affected by the work.
- c) Evaluate the risks and identify the precautions required by, for example, comparison with good practice and categorization of risk level (likelihood and severity).

- d) Record the findings and implement the control measures for the residual risks.
- e) Review the risk assessment and update if necessary.

The risk assessment should take into account any constraints that the client has identified, but the contractor should be given the freedom to determine the proposed methods of demolition.

The risk assessment should identify the risks associated with the work and enable the contractor to select appropriate demolition solutions that remove or reduce the risks before the work commences.

The contractor should then select the most suitable methods of demolition which include measures to properly control any remaining risks (see 5.2.2.3).

5.2.2.3 Risk control

The steps required for effective risk control are simple. First, a determination should be made as to whether the hazard can be eliminated altogether. If not, consideration should be given to the control measures required to reduce harm, e.g. equipment, systems of work and sequencing. If the risk is unacceptable, alternative control measures should be applied till the risk is acceptably low.

The following principles should be applied to the control of risk.

- a) If possible, avoid the risk completely by using safer alternative methods or materials.
- b) Address risks at source, rather than using superficial control measures that result in a high or unnecessary residual risk remaining in place.
- c) Wherever possible, adapt the work to the individual, particularly in the choice of work equipment and methods of work, as this makes the work less monotonous, improves concentration and reduces the temptation to improvise equipment and methods.
- d) Take advantage of technological progress, which often offers opportunities for safer and more efficient working methods.
- e) Incorporate the protective and preventive measures into a coherent plan to reduce progressively those risks which cannot altogether be avoided, taking into account working conditions, organizational factors, the working environment and social factors.

5.2.2.4 Demolition plan

All demolition, and partial demolition, activities should be planned and carried out such as to remove or reduce the risks to people to as low as reasonably practicable. The arrangements for carrying out such demolition, or partial demolition, should be recorded in writing before the demolition work begins, with a level of detail proportionate to the risks involved. For projects notifiable under the CDM Regulations 2007 [2], the demolition plan should form part of the CCP prepared by the principal contractor. On individual projects, the demolition plan should be the focus for ensuring adequate cooperation, coordination and planning between all members of the project team.

Adequate pre-construction information should be provided by the client to allow the contractor to identify the hazards and risks associated with the proposed work.

5.2.3 Method statements

5.2.3.1 General

Method statements should address the particular needs of the site and detail the planned sequences and methods of demolition works. The proposed working methods should be assessed to determine whether a number of method statements are required, particularly where the operations are phased.

Method statements should be prepared in such a way that they enable supervisors and managers to ensure that persons on site are made aware of how the work is to be carried out, including the sequence of operations, the plant and types of equipment to be used and the precautions to be taken, as appropriate.

NOTE Methods such as "tool box" talks are recommended to help in disseminating the information, especially for those carrying out the work.

Method statements should be regarded as live documents and modified as required to cater for planned changes in systems of work. Any modifications should be made in accordance with 5.2.2 and 5.2.4.

5.2.3.2 Format

Each method statement should be succinct and should form a single document, including site plans, annotated diagrams and a detailed programme for the work, to clearly communicate to those carrying out the work on site what is required. A logical order should be followed. It should be easy to understand, and agreed by and known to all levels of management and supervision. Repetitive tasks may be covered by standard sheets, but critical activities should be specified in full.

NOTE The use of photographic sequences has been found to be effective.

Each method statement should be clearly marked with the date of preparation and any revision number or letter, so that the latest edition can be readily identified.

5.2.4 Determining methods and sequences of work

The chosen methods of work should be determined in accordance with 5.2.1 and 5.2.2 and detailed in each method statement (see 5.2.3).

When proposed methods of work need to be altered because of changed and/or unforeseen circumstances, the cycle of determining methods and sequences of work should be repeated, commencing at 5.2.1.

New methods should not be applied on site unless agreed by all concerned. They should then be included in a revised method statement that should then be promulgated before implementation.

Operatives about to carry out work should be informed of the methodology and be required to give an acknowledgement of understanding of the safe system of work.

5.2.5 Avoidance of unplanned collapse: surveys

Inspection surveys and assessments should be undertaken before work is carried out. The chosen methods of work should be such that demolition activities can be carried out in such a way that the unplanned collapse of any part is avoided by maintaining the structural stability of the remaining parts at all times. The methods of work should therefore emphasise the importance of planning surveys, including those of the structure, being undertaken before any work is carried out. The types of surveys required should be explicit and the reasons given if they relate, for example, to features which might not be immediately apparent. Such surveys may be intrusive to ensure an adequate survey of the structure is undertaken. The surveys should permit structural assessments to form a fundamental basis for maintaining adequate structural stability at all times, so the terminology and requirements should be clear to avoid any misunderstandings.

CAUTION: The term “structural survey” can cause confusion as its meaning can differ, for example, when the term is used by estate agents where the survey is for different purposes, such as valuation.

NOTE 1 See also Clause 7, which includes advice about types of surveys, inspections and assessments.

NOTE 2 Unplanned collapse can result from instability caused by, for example, the interruption of load paths or from overloading individual elements.

NOTE 3 The IStructE guide, Appraisal of existing structures [22], gives advice.

A detailed structural assessment should identify any weak elements, supports or connections, and allow for the overall stability throughout demolition to avoid danger from unplanned collapse, including neighbouring properties. The findings should be recorded within the risk assessment (see 5.2.2.2).

When methods of work require modification, the structural assessment should be revisited and, if necessary, revised.

5.2.6 Supervision

Managers and supervisors should ensure that the planned method of work arising from any assessment is monitored for its correct implementation during the demolition processes, and that the actual conditions found on site, e.g. concerning the type and strength of the structure, confirm the assumptions made in any survey of the structure, the risk assessment and the planned method of work.

NOTE 1 Those undertaking demolition activities are required by health and safety legislation to employ a competent person to supervise and control the work on site.

Where two or more of those undertaking demolition activities take part in work on the same site, each should appoint persons to supervise the work. To ensure the safety of the whole works these persons should collaborate in the planning and execution of the work.

NOTE 2 See 5.5.

Those undertaking demolition activities should maintain competent supervisory staff on site throughout the working day. The extent of supervision and management should be appropriate to the complexity and extent of the work to be undertaken. Supervisory staff should have direct access to higher management at all times.

5.3 Competencies and training

5.3.1 Competencies

All demolition and structural alteration activities should be carefully planned and carried out by competent practitioners and organizations. People making appointments should take reasonable steps to ensure that those appointed are competent for what they are expected to do. Likewise, those accepting such appointments should only do so if they are competent to undertake the particular activity. Clients and procurers of demolition works have a key role and should ensure that all contractors, designers and other team members that they propose to appoint have either the competence to carry out the work themselves or have engaged the services of an individual or organization with these competencies.

NOTE 1 See Annex A for further details on competence and training.

NOTE 2 The CDM Regulations 2007 [2] place responsibilities on the client and other persons involved with construction activities, including demolition works, to ensure that competent persons are employed on the project.

5.3.2 Training

Management should ensure that the necessary levels of competence exist and are developed by appropriate training as required. This should include industry-recognized training schemes intended to ensure that managers, supervisors and operatives in the demolition industry are competent at the level of experience that they claim and that they have received suitable training in, for example, health and safety and waste management.

NOTE Bodies providing industry recognized demolition training schemes are listed in Annex C.

5.4 Management and planning tools

5.4.1 Quality assurance (QA)

As part of rigorous project management, consideration should be given to using QA systems to help compliance with environmental, health, safety and legal requirements.

NOTE Users of this code of practice are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 and BS EN 14000 series by an accredited third-party certification body.

5.4.2 Information technology (IT), including knowledge-based systems

Computer-based IT should be used, where appropriate, to record, access, search, update and retrieve information about the demolition process.

The potential for the use of innovative technology, including IT systems, should be explored, for example:

- a) virtual reality;
- b) knowledge-based and expert systems;
- c) robotics;
- d) sensing and recording devices including lasers;
- e) three-dimensional modelling;
- f) project management and project control systems; and
- g) the internet, e.g. SMARTWaste and BREMAP, hosted by BRE which offers a

SWMP tool and a database for recovering and exchanging construction and demolition materials (see Annex C for useful website addresses).

NOTE The Data Protection Act 1998 [23] is applicable to the storage of personal information.

5.4.3 Waste protocols

The client team should engage in early discussions to secure the highest value recovery of products and materials by implementing an appropriate waste protocol at an early stage of a project where removal of materials is being considered as an option. A number of such protocols are available and should be considered, and the client may require the use of a protocol that is more suitable for a particular application. The client should therefore ask for a waste protocol to be taken into account.

NOTE More background on, and examples of, such protocols are given in Annex E.

5.5 Work on site

Where more than one contractor is working on the same site, one party should have the authority to coordinate and manage all the activities on the site. If the project is notifiable under the CDM Regulations 2007 [2], such authority should be vested in the principal contractor. Particular attention should be paid to such issues as the following.

- a) Fire, including process and general fire precautions.
- b) Waste management.
- c) Electrical distribution.
- d) Transport on site.
- e) Deliveries to the site.
- f) The proximity of different contractors' operations and allowance of clear routes to and from each area of operations
- g) Exclusion zones.
- h) Auxiliary or temporary works.

6 Procurement

6.1 Professional advice

The client should be aware of any direct responsibilities under their duty of care and receive professional advice as appropriate.

All demolition activities should be planned, designed and undertaken following agreement of a formal written contract. This should be entered into and signed by both the client (or their legal representatives) and the contractor undertaking demolition activities. Standard forms of contract, which can be obtained from various sources, e.g. professional bodies and industry associations (see Annex C), should be used.

Subcontracting the whole or part of the works should only be permitted with the prior written consent of the building owner. Where such consent is granted, the terms of the contract should be the same as those between the building owner and those undertaking demolition activities.

6.2 Scheme for demolition and contract documents

A proposed scheme for demolition, and associated contract documents, should include, as appropriate, the following.

- a) The location and site of the works.
 - b) All relevant site surveys (see Clause 7).
 - c) Plans showing the position, ownership and nature of boundary walls, fences, hedges and trees, and the location of buildings, structures or subterranean features that are to be the subject of the works or that are to be preserved.
 - d) Plans obtained from utility companies showing the alignment, position and depth of all their cables, pipes, ducts, tunnels, apparatus and equipment, together with any special requirements to safeguard and maintain, where necessary, their installation and service.
 - e) Written confirmation from each of the utility companies providing services on the site, e.g. water, gas, electricity, telecommunications, that they have disconnected their supply.
 - f) Highways authorities and/or police requirements regarding the position of points of access to and egress from the site and the periods of the day when such access/egress will be permitted.
 - g) Local requirements relating to the provision of hoardings, gantries, walkways, fans, scaffolding, working arrangements and notices prior to commencement of work by those undertaking demolition activities.
 - h) Insurance provisions to indemnify the building owner and cover employers' public and third party liabilities to a specified level appropriate to the scheme and sufficient to cover any specified risks arising as part of the works.
 - i) The action to be taken by those undertaking demolition activities to protect specified features of heritage or geological importance during the works and, if unknown at the commencement of works, provisions as to the notification of such items and costs arising from the need to preserve them.
 - j) The appointment and duties of the person supervising the demolition activities for the building owner.
 - k) A contract appropriate to the scheme, including provisions setting out the roles of the parties, the agreed works, the method of dealing with any delay in the progress of the works, completion of the works by the building owner if the contractor is unable to complete the works at the required time, payment provisions, insolvency of either the building owner or contractor, and other appropriate conditions.
- NOTE 1 The Scheme for Construction Contracts (England and Wales) 1996 [24] affects procedures for demolition contracts. It is automatically applicable to all contracts signed after the scheme that brings the Housing Grants Construction and Regeneration Act 1996 [25] into effect. See also similar schemes for Scotland and Northern Ireland.*
- l) The date, where known, for commencement of the works and the date, or time allowed, for the completion of the works.
 - m) Any party wall agreements and schedules of condition, including photographic materials and a list of adjoining owners' names and addresses, together with those of their agents, agreed between the building owner and adjoining owners/occupiers.

- n) Indication of any known prescriptive rights of support, rights of way which have been acquired, easements, covenants or licenses and other property rights.

NOTE 2 Such rights can include rights of support provided by part(s) of the building owner's building to an adjoining building.

- o) The specification of the works should be clear and unambiguous, provide the contractor with the building owner's requirements and a list of all documents, plans and notices, and include information obtained by the building owner necessary for incorporation in the contract.
- p) Specific constraints imposed on working methods, including arrangements in respect of hazardous materials.
- q) The decommissioning report for the site.
- r) The demolition plan (see 5.2.2.4).
- s) The health and safety file (for previous work when available).
- t) The SWMP.

NOTE 3 The provision for SWMP may be passed on through the tender process: clients are increasingly producing high-level waste management strategies with outline SWMPs which form part of the tender.

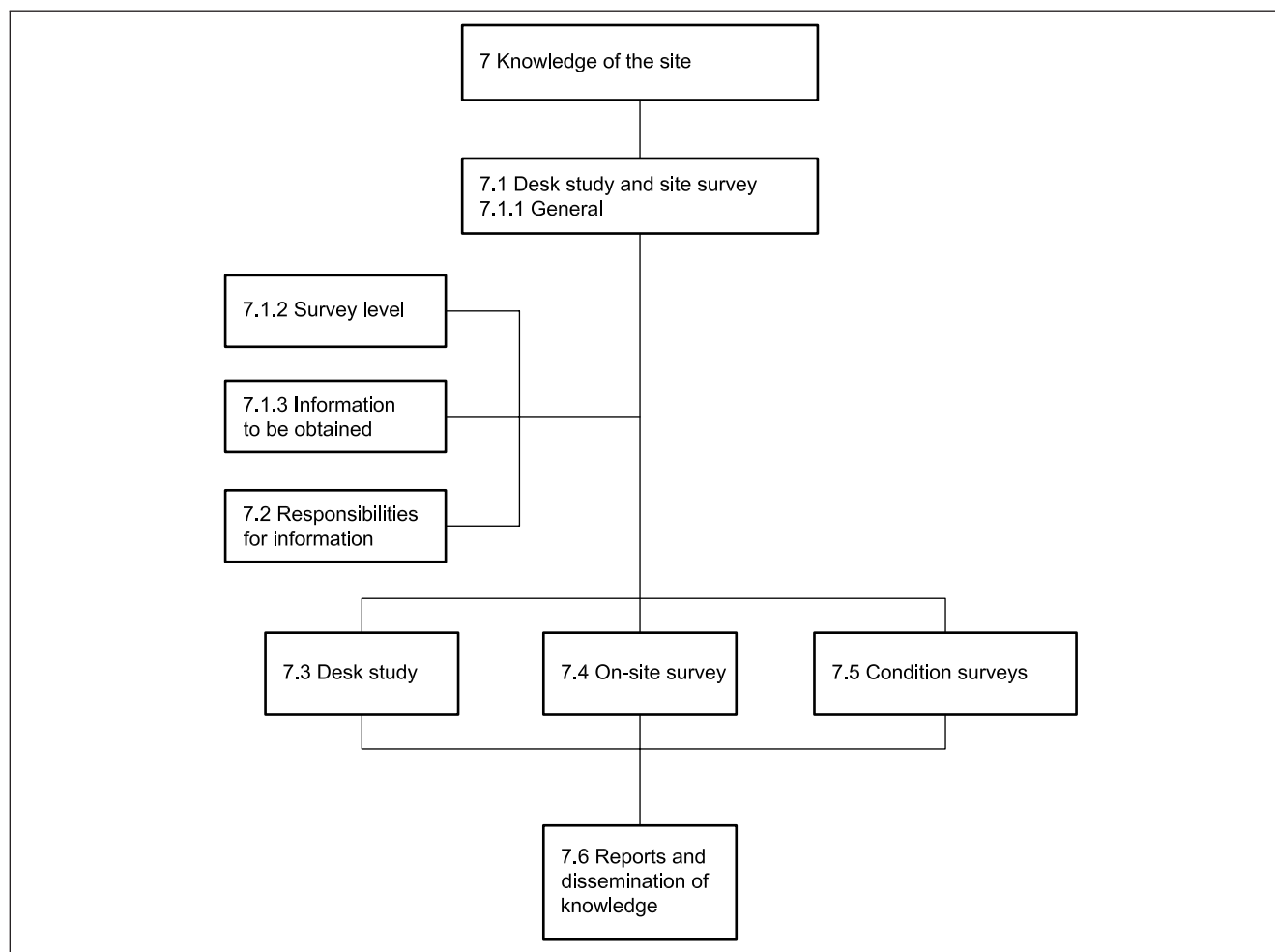
NOTE 4 For larger projects, the SWMP may be a key environmental mitigation measure, or may even be passed on as a planning Condition.

6.3 Tender procedure and administration

Tendering for demolition works, separately or as part of a larger contract, should follow the procedures used in good construction industry practice. Professional advice should be sought to assist the building owner in the preparation of tender documentation and the selection of contractors to undertake the work.

7 Knowledge of the site (see Figure 5)

Figure 5 Route map for Clause 7



7.1 Desk study and site survey

7.1.1 General

The following should be undertaken to obtain a clear understanding of the site's state and condition.

- a) An initial desk study (see 7.3).
- b) An on-site survey (see 7.4).

NOTE 1 This understanding is fundamental to the completion of a successful project in terms of the environment, efficiency and health and safety, including physical and health hazards. The information is needed initially for the tender stage.

NOTE 2 In this context "the site" includes everything above, at or below ground level, within the area under consideration.

Off-site features that can affect work on site should also be determined and the condition of adjoining premises surveyed, where necessary (see 7.5).

The assessments/surveys might need to be repeated when work starts on site as more information is revealed as demolition proceeds. Any additional information should be incorporated into the risk assessment process and reviewed to establish whether the methods of work need to be amended.

CAUTION: Buildings should be considered on their own merits since geographical variations in structural approach often occur between apparently similar buildings. Additionally, the original structure might have been subject to structural alteration in the past and might not be as initially expected.

7.1.2 Survey level

The appropriate level of survey should be identified and undertaken prior to work commencing (see Table 3).

Table 3 Types of survey and levels and information that might be revealed by surveys

Type of survey	Examples of levels and information that might be revealed
Structural	Desktop; visual; intrusive
Utilities	Desktop; intrusive
Asbestos	Refurbishment and demolition survey
Topographical	Dimensional; services information; environmental information; vegetation (inc. tree preservation order information); hazard identification; party wall issues; neighbouring properties; rights of way
Geotechnical	Existing foundations; desk study; trial pits, boreholes; interpretative reports on ground conditions; contaminated land surveys
Services on site	Desk study (incoming services and distribution on site); intrusive (confirmation of accuracy of desk study)
Environmental	Watercourses; contaminated land; pest infestations; dry rot

NOTE See also CIRIA C653 Reuse of foundations [26].

7.1.3 Information to be obtained by desk study/on-site survey

7.1.3.1 Industry processes and materials

The desk study/on-site survey should identify any industrial processes that have taken place on the site, and their associated materials, particularly hazardous residues, including the following.

- Materials forming, and within, the fabric of the building(s) and other structures.
- Raw materials.
- End-products.
- By-products or wastes.
- Materials from neighbouring sites.
- Organic deposits.

A systematic approach should be used including a pre-demolition audit.

7.1.3.2 Built environment

The desk study/on-site survey should gather information about aspects of the built environment that could pose a risk to health and safety, including the following.

- Physical features, either natural or built, such as buried tanks or waste materials.
- Form, type, elements and other features of the building(s) and other structures.
- Design and load paths, including stability features, of the building(s) and other structures.

- d) Construction materials and strengths of constituent materials.
- e) Any peculiarities of, or modifications to, the building(s) and other structures.
- f) Other potential physical hazards, e.g. from plant, machinery and equipment.
- g) Claddings and coverings that could be a health risk, e.g. asbestos lagging or sheeting.
- h) Health risks from the building fabric, e.g. treated timber.
- i) Previous collapse history relating to the form of the structure, e.g. large panel precast concrete construction (see 19.2.3) or lift-slab concrete structures.

The types of hazard associated with materials in the built environment, which can be toxic, carcinogenic, pathogenic, sensitizing, corrosive or irritant, should be identified, for example:

- 1) radioactive materials;
- 2) fibres which can be harmful, such as asbestos and man-made mineral fibres; and
- 3) chemicals which can be harmful, such as polychlorinated biphenyls (PCBs).

7.2 Responsibilities for acquiring and providing information

NOTE The responsibilities for providing information are addressed by criminal, civil and common law and professional liabilities.

7.2.1 Client

The client should:

- a) initiate the desk study and on-site site survey so that a detailed site report can be produced (see 7.6), providing drawings and sketches for information that incorporate any alterations that have occurred;
- b) arrange a pre-demolition audit to identify the types and amounts of waste that are likely to be produced and how they are to be managed, and feed this information into the SWMP, where one is required;

NOTE 1 The client has ultimate responsibility, but the principal contractor assumes responsibility for producing and implementing the SWMP.

- c) arrange for a decommissioning report (see 8.1.3) to be prepared which, amongst other things, identifies specific areas of concern relevant to future demolition work;
- d) engage professional advisers, where appropriate, and provide full and accurate information to enable them to carry out relevant surveys which aid in the preparation of the tender documentation;

NOTE 2 The appointment of a professional adviser does not ultimately relieve the client of their responsibilities.

- e) make available the decommissioning report and results of surveys at the tender stage to assist in the provision of a tender that covers the cost of dealing with the identified issues;
- f) appoint the principal contractor and provide full and accurate information before work commences; and
- g) respond to requests from the professional advisers or principal contractor for further information.

NOTE 3 Attention is drawn to the CDM Regulations 2007 [2].

7.2.2 CDM coordinator

On projects notifiable under the CDM Regulations 2007 [2], the CDM coordinator should ensure that:

- a) the required information about the site and proposed work is collected in the principal contractor's construction phase plan, which should incorporate the demolition plan (see 5.2.2.4);
- b) during the execution of the work, any additional relevant information is collected and incorporated into the health and safety file (see 20.2) to be given to the client on completion of the project.

NOTE The CDM Regulations [2] require a CDM coordinator to be appointed on notifiable projects. CDM coordinators have statutory duties that include ensuring that the relevant information regarding the site is passed over to contractors, in a timely manner, in order for them to formulate the safe methodology, method statements, risk assessments and demolition plans prior to works commencing.

7.2.3 Professional advisers

NOTE Professional advice may be drawn from a number of disciplines which could include independent consulting engineers, surveyors, environmentalists and CDM coordinators. Equally, the information needed by the client and/or client team may be drawn from within the organization.

Professional advisers should ensure that initial and/or additional information that could affect the planned site activities is given in a timely manner, and is effective, relevant and accurate.

They should be receptive to requests from contractors for further information, particularly if the planned works include demolition activities where such information is critical to the planned and safe execution of the work.

7.2.4 Contractors

Contractors should:

- a) ensure they have all the information necessary to undertake the work in a safe and efficient manner;
- b) confirm receipt of all such information provided by the client, requesting any additional information that is required; and
- c) verify the information received before it is used in the preparation of proposed methods of work and the development of the demolition plan and the SWMP, where the latter is appropriate.

NOTE If the SWMP applies directly to the demolition contractor as principal contractor, they are required to name the person producing the SWMP. If the demolition team is subcontracted, responsibility lies with the principal contractor.

7.3 Desk study

7.3.1 General

The desk study should identify:

- a) all former uses of the site, including its buildings, taking account of:
 - 1) any manufacturing processes and materials that are likely to have been present; and

NOTE 1 Where adequate information or detail cannot be obtained for a specific site, a more general review of processes and practices appropriate to the industry can be made to give an indication of potential hazards. For a given industry, the processes and materials are often similar regardless of geographical location.

- 2) any hazards, including gases or chemical contaminants and the possible locations of hazards from gas or chemicals, with a schedule containing a preliminary assessment of the nature of the hazard at each location and suggestions for suitable means of dealing with it;

NOTE 2 Any contamination is likely to be concentrated in particular areas of a site. The investigations can become complex when many changes of use have occurred during the site's history of occupation.

- b) structural features, such as:
 - 1) below-ground structures, e.g. basements, cellars, tanks and vaults with no structures on top, and their proximity to the boundaries of the site; and
 - 2) above-ground structures, including those with basements, etc., and those at or near the boundaries of the site;
- c) topographical features, such as trees and water courses which can require protection (see **12.3.12** and **12.4**), or otherwise affect the planning of the work;
- d) ground conditions, including the water table, the potential for flooding (see also **11.9**), ground types, and the presence of sink holes, mineshafts and shallow workings;
- e) access routes that have been established to, from and around the site;
- f) the location and type of services, both above and below ground, as these can pose a hazard or require protection, isolation or diversion, including details of relevant contacts;
- g) the presence of neighbours whose premises or equipment:
 - 1) might be sensitive to the works, e.g. impact vibration, noise, dust or electronic transmissions; or
 - 2) might impact upon the works, e.g. by producing radio transmissions that could affect the use of electric detonators;
- h) expected waste arisings and options for waste management (see **12.3.2**), including special or hazardous wastes [see also item a)2)].

NOTE 3 If subcontractors are undertaking the work, information needs to be obtained from the main contractor regarding SWMP requirements. Ideally, the main contractor will work in partnership with key subcontractors (such as the demolition contractor) to agree achievable SWMP objectives, particularly in relation to reuse and recycling options.

7.3.2 Types and sources of information

The following types of information should be considered during the desk study.

- a) Graphical, such as drawings and historical maps.
- b) Pictorial, such as photographs, engravings and paintings.
- c) Textual, such as trade directories and special interest books.
- d) Verbal, such as personal recollections.

Information may be obtained from the following sources during the desk study.

- 1) County, national and industry-based archives and records offices, local history societies, libraries and museums.
- 2) Local government departments, such as planning and building control, and central government organizations, such as the Health and Safety Executive (HSE), the Environment Agency (EA) and the Scottish Environment Protection Agency (SEPA).

3) Internet and data warehouses.

Archive material should be used cautiously as conditions might have changed since the archive was prepared or the original information might have been inaccurate. Any modifications that have taken place on site since the creation of the archive should be taken into account.

7.3.3 Out-of-service decommissioning report

The existence of a decommissioning report should be ascertained during the desk study. The date, status and extent of decommissioning on the site should be established, including whether:

- a) it is out of service for re-fitting, repair or structural refurbishment;
- b) it is out of service for mothballing;
- c) it has been out of service for some time prior to demolition so that there might, for example, be health and safety hazards that were not present at the time of decommissioning; and
- d) it is to be taken out of service immediately prior to demolition activities.

NOTE Decommissioning reports are usually prepared when a facility or site is taken out of service. A decommissioning report is an essential part of the desk study; however, its value depends on its age and accuracy. See Clause 8 for further information on decommissioning procedures and reports.

CAUTION: The decommissioning (and hence the report) might not have been intended for demolition purposes as there might have been plans to bring the facility back into service at a later date after being mothballed.

7.4 On-site survey

7.4.1 General

The on-site survey should augment the knowledge gained during the desk study and enable a more accurate understanding of:

- a) past features;
- b) present features; and
- c) the existing condition of the site.

The survey should identify health hazards (see Clause 10) and measures to address these (see Clauses 11, 12 and 13).

Existing information, including drawings, should be used during the survey. Once its accuracy has been confirmed, the information should be used as a basis for extending knowledge of the site by, for example, taking account of any differences such as alterations or modifications that have taken place. Records should then be updated with the current knowledge and their status should be confirmed. During partial demolition, the information should be updated as work progresses to ensure that the altered condition of the structure is accurately recorded.

CAUTION: The term “structural survey” is to be avoided since misunderstandings can arise between clients and professional advisors about what is actually included and/or excluded, and the degree of intrusive investigation (see Table 4).

Table 4 Examples of types and purposes of building and structure investigation

Type	Use	Qualifications, including limitations	Notes
a) Evaluation	May be taken as an assessment, appraisal, estimate or valuation of the structure for the purpose of tendering for the work or as a final costing to update any changes in the procurement process, intended methodology and/or disposal costs.	An evaluation is not to be interpreted as, or used in place of, a survey report for structural stability purposes. Generally, the scope of an evaluation inspection, and any measurements taken, is restricted to what is necessary to establish aspects and factors material to value.	The person undertaking the evaluation might need more detailed advice on condition before completing the evaluation.
b) Structural inspection	Can be undertaken for a variety of reasons, such as: 1) an investigation of the facility, such as its construction method, materials and condition of the building or structure; 2) preparing a schedule of condition to record the condition of the building at that particular time, supported as necessary by photographs, sketches and drawings; and 3) as part of an elemental and/or specialist investigation, including other specialist advice obtained relating to specific issues, as appropriate.	The survey of a building or a structure generally includes the structure detail, fabric, finishes and grounds. The extent of the survey is subject to specific agreement between the professional and the client. Such a survey includes a measured survey, sometimes referred to as a dimensional survey, which involves taking measurements of a building and/or its site in order to prepare accurate drawings to scale or for comparing with existing drawings. It may include taking levels. The purpose for which the drawings will be required, their scale, detail and acceptable tolerances need to be agreed between the parties beforehand.	The survey report should include reference to visible defects and guidance, as appropriate, on relevant aspects, such as maintenance and remedial measures. An elemental or specialist investigation is carried out where concern exists over specific parts of, or defects in, a premises. The exposure and testing of services are not usually covered (see 5.1.2).
c) Structural examination	Can be undertaken for a variety of reasons, such as a more detailed look at a building or structure.	Would need to be undertaken by those with more specialized competencies.	Clarification would be required on what was to be included, as well as any exclusions.
d) Structural assessment	Can be undertaken for a variety of reasons, such as: 1) an investigation and assessment of the construction and condition of a building or structure to establish residual strength; 2) an investigation and assessment, as in 1), for various states of loading (see BS EN 1991-1-6).	The scope of this type of investigation is specific to each individual job and, if necessary, the brief may be altered as findings on site dictate. A schedule of dilapidations identifies the need for repairs to premises, perhaps in relation to obligations under the terms of a lease. Tends to use information from a), b) and c).	Examples of this specialist work are the detailed study of movement, cracking, bulging, bowing, timber decay and corrosion.

7.4.2 Survey methodology

When planning the on-site survey, the desk study should be taken only as an indication of what is present, as other substances and conditions can occur in practice.

Methods of measuring and recording information can vary, but those used should be appropriate to the circumstances to minimize the risk of harm to any individuals undertaking such measurements and recordings, e.g. for lone-working (see 11.12).

NOTE Clauses 11 and 13 give advice on personal safety.

The on-site survey should be undertaken in accordance with BS 5930:1999+A2:2010 as a progressive, information-gathering process. It should be carried out in such a manner that it does not compromise the safety of the structure, and should include, where appropriate:

- a) observation;
- b) close inspection;
- c) dimensional measurement;
- d) removal of, for example, panels and cladding to locate hazardous materials, including asbestos;
- e) identification of materials, e.g. residues; and
- f) sampling of the key features to assess potential hazards (see Table 5).

Table 5 Key features to be sampled for potential hazards

Key feature	Potential hazards
Atmospheres	Breathable quality and explosive potential
Residues of chemicals	Toxicity and detrimental vapours
Organic deposits and growths	Pathogens
Water/moisture contents and residues	Toxicity, pathogens and materials strengths
Ground water	Assessment of migrated or deposited contaminants
Materials used in the construction	Chemicals and fibres
Structural materials and connections	Type, condition and thus residual strength
Materials changed during maintenance/structural refurbishment	Potential entrapment of hazardous material/weaker construction
Insulating materials	Chemicals and fibres, ozone-depleting substances
Paints and other preservatives	Lead and other chemicals

Where there is a possibility that toxic materials are present, for example asbestos, a specific survey detailing the extent and identifying the type of the materials should be carried out.

7.5 Condition surveys of adjoining premises and for delapidation

A condition survey(s) of adjoining premises and associated street furniture should be prepared, when appropriate, to help avoid or resolve any dispute that arises about alleged property damage (see also 9.3.2).

7.6 Reports and dissemination of knowledge

Reports should be produced detailing the findings of:

- a) the desk study, including decommissioning and expected waste arisings;

- b) the on-site survey, covering the current state of the site and buildings, including true decommissioning status and structural and health hazards; and
- c) any condition surveys of adjoining premises [see also 6.2m) and 7.5].

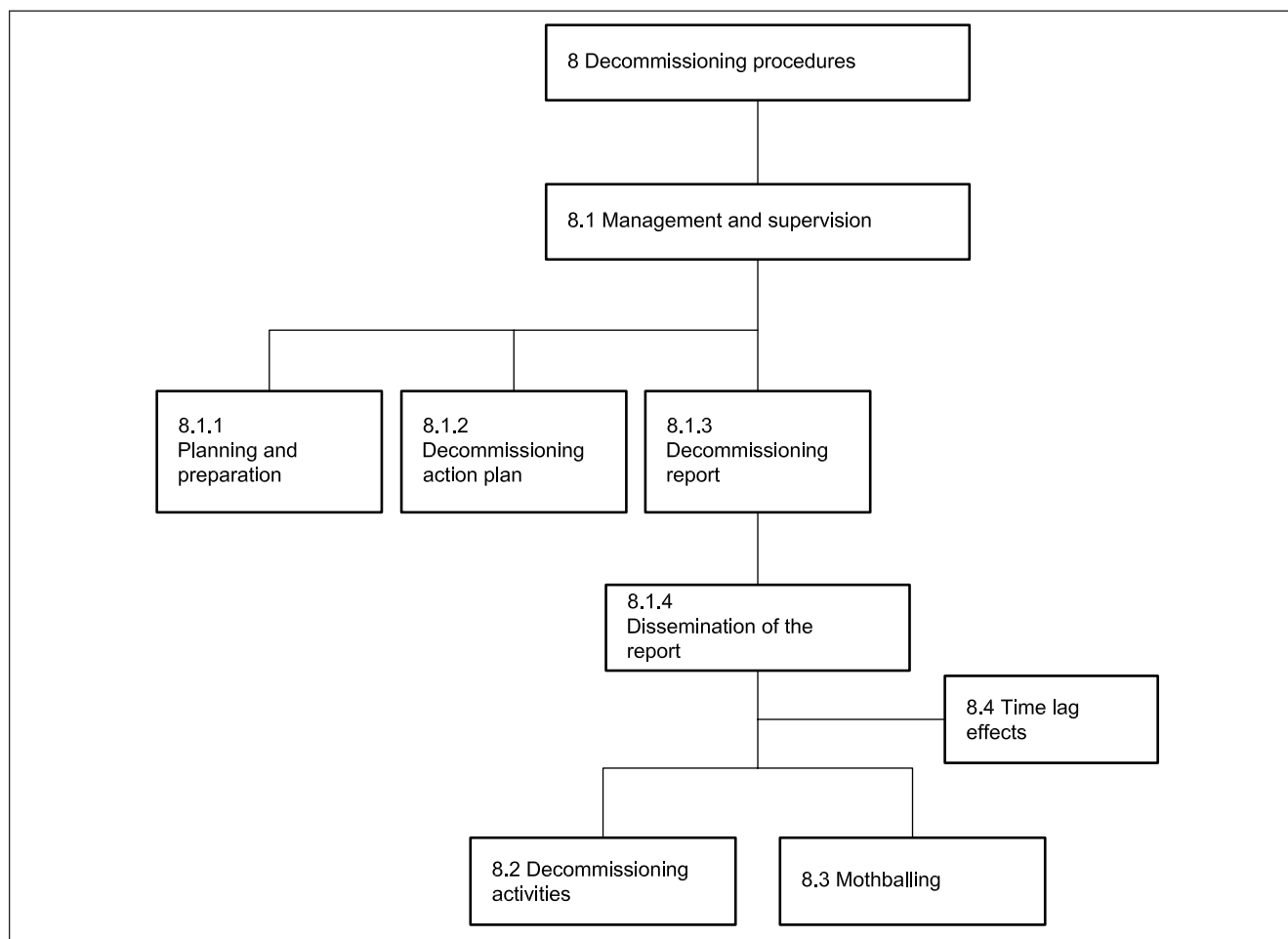
NOTE Full decommissioning ought to have been achieved prior to the commencement of any demolition. However, where the site is not fully decommissioned, the measures needed to achieve full decommissioning have to be included in a supplementary decommissioning action plan (see 8.1.2).

A site report should then be prepared which combines these outputs. The site report should be regarded as a “live” document and should be updated whenever more information becomes available as the project progresses. It should be used throughout the project, from the procurement process into the works stage.

The site report should be made available to all parties involved in the work as part of the dissemination of information for the site.

8 Decommissioning procedures (see Figure 6)

Figure 6 Route map for Clause 8



8.1 Management and supervision

8.1.1 Planning and preparation

Prior to the demolition or partial demolition of any buildings, structures or industrial plant, a planned decommissioning procedure should be carried out by the client or body responsible for the facility. The objective of this procedure should be to bring the building, structure or industrial plant from its fully-operational status to one where all “live” or charged systems are rendered “dead” or reduced to the lowest hazard level.

If there is a delay (see **8.4**) between decommissioning for demolition and the demolition itself, or if there is a change of plan such that a mothballed facility is to be demolished rather than brought back into service, the recommendations of **7.3.3** and **7.6** should be followed.

Planning and preparation should include the elimination of any hazards arising from the process that was carried out prior to closure of the facility. All hazardous materials should be identified and recorded in the decommissioning action plan (see **8.1.2**).

Where hazards remain, for whatever reason, these should be made evident on site.

NOTE Further information can be found in Decommissioning, mothballing and revamping, published by the Institution of Chemical Engineers [27].

Wastes should be considered together with the planned removal of such wastes with the waste hierarchy in mind.

8.1.2 Decommissioning action plan

A decommissioning action plan should be prepared by the client as an aid to the effective management of decommissioning. The plan should identify key target dates, including termination of services, and activities to be achieved for decommissioning.

8.1.3 Decommissioning report

The client should ensure that the decommissioning procedure is fully and accurately documented in a comprehensive report that shows exactly what activities have been carried out in accordance with 8.2 to reduce the inherent hazards. The decommissioning report should clearly state the extent of decommissioning and include details of possible health, safety or environmental implications during the course of demolition.

The report should also provide a general description of the nature of the plant or building, its age, the various processes that are likely to have been carried out, and details of any major changes like replanting or structural alterations.

Comprehensive drawings and plans, particularly those showing underground services and underground chambers or plant rooms, should be included.

8.1.4 Dissemination of the report (see also 7.6)

On completion of the decommissioning report, the client or body responsible for the premises should arrange for the report to be made available to those undertaking pre-contract site surveys and/or contaminated land/building investigations. The report should be made available to the CDM coordinator for inclusion in the pre-tender information to tenderers.

8.2 Decommissioning activities

Decommissioning should involve a number of activities that, where appropriate, take into account any earlier decommissioning work that was not completed [for example, because of mothballing (see 8.3)]. Where relevant, decommissioning activities should include identification of, and action in respect of, for example:

- a) isolation, earthing, spiking and cutting of high-voltage cables at points outside the demolition area, with a physical cut being made at point of entry to the main distribution box and all tails exiting the box;
- b) isolation of low and medium voltage cables not rendered "dead" by the actions in item a);
- c) disconnection of cables crossing the demolition area from buildings that are not to be demolished;
- d) disconnection and separation of emergency/standby direct current (d.c.) battery systems;
- e) removal of bulk process or other chemicals, including battery acids and oils;
- f) draining and purging of all process chemicals from pipework and vessels such that the plant is chemically inert;
- g) draining, purging and venting to atmosphere of vessels and systems that have contained flammable or noxious gases, ensuring that fluids cannot accumulate;
- h) draining of all substantial heads of water;

- i) isolation of water and gas supplies at points outside the demolition area, or removal of a section of the pipework and the fitting of blanks or plugs;
- j) controlled release of stored energy in strong springs or suspended counterweights;
- k) removal or elimination of substances that can give rise to biological, chemical, explosive, fire or radiological hazards; and
- l) removal of asbestos (however present) or, if not removed, preparation of an "asbestos register".

Hazards related to, for example, the following industries should be taken into account during decommissioning.

- 1) Chemical.
- 2) Power.
- 3) Offshore.
- 4) Nuclear.
- 5) Manufacturing industries.
- 6) Mineral extraction.
- 7) Food processing.
- 8) Health care.
- 9) Munitions.

8.3 Mothballing

Mothballing should be planned and executed in the same way as decommissioning, ensuring that every operation is undertaken with due regard for health, safety and the environment, and is recorded.

The choice of method of mothballing should be informed by the following.

- a) The probability of recommissioning ever being required.
- b) The extent of operation after recommissioning.
- c) The length of period of preservation.
- d) The current state of the plant.

When planning the demolition of a previously mothballed facility, the decommissioning procedure should be reactivated and consideration given to the effect of the time lag (see 8.4).

8.4 Time lag effects

The following effects of time lag between taking a facility or part of a facility out of service and its demolition or partial demolition should be taken into account.

- a) Deleterious atmospheres.
- b) Ingress and egress of fluids.
- c) The chemical action of contained substances.
- d) The deterioration of structures and containment vessels.
- e) Reduced stability, e.g. weakening of foundations and support members.
- f) Impact damage.
- g) Reduced strength of any support intended to be temporary, e.g. scaffolding.

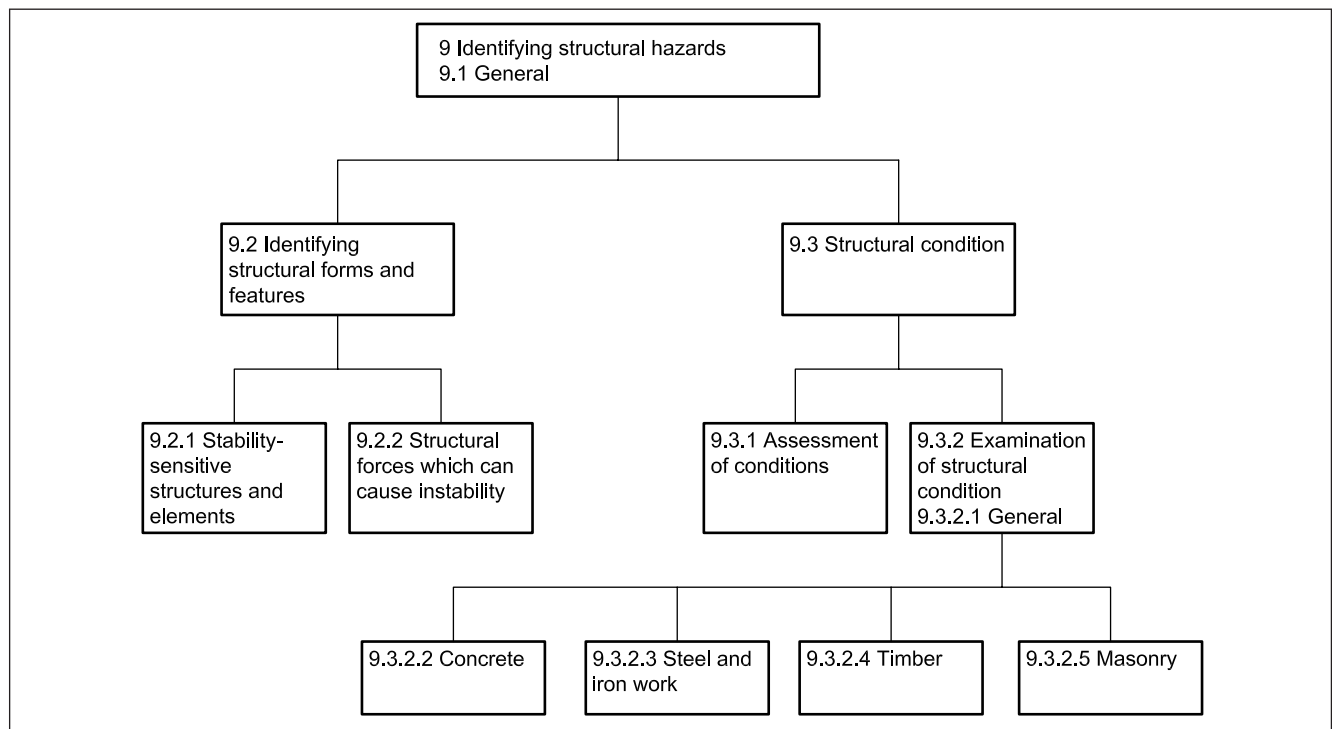
- h) Deliberate removal of parts of the facility for other uses elsewhere (cannibalizing).

The extent of the effects can vary and the following aspects should be considered together with the length of time involved.

- 1) The environment in which the facility is located.
- 2) The extent of any earlier decommissioning (either full or partial).
- 3) Whether mothballed or not.
- 4) The effects of weather.
- 5) Variations in water table.
- 6) Possible vandalism.
- 7) Effects of "organic invasion".
- 8) Effects of "biological invasion".
- 9) Fire damage.

9 Identifying structural hazards (see Figure 7)

Figure 7 Route map for Clause 9



9.1 General

Structural form and features should be identified in order to reduce the risk of unplanned collapse of any parts of structures during the demolition activities. This should involve assessment of local stability of parts of the structure and the global stability of the structure as a whole. This information should be used to help avoid unplanned collapses (see Clause 15). To achieve this, however, the ways in which all loads are transmitted to the ground, i.e. the load paths, should be identified. The behaviour of the structure and its elements under the action of those loads will vary and should be understood. Structures that are designed with load paths which might not be immediately obvious from an initial inspection should be identified, e.g. when they are covered by cladding or suspended ceilings, or where they have been altered during their lifetime, e.g. for a change of use, extension of the premises or provision of additional services.

9.2 Identification of structural form and features

9.2.1 Stability-sensitive structures and elements

Structural features should be identified which are stability-sensitive, and/or where structural problems are known to occur and can lead to particular problems in demolition. Expert engineering advice may be called upon to confirm the type of structure present. In particular, problems that arise due to the following should be identified.

- a) Inherent form, elements and features, including those that rely on interdependence for stability of structures and buildings, including any modifications.
- b) Intrinsically weak features of structures and buildings, including any modifications.

- c) Stability features, including those that are novel, of structures and buildings, as well as their effect on adjoining buildings and structures.
- d) Site physical features, either natural or built, including those that are buried and that can affect stability, e.g. ground anchors.

Stability-sensitive structures and elements that should be identified include the following.

- 1) Structures in which the floors are suspended by hangers, e.g. hanging bolts, from overhead cross beams supported by a structural central core.
- 2) Cable stayed roofs.
- 3) Shell or membrane structures such as barrel roofs and domes.
- 4) Space frame roofs.
- 5) High bay warehouses.
- 6) Stressed-skin structures.
- 7) Low and high-rise panel buildings, including proprietary "system-buildings".
- 8) Structures with unbalanced thrusts such as single and multiple arches, kilns, domes and single and multi-bay portal frames.
- 9) Structures, roofs and floors that rely on tie bars for stability.
- 10) Lift-slab structures.
- 11) Retained facades.
- 12) Prestressed structures and components, e.g. in concrete.
- 13) Cantilevered features, e.g. balconies, staircases or heavy cornices.
- 14) Segmental, stayed and suspension bridges.
- 15) Tanks and silos.
- 16) Crosswalls and walls formerly restrained by roofs or floors.
- 17) Structures retained by features such as ground anchors.
- 18) Structures which provide stability to adjacent structures, e.g. basements and arches.
- 19) Structures which need stability from adjacent structures, e.g. arches.

NOTE See 15.2 and Clause 19 for factors to be taken into account and for examples of demolition techniques appropriate for such structures.

9.2.2 Structural forces which can cause instability

Potential causes of structural instability should be identified, including the interruption of a load path, the effect of gravity and the inability of the rest of the structure to support any redistribution of remaining forces in load paths through other parts of the structure that remain.

The structural forces potentially causing instability that should be identified include:

- a) unbalanced thrusts;
- b) lateral components of forces, e.g. from sway loads;
- c) forces on basement walls from adjacent properties and thoroughfares;
- d) effect of backfill loads on the stability of adjacent basements and other walls;
- e) propping effect on vertical cantilever walls;

- f) premature release of tensioned reinforcement in post-tensioned concrete beams; and
- g) non-vertical alignment of load-bearing walls, e.g. eccentric loadings.

NOTE Structural Eurocodes give further advice, in particular BS EN 1991-1-6 (see also "Further reading" section of Bibliography).

9.3 Structural condition

9.3.1 Assessment of condition

The current condition, as well as the cause of the condition (e.g. moisture ingress, overloading or fire, impact and blast damage) of the structure, should be established.

Assessments should include, for example, the following.

- a) The form of construction and the condition of the building, including the extent and frequency of any particular defects.
- b) Any identified structural defects, such as missing bolts or bracing members.
- c) Whether the building is inherently liable to disproportionate collapse through its design and construction and what could be the initiating event for such a collapse.
- d) Whether the rate of change in its condition needs to be monitored to enable further assessments of structural safety to be made.
- e) The significance of any defects or deterioration, e.g. the potential for unplanned collapse (see Clause 15), whether such collapse is imminent and what would be the initiating event.

9.3.2 Examination of structural condition

9.3.2.1 General

The materials, their quality and the type of construction should be examined in order to identify any poor construction or deterioration that can affect the load-bearing capacity of the structure and cause it to behave in an unpredictable way during demolition. The causes and rate of any deterioration should be identified where possible in order to determine their potential significance for the demolition process.

9.3.2.2 Concrete

Concrete should be examined for, for example:

- a) defects in original construction;
- b) deformation;
- c) cracking and spalling;
- d) corrosion of reinforcement;
- e) chemical deterioration of the concrete, e.g. alkali-silica reaction (ASR), high alumina cement (HAC) problems;
- f) attack by previous process chemicals;
- g) effectiveness of grouting to tendons;
- h) effectiveness of any concrete repairs; and
- i) effectiveness of connections at critical interconnecting joints in precast concrete construction, such as in industrialized system buildings.

If cores are to be taken in prestressed structures, this should be done in such a way as to avoid damage to tendons.

9.3.2.3 Steel and iron work

Steel and iron work should be examined for, for example:

- a) deformation;
- b) corrosion, e.g. of gusset plates, boltheads, nuts and members;
- c) rust jacking at connections;
- d) loss of section that might be significant;
- e) integrity of tie rods, e.g. at jack arches;
- f) springing of rivets; and
- g) effectiveness of any repairs, overplating, etc.

9.3.2.4 Timber

Surface-mounted wall plates should be checked for fixity and condition. The condition of inset wall plates should be checked, particularly if they are carrying loads. The support bearings and seatings of beams should be inspected with particular reference to the condition of old or decayed joists, lintels and beams.

Timber should also be examined for, for example:

- a) deformation;
- b) splitting and cracking;
- c) shakes;
- d) knots;
- e) integrity of fixings and bolthole elongation;
- f) infestation (e.g. woodworm and toredo); and
- g) rotting (e.g. wet rot, dry rot).

9.3.2.5 Masonry

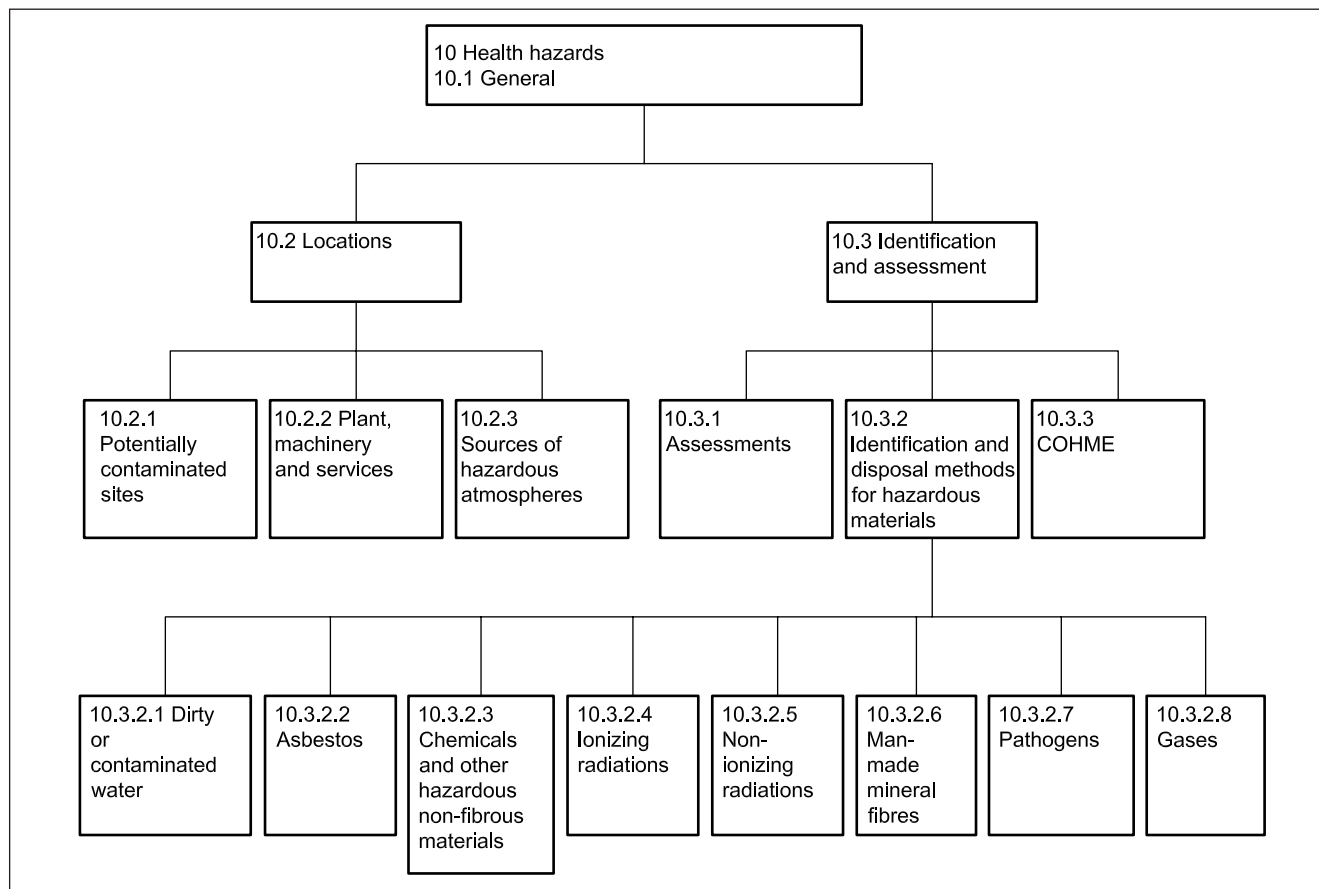
Load-bearing walls should be identified, with particular attention to those that are to remain, including the walls of any adjoining property. Their thickness should be noted, especially any reductions of thickness, for example, at fireplaces, cupboards, inset wall plates or deep chases.

Masonry should also be examined for, for example:

- a) type of construction, including solid walls, cavity construction, ashlar construction or rubble-filled cavities;
- b) deformation, such as bowing;
- c) cracking and spalling;
- d) delamination;
- e) corrosion of reinforcement and cavity wall ties;
- f) effectiveness of any repairs;
- g) verticality of walls;
- h) security of bonding at the ends of crosswalls; and
- i) condition of mortar joints, including for example sulfate attack.

10 Health hazards (see Figure 8)

Figure 8 Route map for Clause 10



10.1 General

As the main health hazards to those affected by demolition activities arise from substances likely to be inhaled or ingested, or to react with or be absorbed through the skin, hazards such as the following should be identified.

- Gases, vapours, fumes and dusts which can be inhaled and which can be acutely or chronically toxic, allergenic, fibrogenic, carcinogenic and/or asphyxiant.
- Dusts, powders and liquids in contact with the skin that can be toxic or corrosive or give rise to, for example, dermatitis or cancer.
- Inert dusts which in large quantities can cause, for example, irritation.

Contaminants arising from previous uses of the site, or abandonment of materials such as containers, tanks, dust and debris including used syringes and organic deposits, e.g. bird droppings, should be identified. A SWMP should be implemented at pre-demolition audit stage to help with the identification of features such as contamination hazards (as well as recycling opportunities).

HSE Guidance Note EH40/2005 [28], which is updated regularly, should be consulted for the workplace exposure limits (WEL) of these substances (EH40/2005 is available at <http://www.hse.gov.uk/pubns/books/eh40.htm>).

Information, instruction and training should be provided on necessary hygiene measures and protection against these hazards.

NOTE 1 Recommendations for personal safety and methods of working safely are given in Clause 11.

NOTE 2 See also the HSE website at www.hse.gov.uk for further current advice.

10.2 Locations of health hazards

10.2.1 Potentially contaminated sites

Any sites (including both ground and buildings) that could be contaminated as a result of the processes undertaken there at some time and that can harbour residual health hazards should be identified, including the following.

- a) Waste disposal sites.
- b) Gasworks, coking plants and ancillary by-products works.
- c) Power stations.
- d) Nuclear facilities.
- e) Sewage treatment works.
- f) Scrapyards.
- g) Railway land, including sidings and depots.
- h) Coal yards (contaminated by phenols);
- i) Oil refineries, distribution terminals, petrol stations and associated sites.
- j) Metal mines, smelters, electroplating works, refineries and foundries.
- k) Chemical works.
- l) Munitions production and testing sites.
- m) Asbestos works.
- n) Slaughter yards and abattoirs.
- o) Fish and meat markets.
- p) Tanneries.
- q) Paper and printing works.
- r) Wood preservative treatment sites.
- s) Hospitals, including isolation and quarantine premises.
- t) Dental surgeries, and medical and paramedical practitioners' clinics.
- u) Industrial laboratories.
- v) Mortuaries and pathology laboratories.
- w) Cemeteries.
- x) Wool warehouses and works, and roof insulation and plaster reinforcement incorporating animal hair (anthrax).

10.2.2 Plant, machinery and services

Fluids, sludges and solids that remain should be accurately identified as they can be hazardous. Where appropriate, the contents of tanks and receptacles should be analysed. Residues should be handled and disposed of according to the results of analysis. Specialist advice should be applied to the handling and disposal of any hazardous materials, e.g. fluids contained in refrigeration plant and engine sumps, and a safe process for the work established (see also Clause 12). Where appropriate, the regulator should be consulted, for example, the local petroleum officer for licensed petroleum storage facilities.

When gas cylinders and chemical containers are not accepted for return by their manufacturers, the appropriate authority should be contacted for advice on their disposal.

UKLPG may be approached for advice on the disposal of liquefied petroleum gas (LPG) cylinders and tanks (see Annex C).

10.2.3 Sources of hazardous atmospheres

Sources of hazardous atmospheres that should be identified include the following.

- a) Residues from former use or misuse in confined spaces.
- b) Leaking pipes in structures.
- c) Entry of contaminants to the structure through unsealed openings.
- d) Infiltration through ground.
- e) Decaying organic material, including sewage.

10.3 Identification and assessment of health hazards

10.3.1 Assessments

Where the pre-contract assessment indicates that the ground or building on the site is suspected of being contaminated, an investigation of the ground and/or building should be carried out in accordance with BS 10175. The investigation should be carried out by a competent person who understands the problems, hazards and risks associated with sample collection, and who can take appropriate precautions, which should include an assessment of any hazardous material found and whether the contaminants present are a risk due to inhalation, ingestion or skin contact. The initial site assessment should provide information on likely hazards.

Monitoring should be initiated and maintained as demolition proceeds to ensure that workplaces are as planned. The workforce should be monitored as appropriate for indications of health problems, however minor they appear.

The site survey report (see 7.6) should be updated and disseminated as locations are tested for hazardous atmospheres. The workplace exposure limits (WEL) in HSE Guidance Note EH40/2005 [28] should be applied. The latest edition of EH40 should be referred to for the current WELs (see 10.1).

10.3.2 Identification and disposal methods for hazardous materials

10.3.2.1 Dirty or contaminated water

Accumulation of water from any source can become contaminated and should be treated and moved to a licensed waste tip where appropriate (see also 10.3.2.7 and 12.3.11.3).

10.3.2.2 Asbestos

Asbestos should be expected in many forms (see Note 1) and should be expected to be present, unless established otherwise. As all non-domestic premises are required to have an "asbestos register" in place (see Note 2), this should be sought and used as a reference source. However, this should merely form an indication of the presence of any asbestos and should not form the basis for any planned removal process. Where there is a planned process of refurbishment or demolition, no works should be executed without a "refurbishment and demolition survey" having been carried out. This survey should include intrusive measures designed to locate and indicate, so far as is reasonably practicable, the full extent of any asbestos present.

NOTE 1 Asbestos, in many forms, has been used extensively in buildings and structures, particularly those constructed between the 1960s and late 1990s. Among the many types of products containing asbestos the following are prevalent: asbestos insulation board (AIB), lagging for pipes and vessels, fire and sound insulation, cladding or roofing (asbestos cement and AIB), braided tapes, rope, packing, gaskets, fuse guards and decorative coatings.

NOTE 2 All non-domestic premises are required by UK law to have an "Asbestos Register" in place.

The removal of asbestos from premises should follow accepted industry practice relevant to the proposed operations (see Note 3). Clients and contractors should ensure that for "notifiable materials" the exposure control limits for the density (or volumetric frequency) of fibres over any specified range of continuous periods (see Note 4) are not exceeded. Asbestos should be removed by a licensed contractor approved by the HSE following the necessary notice to remove. Works which would not normally exceed the control limits should be carried out either by a licensed contractor or by others, provided that adequate training has been given to those carrying out the work and all control measures to reduce exposure to asbestos fibres are in place.

NOTE 3 Industry bodies and regulators, for example, provide such guidance and codes of practice, usually based on experience and regulatory requirements.

NOTE 4 Limits for exposure to asbestos fibres not requiring respiratory protection have not to exceed the control limit of 0.1f/mL or cm³ over any continuous period of 4 hours or 0.6f/mL or cm³ over any continuous period of 10 minutes. Actual control limits can vary and need to be ascertained and specified. The Control of Asbestos Regulations 2006 [29] require prevention of exposure so far as reasonably practicable and that any exposure is to be reduced to the lowest level reasonably practicable without relying solely on respiratory protective equipment.

In all instances of work with asbestos, the removal contractor should ensure the safety of their employees and any other persons who could be affected by their works. Air should be sampled during and after the removal works, unless assessments deem it unnecessary. All air sampling should be carried out by technicians independent of the removal contractor and under the conditions set by appropriate standards.

As the carriage and disposal of all asbestos waste is controlled, waste asbestos should be placed into suitable labelled bags, wrapping or packaging and sealed against release. The waste should be placed into a lockable skip and taken to a licensed disposal facility by a licensed waste carrier with all waste consignment notes and other relevant documentation present.

10.3.2.3 Chemicals and other hazardous non-fibrous materials

If previous uses and/or equipment have left hazardous chemicals, e.g. radioactive luminous paint, lead paint, isocyanides, PCBs, mercury, acids, alkaline solutions, fumigation agents, water treatments, wood treatments or dusts, a survey should be undertaken by an appropriate specialist.

Chemical wastes should be analysed to ascertain whether they are hazardous and, if so, in which way and to what extent. The analysis results should be used in the risk assessment to identify the risks, to determine the preventative and protective measures required, and to provide a recommendation for their treatment, safe handling and disposal.

10.3.2.4 Ionizing radiations

Prior to the commencement of demolition work, the client should establish whether the presence of radioactive material is possible. If ionizing radiations are known or expected to be present, expert advice should be obtained.

NOTE 1 A survey might be required and radiation monitoring equipment and/or a radiation alarm might be needed.

If radioactive materials are encountered unexpectedly, access to the area should be restricted and advice sought from specialists in radiation protection, who should carry out surveys and develop safe systems of work before any other action is taken.

NOTE 2 There are many potential sources of radiation on sites, including naturally occurring radionuclides that can be concentrated by human activity or manufactured radioactive materials and sources. Examples of sources are lightning conductors, smoke detectors, low specific activity materials such as some refractory sands and pipe scales, luminous paint and contaminants in land, including normally occurring radioactive material (NORM) and that associated with subsea structures. Natural ionizing sources can be present, e.g. as radon gas, in many areas of the UK. The Health Protection Agency map for vulnerable locations is available at: http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/Radon/radon_Map/

10.3.2.5 Non-ionizing radiations

Physical exposure to non-ionizing radiations (such as ultraviolet and infrared radiation, or radio waves used for communication) can be harmful, so specialist advice should be obtained, including surveys and safe systems of work.

NOTE Non-ionizing radiation might be an issue adjacent to operational facilities such as hot processes, e.g. steelworks, glassworks (infrared); arc welding processes (ultraviolet); induction furnaces, radar or communications transmitters (radioelectromagnetic waves).

10.3.2.6 Man-made mineral fibres

Where man-made mineral fibres, such as mineral wool and glass fibre, are found, current guidance should be consulted as they require an assessment of exposure to potential risk and systems for preventing or controlling the risks.

10.3.2.7 Pathogens

Pathogens are organisms that cause diseases and can be derived from, for example, dead animals, birds or insects, and their wastes, and fungal spores, so consideration should be given to the possibility of pathogens occurring in the structure and/or in the soil on sites, particularly where organic materials have been processed or handled. Where pathogenic materials are identified, appropriate working practices should be used, including for example the issue and use of appropriate personal protective equipment (PPE) and a high level of personal hygiene.

Where there is or has been rat infestation, or presence, measures should be taken to prevent skin contact, and a ban on eating, drinking or smoking in the workplace enforced, in order to protect the workforce from Weil's disease (or leptospirosis). The workforce should be made aware that Weil's disease is spread through rats' urine, either directly in water or from contact with their tails or paws. The virus survives in water, so appropriate measures should be introduced where there is water and rats.

The presence of stagnant water should also be considered a hazard. Anyone who might come into contact with it should be made aware of the advice given in the HSE Guidance Note on Leptospirosis [30] and appropriate action should be taken.

Where there are human remains, the appropriate authority, e.g. Home Office or police, should be consulted regarding their identity and reinterment.

Dead animal remains or animal products, such as hides, fleeces, horns and hooves, can support the anthrax bacillus, and should therefore be handled appropriately, following specialist advice.

NOTE Cattle remains can also contain the Bovine spongiform encephalopathy (BSE) agent, so PPE and an appropriate level of personal hygiene are necessary.

CAUTION: Anthrax spores can survive for many years in bricks, mortar, horse-hair roof insulation and hair-reinforced plaster.

10.3.2.8 Gases

The site should be checked for the presence of the following dangerous atmospheres that have migrated or ingressed from neighbouring premises.

- a) Carbon monoxide (fumes from combustion).
- b) Carbon dioxide (combustion, decaying organic material).
- c) Hydrogen sulfide (decaying organic material).
- d) Methane (public gas supply, landfill sites, coal mines and organic material).
- e) Petrol fumes.
- f) Liquefied petroleum gases (from leaky joints in equipment).
- g) Chemical fumes.
- h) Aging fire protection systems containing vaporizing liquids, such as halon.

Where such migration is found, its source and extent should be determined.

The recommendations of BS 6164 for recognizing and dealing with potentially hazardous gases should be followed (see also 11.10).

10.3.3 Construction occupational health management essentials (COHME)

10.3.3.1 Common ill-health problems

Existing health conditions should be established to permit appropriate methods of work to be implemented taking account of such common ill-health problems as:

- a) back pain;
- b) skin problems;
- c) breathing problems;
- d) problems caused by noise or vibration; and
- e) stress.

10.3.3.2 Roles in managing occupational health risks for demolition activities

The following, among others, should be involved in managing occupational health risks for demolition activities.

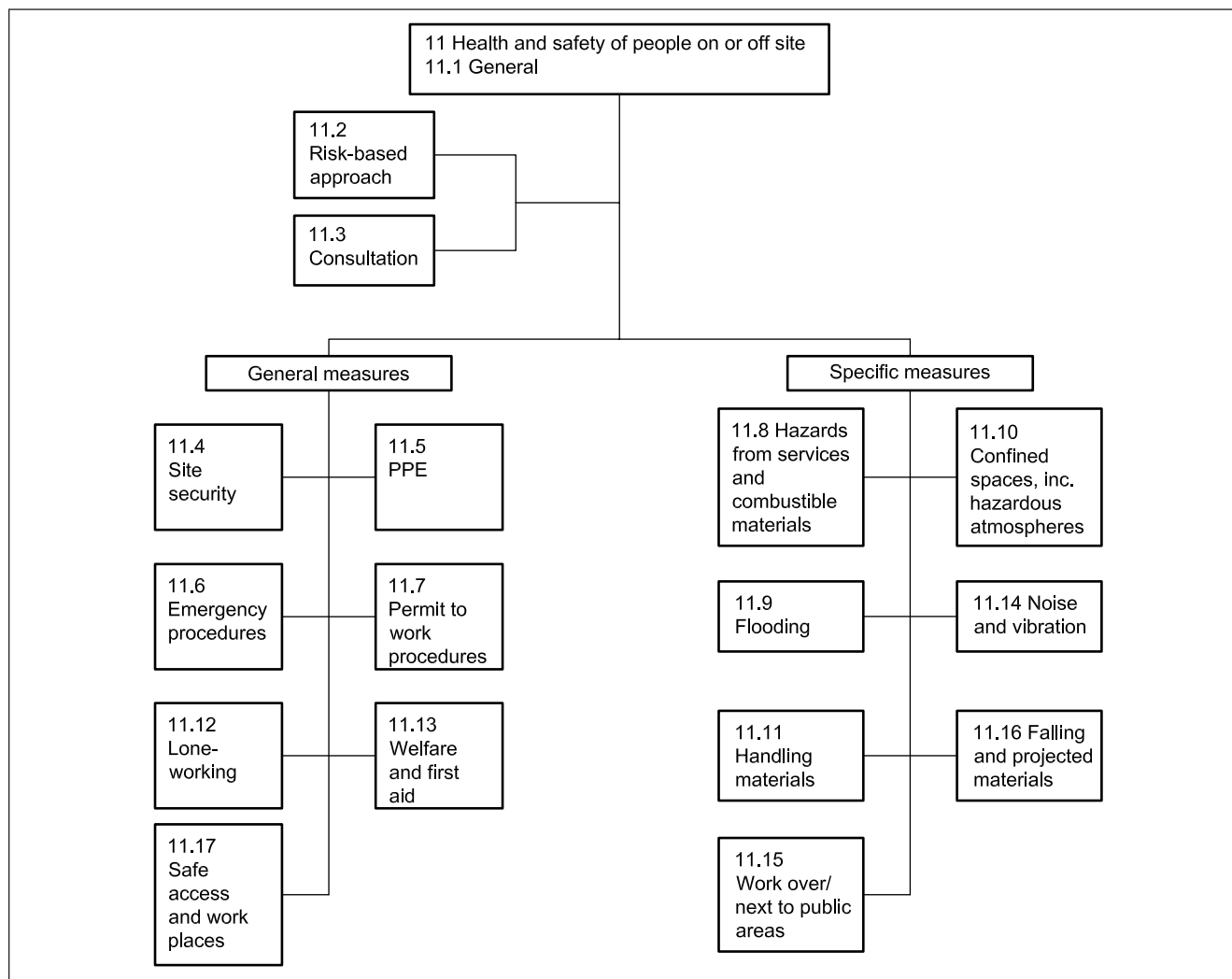
- a) CDM coordinators have a key role in advising and assisting clients about health risk management matters. They manage the flow of information between other duty holders and have an understanding of the duties of others involved in the project.
- b) Clients can remove or reduce risks to health.
- c) Designers can identify and eliminate hazards, and reduce remaining risks.
- d) Principal contractors can plan and implement a strategy to manage occupational health risks.

- e) Contractors can manage any occupational health risks that their workers might be exposed to.

NOTE More advice on COHME is available at <http://www.hse.gov.uk/construction/healthrisks/index.htm>

11 Health and safety of people on or off site (see Figure 9)

Figure 9 Route map for Clause 11



11.1 General

The health and safety of persons, such as the following, on or off site should be addressed from an early stage.

- Those involved before work commences, e.g. those undertaking surveys.
- Those directly involved with the demolition processes.
- Those who could be affected but are not directly involved in a) or b), e.g. members of the public, including those in neighbouring properties.
- Those involved in processing materials, including waste such as site arisings.

11.2 Risk-based approach

Demolition activities are recognized as potentially hazardous operations and, at all times, the methods, materials, access and equipment used should accord with the need to minimize the risk arising from the work.

The contractor should take responsibility for managing the health and safety risks on site. Risks to health and safety should be identified by an appropriate risk assessment before the work commences, and measures should be introduced to reduce and control the risks during the work (see 5.2.2.2). Where risks are identified the principles of prevention and protection should always be applied by adopting measures either to prevent the risks or provide protection from the risks that have not been eliminated.

In addition to general precautionary measures, specific precautions should be considered in association with the particular method(s) of demolition employed and the structure or structural element being demolished.

Where high-risk situations remain, a permit to work procedure should be considered and can be required (see 11.7).

11.3 Consultation

Prior to carrying out the works, and at relevant stages throughout the works, the following should be contacted, as appropriate, in order to discuss the effects of the proposed demolition works (or their progress) and the working spaces or exclusion zones where they are planned to extend beyond the site boundary.

- a) Local authorities, including housing, environment and building control departments.
- b) Statutory undertakers.
- c) Highways and roads authorities.
- d) Local residents and housing bodies.
- e) Other interested or affected parties, for example, schools, hospitals and neighbouring businesses.

Consideration should also be given to contacting other organizations, as appropriate, such as the police, Fire and Rescue Service, Environment Agency and the Health and Safety Executive (see also Annex C).

11.4 Site security

High standards of site security should be established and maintained at all times because the public, and children in particular, are likely to be curious about the work and can be ignorant of the potential hazards. The guidance in HS(G) 151 [31] should be followed.

Although spectators should be discouraged and unnecessary publicity avoided, those members of the public who will be affected by the demolition works should be consulted before work commences (see 11.3).

The sites of demolition activities should be segregated from the public by an effective barrier selected following risk assessments, e.g. fencing, hoarding or possibly existing structures that are independent and remote from the demolition activities.

Any fence should be not less than 2 m high and maintained to be effective at all times. It should not be capable of being climbed readily and should not have a gap at the base which is capable of being breached. Access gates should be secured outside working hours. If the fencing causes an obstruction it should be adequately illuminated at night to the satisfaction of the relevant authority.

At sites where it is not reasonably practicable to erect a perimeter fence, smaller secure compounds should be established to protect individual hazardous areas.

The following actions should be taken, as appropriate.

- a) Fence excavations.
- b) Immobilize vehicles and plant.
- c) Isolate electricity and gas supplies, or enclose them in locked compounds.
- d) Outside working hours, remove ladders which provide access from the ground to the first landing place and store them in a secure area.
- e) Secure potential access points to buildings, including windows.

The number of entrances to the site should be kept to the minimum required for the safe and efficient operation of the site. In order to prevent public access to the site and to control, for safety purposes, the movement of visitors on and off site the entrances should have adequate security controls. In addition, consideration should be given, where appropriate, to employing 24-hour security patrols to deter trespass, vandalism, arson and theft.

Warning signs should be used to communicate the presence of hazards to site personnel and third parties.

11.5 Personal protective equipment (PPE) on site

The method of work chosen should ensure that the exposure to risk is minimized to such an extent that PPE is required to provide protection only against those risks that cannot be avoided by any other planned approach to the work.

NOTE See the Personal Protective Equipment at Work Regulations 1992, as amended [32] and the HSE guidance L25 [33].

As a result of the known risks to health and safety that are present during demolition work, all personnel should be required to wear, in addition to safety helmets, suitable basic protective clothing such as footwear, gloves and high-visibility clothing as appropriate. Additional PPE, e.g. eye protection, fall arrest systems (including full body harnesses), hearing protection, respiratory protection equipment (RPE) and ori-nasal masks, should be issued only when alternative methods of work which do not require additional protective equipment have been assessed and found to be unsuitable (see also 17.12 when hot cutting).

Appropriate training should be provided in the use of PPE, when needed.

Such equipment should be suitably maintained and stored to ensure continued levels of required performance.

Examples of hazards which should be catered for through the provision of planned control measures include the following.

- a) Chemicals which have been stored or used.
- b) Arisings from lead paint, asbestos, dust, fumes or substances.

11.6 Emergency procedures

Contractors should establish emergency procedures to be followed in the event of premature collapse, fire or explosion. Suitable and sufficient emergency procedures should be prepared in an emergency plan for identified scenarios, in association, as appropriate, with the emergency services, public and private bodies such as local authorities, transport operators, housing managers, waterways operators, and health, safety and environment regulators. The emergency plan should set out appropriate actions (including limits of actions) and identify with whom the responsibilities are placed. The emergency plan should be incorporated into the demolition plan.

All persons on site should be instructed in the emergency procedures. All those who could come on to site should also be made aware of the procedures. A means of contacting the emergency services should always be available while work is in progress, even on small jobs.

The arrangements should be tested by carrying out exercises at suitable intervals to familiarize site personnel with the procedures, to test their effectiveness and, where necessary, to ensure effective liaison with the emergency services and others as appropriate.

Where there is a risk of fire, suitable fire precautions should be put in place (see 11.8.4), including adequate escape routes, as appropriate, identification and illumination of those routes, exits that are readily usable, means of raising the alarm, and fire fighting equipment and emergency plans. The guidance in HS (G) 168 [34] should be followed.

11.7 Permit to work procedures

11.7.1 Planning

A permit to work procedure should be implemented where there is a risk of serious injury unless specific procedures are followed, e.g. where there is:

- a) work on or near live electrical plant;
- b) entry to or work in, for example, confined spaces;
- c) moving machinery that requires isolation before approach; or
- d) hot work.

NOTE 1 Permits to work might be required either by the client or by a contractor's proposed method of work, based on the risk assessment.

NOTE 2 Special conditions can apply when working, e.g. on or near railways or waterways.

The permit to work procedure should be used:

- 1) to ensure that personnel working in the restricted area are aware of the hazards involved, and the identity, nature and extent of the work to be done;
- 2) to ensure that a formal check is undertaken to confirm elements of a safe system of work are in place before people are allowed to enter or work in the restricted area;
- 3) where there is a need to exclude or coordinate other people or their activities which could affect work or conditions in the restricted area; and
- 4) if the work requires the authorization of more than one person, or there is a time limit on entry.

HS (G) 141 [35], HS (G) 168 [34], IND(G) 98 [36], IND(G) 314 [37] and HSE ACOP L101 [38] should be consulted for appropriate advice.

The aim of a permit to work procedure should be to provide a managed, safe, restricted working area. The permit to work procedure, including the issue of a permit, should be regarded as an integrated part of a "safe system of work", but does not by itself make the job safe. The permit to work procedure should support that safe system and provide a record of activities, authorizations and timings for the protection of those undertaking the activities, and sometimes others. (See also HSE Guidance IND(G) 98 [36] and HSC (OIAC) *Guidance on permit to work systems in the petroleum industry* [39].)

There should be sufficient procedural control of temporary works, including the appointment of a temporary works coordinator with responsibility for ensuring that structural stability is maintained throughout temporary structural states during operations. An assessment should be made as to whether a permit to work system is appropriate.

NOTE 3 See BS 5975, particularly Section 2 referring to the "procedural control of temporary works".

11.7.2 Content

Where permit to work procedures are established, the client should clearly state in the tender procedures the site rules and procedures regarding the permit to work procedure on site. In every case the permit to work should be issued to a competent person.

A typical permit to work procedure should include the following.

- a) The task or work to be conducted.
- b) The risk assessment and method statement.
- c) The minimum level of protection required of PPE, including respiratory protective equipment (RPE) if appropriate.
- d) Any specific precautions to be taken.
- e) Details of electrical, piping, mechanical and underground service isolations.
- f) A hazard check list.
- g) Timescales, as appropriate.
- h) End of permit to work and handback procedure.

11.8 Hazards from services and combustible materials

11.8.1 General

Before commencing demolition work, the locations of any underground and overhead services, including gas pipes, water supplies, and electric, telephone and other cable communications systems should be identified and their status as operational, abandoned or decommissioned should be confirmed (see Clause 8). Work in proximity to operational services should be carried out following consultation with the owners and operators.

The site plans and drawings for the works should be checked for accuracy by appropriate tests on site, for example, an inspection around the site perimeter to ensure that there are no live power cables remaining, unknown to the electricity supply company.

NOTE While any plans and drawings supplied are a useful starting point, the building owner/client, professional consultants and the contractor all have defined responsibilities under the health and safety legislation to ensure that the actual services present on site, their location and condition, are accurately identified; those undertaking demolition activities where this applies, the principal or main contractor, are responsible for ensuring that there are no live electricity supplies remaining on site prior to commencement of the work.

11.8.2 Sensitivity of buried services

If demolition activities are likely to disturb pipes and cables outside the site boundary, prior contact should be made with the services providers to determine the extent, if any, of the protective measures to be taken.

Arrangements should be made to ensure that those pipes and cables are identified which could be disturbed through ground movement or pressure as a result of, for example:

- a) movement of heavy plant, such as when crossing public footways;
- b) work which alters the degree of support on retaining or basement walls, which might give rise to ground movement; and
- c) ground-transmitted vibration from the operation of plant or from falling debris.

NOTE Under the New Roads and Street Works Act 1991 [40], only persons with a statutory power or a licence from the roads or highways authority can undertake any excavation in the public street.

The guidance in HS (G) 47 [41] should be followed.

11.8.3 Electrical hazards from overhead cables

When mechanical plant, especially cranes, pusher arms or scaffold tubes are used in the course of demolition, no part of such equipment should be handled or operated in the vicinity of exposed electrical sources such as overhead cables. Where such a possibility exists, the local electricity supplier (or operators of overhead or third rail railway conductors) should be consulted and precautionary measures adopted, including physical barriers, disconnection and removal or diversion of the affected wires or cables, in order to ensure safe working.

GS6 [42] should be consulted for further guidance on work in the proximity of overhead electricity lines.

11.8.4 Fire or explosion risks

Precautions should be taken to prevent the risk of fire or explosion caused by the presence of combustible materials. As part of the site general fire precautions (GFP) consideration should be given to maintaining and utilizing existing GFPs, such as means of escape and fire doors, during the demolition process, as appropriate.

NOTE 1 Combustible materials can be gas, liquid, vapour or solids, including dusts or powders, e.g. flour, coal dust, wood dust and metal powder.

Any activity involving potentially flammable materials should be the subject of a risk assessment. Where appropriate, the operation should be managed through a permit to work procedure (see 11.7). When work activity can give rise to a risk of fire, the activity should not commence until suitable fire fighting equipment is available, together with a person who is trained in the use of that equipment.

Steps should be taken to prevent oxygen enrichment (e.g. from a leaking bottle valve or hose) which can cause intense fire in the presence of any combustible material.

NOTE 2 There is also the risk of explosion or fire from the ignition of flammable gas escaping from a leaking bottle valve or hose when gas cutting methods are used.

Containers of oxygen, acetylene or liquid petroleum gas should be used, handled and stored appropriately.

CAUTION: Cutting tools, such as oxy-fuel gas torches and disc grinders, can set fire to materials that are normally difficult to ignite, e.g. timber.

Where combustible materials cannot be removed and a decision is taken to proceed with hot work, operators should ensure that, prior to work commencing, those materials are suitably covered or wetted for the duration of the work, taking into account the fact that hot sparks/slag from these activities can fall considerable distances and still have the potential to cause a fire (see 17.12).

Adequate precautions should also be taken to prevent hot sparks/slag from entering hidden voids. In the case of hot work on, or in the vicinity of, vessels which contain, or have contained, combustible materials, particular precautions should be taken to either remove the materials or render them inert (see 19.7).

Some materials can constitute both a fire risk and a health risk due to toxic combustion products, so methods of demolition likely to cause ignition should be avoided. Examples of materials that should be considered include polyurethane foam plastics and similar materials, e.g. as insulation within cavity walls.

NOTE 3 Timbers treated with copper/chrome/arsenate preservatives, when burnt, give off poisonous fumes. Attention is drawn to the Hazardous Waste Regulations 2005 [43] (see also Clause 12).

11.9 Flooding

The contractor should assess the risk of flooding of all proposed work areas, with particular attention to deep basements, underground tunnels, cooling water culverts, plant rooms and excavations. Account should be taken of weather predictions and their possible effects on the work area with regard to possible flooding problems.

NOTE Flooding can arise from sources such as:

- a) lack of natural drainage;
- b) ingress of ground water, either from natural sources or a leaking water main or sewer (the local water supply company can assist in determining the source of the water); and
- c) catastrophic flooding, especially if the demolition site is adjacent a large body of water such as a lake, river, canal, sea, lagoon, reservoir or large water main.

Any ingress of ground water or water from a leaking water main or sewer should be assessed in light of the proposed work and consequent potential for catastrophic flooding. Adequate temporary pumping arrangements should be installed to control ground water seepage.

Where appropriate, temporary arrangements, e.g. containment structures or de-watering techniques, should be installed to exclude ground water.

If the processes formerly carried out on site abstracted significant quantities of water from a large body of water, the contractor should establish whether water penstocks, valves, fire-fighting valves and associated pipework are potentially holding back a differential head of water (see also Clause 8). The contractor should also identify walls, dams, bulkheads, bunds and embankments which lie in the demolition area and which can be a part of the normal flood defence system. Account should be taken of any predicted water levels, including tidal variation, which take place adjacent to the work area, and of the effect that these could have on support walls and structures.

Water being used in the demolition process or an accumulation of rainwater can be a nuisance before it becomes a serious safety hazard, so this should be dealt with by improving the drainage and/or installing temporary pumping arrangements at an early stage.

11.10 Confined spaces, including hazardous atmospheres

11.10.1 General

Some spaces which have to be treated as confined spaces can be obvious, for example, manholes, sewers, culverts, shafts, pressure vessels, storage tanks and silos. Others can be less obvious, but nevertheless can be as hazardous, e.g. by causing oxygen depletion or enabling dangerous concentrations of heavier or lighter-than-air gases to accumulate in layers in places such as poorly-ventilated basements, at the bottom of open-topped vats and tanks, tunnels, or roof spaces (see also 19.7).

Work in such spaces should be planned and only undertaken if it is not reasonably practicable to carry out the work without entry. An assessment of whether a permit to work procedure is required should be undertaken (see 11.7) and, where appropriate, the space should be clearly marked by warning notices.

Supervisors and operatives who will be required to work in confined spaces should be suitably equipped and trained in the appropriate safe working practices (see also the Confined Spaces Regulations 1997 [44]).

11.10.2 Hazardous atmospheres

Before decommissioning or demolition begins, all potentially hazardous spaces should be clearly marked by warning notices.

Any confined space should be regarded as a possible harbour for a hazardous atmosphere, such as the following, with a higher risk if the structure has been unoccupied or inadequately ventilated for a long period.

- a) Asphyxiants, including oxygen deficiency.
- b) Toxic.
- c) Explosive/flammable.
- d) Oxygen rich.

CAUTION: Hazardous atmospheres can be created by demolition operations such as:

- 1) the use of flame cutting equipment, e.g. generating lead fumes;
- 2) leaks from gas cylinders, including oxygen or propane cylinders;
- 3) exhaust fumes from internal combustion engines;
- 4) fumes from explosives; and
- 5) the release of trapped pockets of gas, e.g. from beneath the demolition site.

NOTE See also 10.3.2.8.

11.10.3 Methods of work

Prior to and during entry into confined spaces, steps should be taken to establish and maintain an atmosphere fit for respiration. Precautions should be taken when surveying, both initially and once work starts.

Standby personnel trained in the use of rescue equipment should be present during such operations.

The identification of potentially hazardous situations and the testing of the atmosphere for gases should always be undertaken by appropriately trained personnel.

The method for the demolition work should take account of the results of surveys (the pre-start decommissioned state) and the precautions to be taken. The precautions should include the following.

- a) Steps to remove the "confined space" status from the location by improving natural ventilation and light, if necessary by partial demolition (this is usually successful only with above-ground spaces).
- b) Avoiding entry into the space if possible.

Where entry cannot be avoided the following measures should be implemented as appropriate.

- 1) Testing for contaminant gas and sufficient oxygen before entry.
- 2) Removing the source of potential gases.
- 3) Providing forced ventilation to dilute and remove the gas.
- 4) Testing for contaminant gas and sufficient oxygen during the work and before re-entry after breaks.
- 5) The use of breathing apparatus, if necessary.
- 6) Provision of an effective communication system.
- 7) Appropriate rescue procedures, including personnel and equipment.

11.10.4 Emergency arrangements

Emergency arrangements should be put in place before entering a confined space. The following should be provided, as appropriate.

- a) Rescue and resuscitation equipment.
- b) Measures for raising the alarm and rescue.
- c) Measures for safeguarding the rescuers.
- d) Fire safety measures.
- e) Control of plant.
- f) First aid.
- g) Public emergency services.
- h) Training.
- i) Effective communications.

11.11 Handling materials

The risks inherent in handling materials should be assessed and planned as part of the demolition processes (see also Clause 18). Unnecessary handling should be avoided, e.g. operations should be planned to avoid multiple handling of materials.

Operations that involve lifting heavy or awkward loads or repetitive lifting should be identified to enable safe methods to be planned. Where appropriate, mechanical lifting aids should be provided to avoid manual handling injuries. All equipment used for lifting should be in good condition. Workers should be trained in the correct lifting techniques and in the safe handling of loads.

NOTE Attention is drawn to the Manual Handling Operations Regulations 1992 [45].

11.12 Lone-working

11.12.1 General

Where appropriate, two people should work together. Where lone-working is being considered for partial or total demolition (which can be for surveys, examinations and inspections of buildings, etc.), the risks should be assessed, including, for example, initial activities such as surveying for tender purposes. Appropriate precautions should be implemented if this is to be permitted.

11.12.2 Decision criteria

When deciding on appropriate precautions to be implemented, all appropriate hazards should be considered, including the following.

- a) Areas where levels of safety for access are reduced.
- b) Preliminary removal work, possibly by others and either planned or unplanned.
- c) Open shafts and voids.
- d) Deterioration of the structure.
- e) Reduced stability.
- f) Health hazards.
- g) The presence of contamination, including from the site's previous use.
- h) Ineffective, incomplete or no decommissioning.
- i) Poor air quality.
- j) Lack of light.

11.12.3 Lone-working criteria

When lone-working is considered appropriate, it should only be permitted on condition that, for example:

- a) the employer is satisfied that the lone worker is competent to work safely;
- b) the owner of the structure or client is assured that the lone worker is competent to work safely;
- c) unsafe areas have been identified in recent previous inspections and this information has been passed on to any lone worker so that the unsafe areas can be avoided;
- d) the lone worker has the expertise to appreciate structural hazards;
- e) adequate light is available [see also item g)];
- f) lone workers are not expected to risk their safety by clambering over or climbing through structures;
- g) all personnel are furnished with relevant and appropriate safety equipment, including clothing and a torch with spare batteries;
- h) a method of communication with others is available at all times, e.g. a mobile or radio telephone;
- i) the location, timing (including expected return time) and exact purpose of the visit are known and recorded at a base location; and
- j) a procedure is in place prescribing actions to be taken, and by whom, if any lone worker has not reported by the expected return time.

NOTE IND(G) 73 [46] provides further guidance.

11.13 Welfare and first aid

11.13.1 Welfare provision

Welfare facilities should be provided and maintained at readily accessible places for the duration of the works. These facilities should be suitable and sufficient and include toilet and washing facilities (including hot water, soap and towels), drinking water and showers, if required by the nature of the work for health reasons.

Accommodation should be provided in the immediate vicinity, or should be conveniently accessible for the place of work and for shelter, drying wet clothing and storing clothing not worn during working hours.

11.13.2 First aid

Those undertaking demolition activities should ensure that adequate first aid provision is made available. Those on site should be informed of the first aid provisions that have been made for them.

The level of first aid to be provided should be determined initially by risk assessments carried out prior to the work commencing, but the HSE publication L74 [47] should also be consulted.

11.14 Noise and vibration

11.14.1 Noise

Effective noise exposure controls should be provided during all phases of demolition activity. A noise assessment should be made and any appropriate action taken to ensure that the risk to hearing is kept to the lowest reasonably practical level.

NOTE Guidance on lowering noise levels is given in 12.3.9.2.

11.14.2 Vibration

Exposure to whole body or hand-arm vibration resulting from the use and/or operation of tools, plant and machinery should be avoided, wherever possible. If avoidance is not possible, the method of work adopted should minimize exposure to vibration.

NOTE Guidance is available in BS EN ISO 5349-1.

11.15 Work over, or next to, public areas

Lifting loads over areas of public access should be avoided where possible. Where it cannot be avoided, temporary closure of the highway and the provision of safe alternative pedestrian routes should be required (see 5.1.3.2).

NOTE See also Clause 18 for guidance on the safe use of cranes.

Protective gantries, fans, crash decks and/or coverings should be erected to protect areas of public access where there is the potential for falling loads or equipment (see also 11.16.4).

The stability and safety of any bridging structure being demolished and any associated temporary structures or auxiliary works, such as falsework and access scaffolds, should be maintained and the structure should be assessed by a competent person. A detailed plan of operation should be developed through liaison with the organizations responsible for controlling access beneath the bridging structure. Assessments should be made to determine whether it is necessary to restrict or prohibit access beneath the work at times when safety cannot otherwise be assured.

Occupants should not be permitted to remain in a building undergoing major demolition work. Where demolition work is carried out to a building a part of which is to remain, and it is required to permit persons to stay in the remaining part, a risk assessment should be carried out as a basis for a safe system of work. The assessment should include provision for the occupied part requiring evacuation and for effecting such an evacuation safely.

Occupation of connected or affected parts should not be allowed, or work should not go ahead, if there is scope for collapse initiated by a remote event, including for disproportionate collapse, i.e. a major collapse following a minor initiating event.

11.16 Falling and projected materials

11.16.1 Planning for falls of materials

People should be kept away from demolition by the effective application of exclusion zones (Clause 13 outlines the procedure for developing such zones). Exclusion zones should be applied to all sizes of operation where work includes deliberate dropping, or potential for dropping of materials. Such zones should also be established as part of a contingency plan where material might fall (see 5.2.5) not as planned, but where the risk assessment identifies possible events such as inadvertent falls of dislodged material.

11.16.2 Prevention of unplanned falls of materials

Precautions against uncontrolled collapse, including premature collapse, should include seeking expert engineering advice, especially for complex buildings or structures. Before demolition begins, it is necessary to determine where temporary support will be needed and this should be stated clearly in the method statement for the demolition activities. No part of the structure should be so overloaded that any part of it becomes unstable during demolition work. (See also Clause 15.)

CAUTION: The removal of certain parts of the building or structure during demolition can result in other parts becoming unsafe for persons in, on or near the building being demolished.

11.16.3 Protective enclosures

The need for protective, environmental and debris enclosures should be assessed, for example, reinforced plastic sheeting or netting added to scaffolding or other temporary structures. Such structures should be designed to take account of the loads (including wind loads) imposed when sheeting and/or netting materials are used (see BS EN 12811-1 and TG20:08 [48]). All aspects of design should be supported by drawings and calculations that are clearly understood by site personnel.

CAUTION: Fire safety arrangements should not be compromised. For example, fire exit routes should not be obstructed, and consideration should be given to the use of fire retardant sheeting and netting.

Where appropriate, windows should be boarded up to prevent materials falling or being ejected from the apertures.

11.16.4 Catchment of unplanned falls of materials

Protective fans, crash decks and gantries should be of adequate strength to safely support unplanned falls of material. They should be designed to withstand and contain the anticipated loadings resulting from accidental falls of tools and materials. If necessary they should be waterproofed to protect persons below from drips. They should not be used for storage or for access.

Access ways and working places should not be used as catchment areas.

11.16.5 Projected materials

Where material can be projected from apertures or can fall onto waterlogged ground or any energy-absorbing, hard-core impact mat the exclusion zone boundary assessment should take account of the residual potential of projectiles travelling a greater distance than in dry conditions (see also Clause 13).

11.17 Safe access and work places

Before and during demolition operations site managers should ensure that all site personnel have a safe place of work and safe access to their place of work. This should include both provision and maintenance, and should be regularly updated as the work progresses. Work and access areas should be managed so that they are kept in a safe condition and in good order at all times.

Permanent access stairs or catwalks should be maintained in a safe condition for use by demolition personnel for as long as possible. Means of access to be considered should include access by roads, gangways, passageways, passenger hoists, staircases, ladders and scaffolds (see also 17.2.3).

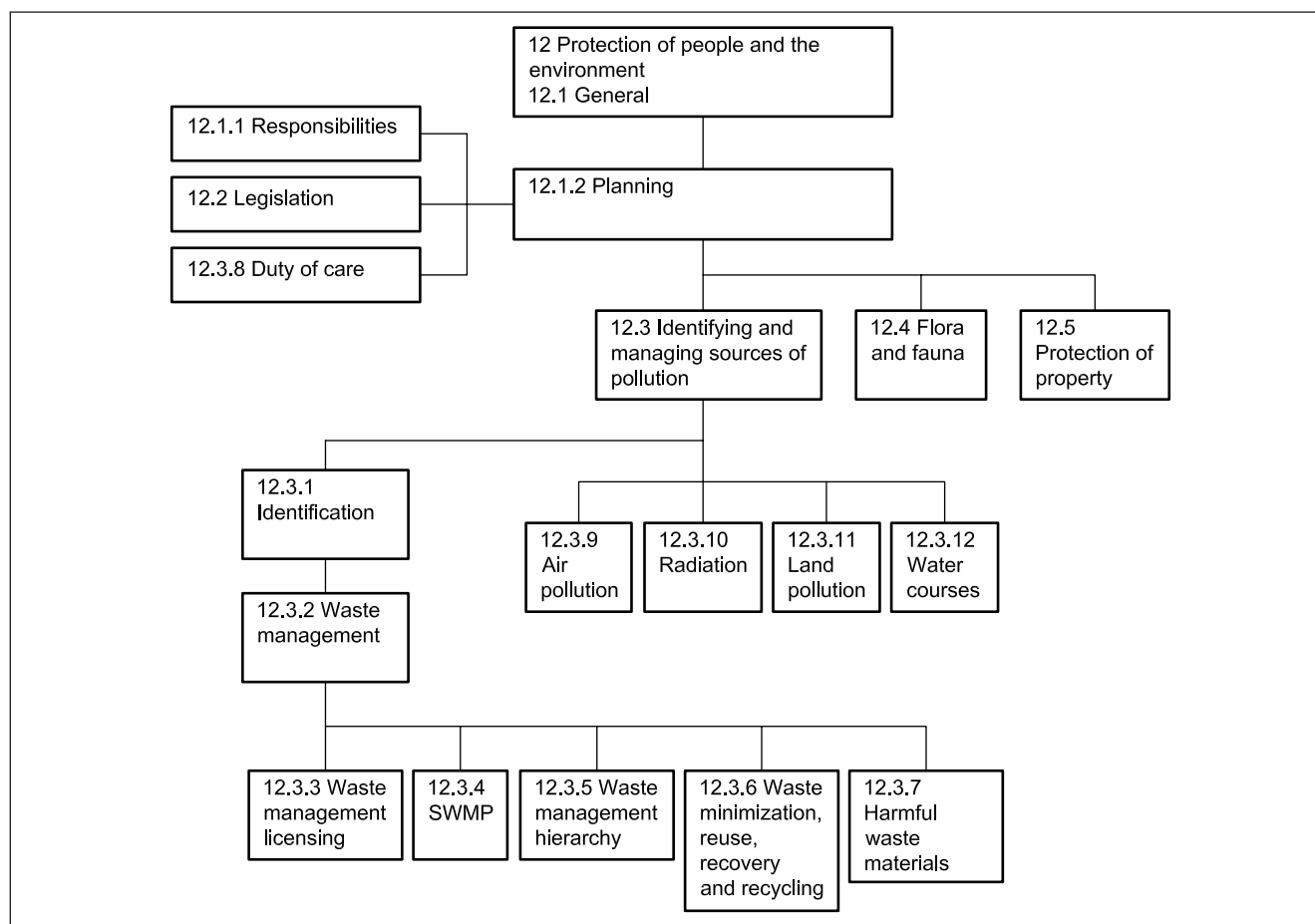
The planning, provision and maintenance of access routes and working places should ensure the following.

- a) Freedom from obstructions, including tripping hazards such as debris, materials and tools, and nails projecting from timbers (which should be removed or hammered flat).
- b) Walkways and working platforms are not overloaded.
- c) Pedestrian routes that are segregated from routes used by vehicles and plant.
- d) Erection of adequate barriers or other edge protection, to prevent falls from the open edges of, for example, roofs, buildings, gangways, staircases and lift shafts.
- e) Holes and openings are securely fenced off or provided with adequate, fixed, clearly marked and properly secured covers.
- f) Adequate artificial lighting is provided when work is carried out in the absence of sufficient natural light.

When the risk assessment shows that the only reasonable method is to work at an open edge, e.g. not using remote machine methods, a safe, independent working platform should be used. Where these methods are not appropriate, suitably-anchored fall restraint or fall arrest equipment should be used. If fall arrest equipment is used a rescue plan should be in place to enable rapid and safe recovery of the suspended worker, especially if the person becomes unconscious while suspended.

12 Protection of people and the environment (see Figure 10)

Figure 10 Route map for Clause 12



12.1 General

NOTE Like new construction, demolition and/or dismantling activities can have wide-ranging impacts on the environment and the site's surroundings. These can be positive and adverse. On the positive side, impacts include, but are not limited to:

- a) dismantling can bring back into productive use, through reuse and/or recycling, materials and components that might otherwise be lost to waste disposal;
- b) dismantling or demolition can also aid regeneration of an area by removing buildings that have come to the end of their useful life;
- c) partial dismantling and subsequent refurbishment leads to redevelopment opportunities.

On the negative side, the potential impacts include, but are not limited to:

- 1) waste generation, for disposal in landfill or energy-from-waste plants;
- 2) dust, smoke, noise and other nuisances to neighbours of the site;
- 3) air overpressure from demolition that uses explosive charges; and
- 4) pollution of the air, land or the water environment.

Note that although these examples include what could be identified by some as "social issues", not "environmental issues", this standard covers them all under the term "environment".

12.1.1 Responsibilities for environmental management

Those involved in planning and undertaking demolition and dismantling activities should ensure, as far as reasonably practicable, that the positive impacts of their work are maximized, and the adverse impacts minimized.

To do this effectively, they should employ sound environmental management practices, including the use of site environmental management plans, or an environmental section of the project plan. These plans may be part of a BS EN ISO 14001-compliant management system or equivalent, but sound environmental management practices should be adopted as set out in guidance available from CIRIA, BRE and others.

A member of the project team should be designated with responsibility for environmental management, especially waste management, pollution control, protection of wildlife and minimization of nuisances to the site's neighbours. All those involved in the refurbishment, demolition or dismantling should be appropriately briefed and trained on the environmental aspects of the work and their role in delivering the site environmental management requirements.

12.1.2 Planning

Demolition and dismantling activities should be planned, procured and undertaken in a manner that protects the environment and the site's surroundings, and, wherever possible, maximizes the opportunities for reuse and recycling of components and materials from demolition operations.

12.2 Legislation

Any environmental management system utilizing current best practice should include an analysis and summary of the legislation applicable to the operations being planned, and a process for keeping such information up to date (see 5.1.3 and Annex B).

Any local by-laws should also be taken into account.

NOTE Guidance on the environmental legislative requirements is provided in CIRIA guidance, including Environmental good practice on site (C650) [49], and on www.netregs.gov.uk, which provides Plain English guidance on environmental regulations.

12.3 Identification and management of sources of pollution

12.3.1 Identification

All those involved in planning and managing demolition and/or dismantling activities should identify and manage sources of pollution in accordance with the guidance available from, among others, CIRIA and BRE.

NOTE There are assessment and award schemes, useful websites for which are given in Annex C.

12.3.2 Waste management

All those involved in demolition and/or dismantling processes should understand their responsibility for the appropriate management of the arisings, including the proper management of waste and the requirements of the SWMP (where appropriate).

As much of the embedded materials as practicable should be recovered, but the health and safety implications should be addressed, taking into account, for example, the potential risk from working close to and handling materials and from working at height.

CAUTION: It should be noted that if the activities on site require planning permission, a waste licence will not be issued until that permission has been granted.

12.3.3 Waste management licensing

NOTE 1 Current UK legislation makes it illegal to treat, keep or dispose of controlled waste without a waste management licence/environmental permit (unless the activity is exempt from waste management licensing) or contrary to the Conditions of a waste licence, or in a manner which causes pollution of the environment or harm to human health. These activities are exempt from licensing only if the terms of the exemption are complied with.

The holder of a waste management licence/environmental permit is required to be a "fit and proper person". When assessing whether or not this is the case, the Environment Agency or SEPA take into account:

- a) whether the applicant, or other relevant person, has any convictions for pollution offences;*
- b) whether the applicant has taken steps to meet the possible cost of the obligations arising from the licence; and*
- c) whether the site is run by someone who is technically competent.*

Persons concerned with controlled waste are under a duty of care to ensure that waste is kept safely, does not cause pollution or harm to human health and is transferred to someone authorized to take it. A joint publication by the Department of the Environment, Transport and the Regions and the Scottish and Welsh Offices gives guidance on this duty of care (see also www.netregs.gov.uk).

*Controlled waste includes household, commercial and industrial wastes. This includes surplus substances, building and demolition waste, and anything which is disposed of by reuse or recycling or in an energy-from-waste plant or landfill due to being broken, worn out, contaminated or spoiled in some other way (see **10.3** and CIRIA SP 133 [50]).*

Anyone who transports controlled waste is required to register with the Environment Agency or SEPA as a waste carrier (or as a waste transporter exempt from waste carrier registration). The Controlled Waste (Registration of Carriers and Seizure of Vehicles) Regulations 1991 [51] set out the rules on registration of waste carriers. The Waste (England and Wales) Regulations 2011 [52] introduce a new requirement for registration as a lower tier carrier for those who normally and regularly carry controlled waste produced by their own businesses.

The licence is subject to periodic renewal. It outlines the controls for storage and disposal of materials from the site, along with all appropriate documentation required.

Applicants for a waste management license or environmental permit should ensure that the proposed activities do not cause:

- 1) pollution of the environment;
- 2) harm to human health; or
- 3) serious detriment to the amenities of the locality.

NOTE 2 The granting of planning permission satisfies condition 3).

NOTE 3 A person is considered to be technically competent if he or she holds a relevant certificate from the Waste Management Industry Training and Advisory Board (WAMITAB) (see Annex C).

12.3.4 Site waste management plan (SWMP)

The SWMP should include a statement relating to waste minimization and a forecast of the amount and type of waste likely to occur and how the waste is to be managed, including waste arising from the demolition process. Once construction work commences, the plan should be updated regularly and include information on the waste generated and recovery/disposal routes. A comparison between the amount of waste forecast and actuals should be made at the end of the project if it exceeds the financial value specified in the Regulations.

Adequate training should be given to those involved in delivering the plan. If the demolition is part of an overall project then a SWMP may be written for the whole project; however if demolition is carried out separately then a SWMP might be required

NOTE SWMPs are also currently a mandatory requirement under a range of government and other schemes, such as the Code for Sustainable Homes and BREEAM. BRE has developed a free tool for SWMPs in partnership with the National Federation of Demolition Contractors: www.smartwaste.co.uk. See Annex C.

12.3.5 Hierarchy of waste management and material recovery

The recovery of materials should be managed within the established waste management hierarchy [3] which gives the order of preference as:

- a) reduction of waste by producing less waste in manufacture and by producing longer-lasting products with lower polluting potential;
- b) reuse, e.g. timber joists, dressed masonry;
- c) recovery incorporating:
 - 1) recycling waste to produce a usable product;
 - 2) composting waste to produce growing media and soil conditioners; and
 - 3) recovering energy from waste, for example, by burning it; and
- d) disposal of waste by incineration without energy recovery or landfill.

However, the choice of waste management option for a particular waste stream should be guided by the principle of using the best practicable environmental option (BPEO) (also known as the best available technique or BAT).

NOTE 1 The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term.

NOTE 2 Materials arising from demolition may be reused or recycled for use in a variety of applications, both on and off site. Information on the potential applications for a full range of materials is given in CIRIA SP 133 [50] and C512 [53]. (See also BREMAP in 5.4.2.)

NOTE 3 Where hazardous materials, such as asbestos, fuels and oils, are to be transported off site, the Transport of Dangerous Goods (Safety Advisers) Regulations 1999 [54] require a dangerous goods safety adviser to be appointed.

12.3.6 Waste minimization and reuse, recovery and recycling of materials

The application of the waste management and material recovery hierarchy in practice should seek to minimize contaminated waste and maximize the opportunity for reuse and recycling. The demolition process should therefore be designed for the optimal recovery of materials, but taking into account health and safety issues.

The site survey, which can include gathering information for the development of the SWMP, should include an estimate of what type and quantity of wastes are likely to be generated and how those wastes are to be managed.

NOTE 1 This assists in planning the storage, transportation and recovery options for the materials arising from the demolition and finding suitable outlets for reuseable or recyclable materials and components.

Preference should be given to reuse of materials (on site if possible), followed by recycling materials for a different application from an environmental perspective. However, more time might be required for the reuse of materials. Consideration should also be given to waste minimization, such as the use of materials and components on site.

In order to maximize the reuse and recycling of materials, different types of materials should be segregated to prevent cross-contamination (a small percentage of timber in with concrete can significantly reduce the recycling potential of crushed concrete).

Other types of materials which should be considered for segregation for reuse or recycling include topsoil, metal, timber, plasterboard and architectural features.

NOTE 2 Further information on waste management and the reuse and recycling of materials arising from demolition is given in SP 133: Waste Minimization in Construction – Site Guide [50], the Waste and Resource Action Programme Protocols and the Construction Resources and Waste Platform Reports. See also Annex E.

12.3.7 Harmful waste materials

Wastes should be classified according to their composition and potential to harm the environment. Hazardous waste materials (called “special waste” by the Special Waste (Amendment) (Scotland) Regulations 2004 [55]) should be pretreated before being disposed of to a licensed facility. They should be tracked until they reach a waste management facility, by way of a consignment note system.

Certain waste materials should always be treated as hazardous, e.g. asbestos and fluorescent tubes. Other wastes may be treated as hazardous dependent upon their properties and the removal process, such as composite panels containing ozone-depleting substances.

In some cases the Environment Agency (or SEPA in Scotland) should be notified prior to the movement of such waste (a fee is payable to the Agency for registration of the site, and other payments cover transport, gate fees and landfill tax).

Asbestos and other hazardous waste should be disposed of at a licensed facility.

Those undertaking demolition and dismantling activities should segregate all wastes into “inert”, “non-inert and non-hazardous” and “hazardous waste” materials to keep reuse and recycling to a maximum and exposure and disposal costs to a minimum.

NOTE 1 This is partly to maximize environmental benefit and partly to avoid contaminating non-hazardous waste.

If materials are mixed then the whole consignment should be classified according to the most potentially harmful material. For example, a whole consignment of concrete and stone rubble should be classified as hazardous waste if it is mixed with some hazardous waste, e.g. asbestos. (See also 10.3.2.2.)

NOTE 2 Refurbishment and demolition works involving asbestos are controlled by legislation and need to involve specially-licensed companies. When working with asbestos in a form such that its removal is notifiable under the appropriate Regulations, 14 days notice is currently required to be made to the HSE. Asbestos wastes are also covered by regulations covering hazardous and special wastes.

12.3.8 Duty of care

Those undertaking demolition activities should understand their responsibility for the safe disposal of all materials leaving the site; they can for example be held responsible if a disposal contractor fly-tips a load of waste from the demolition site in order to avoid gate fees at a disposal site. The client and the principal contractor are required by the Environmental Protection Act [5] to take all reasonable steps to ensure that all waste from the site is dealt with in accordance with the waste duty of care and that materials are handled efficiently and waste-managed appropriately, so this should be specified in the SWMPs.

Those who produce, import, carry, keep, treat or dispose of controlled waste, or as a broker have control of such waste, should take all reasonable measures to ensure that the waste is managed properly and recovered or disposed of safely. Waste should be stored safely and securely and be transferred to an authorized person (see Note), who should be one, or possibly more, of the following.

- a) A waste collection authority employee.
- b) (In Scotland) a waste disposal authority employee.
- c) A holder of a waste management licence.
- d) A person carrying out an activity which is exempt from waste management licensing.
- e) A registered waste carrier.
- f) An exempt waste carrier.
- g) A registered waste broker.
- h) An exempt waste broker.

NOTE In current legislation a "person" can mean, for example, a corporate body, as well as an individual person.

A transport note containing the following information should be completed, signed and retained by the parties involved when waste is transferred.

- 1) A description of the waste.
- 2) The quantity of waste.
- 3) How the waste is contained.
- 4) The time, date and site of the transfer.
- 5) The names and addresses of both parties involved in the transfer and the category of authorized person to which each belongs.

The description of the waste should provide enough information to enable subsequent holders to avoid mismanaging the waste.

Before waste is transferred, it should be contained in a manner that will prevent its escape.

12.3.9 Air pollution

12.3.9.1 General

Air pollution should be monitored where appropriate to minimize the following.

- a) Smoke.
- b) Fumes or gases.
- c) Dust, steam, odours or other effluvia.
- d) Any accumulation or deposit.

- e) Noise.
- f) Any other matter declared by any enactment.

NOTE In UK law these fall within the concept of "statutory nuisances".

12.3.9.2 Noise and vibration

Clients and their agents should ascertain the requirements of the local authority in respect of noise and vibration. The choice of machinery and methods of operation should be based on a suitable assessment by those undertaking the works and conform to the local authority's requirements. When the noise cannot be adequately controlled at source by the appropriate selection of plant, equipment and work methods, enclosures and barriers should be erected. Noise control should be carried out in accordance with BS 5228-1 and BS 5228-2 (see also 11.14).

NOTE 1 Local authorities have powers for controlling noise and vibration from construction sites and other similar works. These powers can be exercised either before works start or after they have started.

NOTE 2 The noise from any plant, machine or equipment can be subject to control/approval.

Agreement about the use of particular methods of work should be reached by consultation with the appropriate authority (normally the local authority environmental health department).

To minimize noise emission, the following should be considered.

- a) The condition of the machinery to be used, e.g. efficient engines, silencers, covers and compliance with manufacturers' maintenance requirements.
- b) The siting of machinery, e.g. the use of available shielding such as walls or buildings, the judicious placing of material stores and distance from noise sensitive premises.
- c) The method of operation, e.g. the use of operational time restraints to avoid disturbance.
- d) Substitution of machinery, e.g. the use of valve compressors in place of reciprocating compressors and electric power in place of internal combustion power.
- e) Substitution of methodology, e.g. pressured bursting (see 17.11.8) instead of percussion methods and the use of an enclosed chute to lower materials instead of throwing or dropping.
- f) Reduction of boundary noise levels by appropriate positioning of preformed shielding.

12.3.9.3 Air overpressure

In demolition, air overpressure, which can be considered as high-intensity sound waves and can include frequencies below the audible range, should be taken into account when planning the method of work.

Air overpressure, which can occur when, for example, significant amounts of material strike the ground and/or when explosives are used, should be minimized by appropriately designed systems of work.

Expert advice should be obtained where necessary to estimate the anticipated values of air overpressure, and events should be monitored if neighbours are likely to be affected.

The anticipated values of air overpressure should be considered when establishing the exclusion zone (see Clause 13) and when determining the risk of damage to property, e.g. windows, which are usually regarded as the weakest part of the structure depending on conditions.

12.3.9.4 Dust

Provision should be made for the reasonable prevention of dust generation. Where this is not possible, adequate dust-suppression management should be applied.

Where dust is likely to occur, e.g. during deliberate collapse, appropriate means of removing the dust that arises should be planned and provided, such as water hoses, road sweepers and window cleaners.

Dust suppression by water should employ a dispersal point close to the position of dust generation in order to be more effective in both dust suppression and minimizing the volume of water used, and thus run-off. The appropriate Waste Regulation Authority should be notified as appropriate. Contaminated or stagnant water should not be used as the resulting aerosol can lead, for example, to inhalation exposure to bacteria that cause legionella.

12.3.9.5 Smoke

Provision should be made for the control of smoke through the effective control of burning of materials on site, when permitted (see 5.1.3 and 5.1.7).

12.3.10 Radiation

Suitable arrangements should be made for dealing with arisings from demolition activities that are contaminated by radioactivity from either natural or manufactured sources (see 10.3.2.4 for more detail).

12.3.11 Land pollution

12.3.11.1 Vibration and impact

Generation of excess vibration should be avoided. An assessment should be made of the potential detrimental effects of vibrations transmitted through structural elements caused by, for example, plant operation, impact with the ground of felled structures or the use of explosives.

NOTE 1 The potential detrimental effects include:

- a) cosmetic and structural damage of adjacent premises;*
- b) disturbance of sensitive equipment, such as hospital equipment and computers;*
- c) buried services including gas pipes; and*
- d) public perception of risk.*

Expert advice should be obtained where necessary to estimate the anticipated values of vibration including, where appropriate, the effects of short duration ground vibration due to impact or detonation of explosive charges which can impose very high peak particle velocity (PPV) levels.

NOTE 2 Guidance on the evaluation of human exposure to vibration in buildings is given in BS 6472 (all parts).

Vibration should be monitored in sensitive locations, e.g. where neighbours and other facilities are likely to be affected both before (to establish existing vibration, e.g. from railways and roads) and during the works.

Where necessary, layers of fine graded material should be provided along the line of any fall (see also 11.14) to reduce vibration caused by ground impact.

The vibration due to impact cannot necessarily be treated in the same way as steady state vibration. To control vibration due to piling, for example, the recommendations of BS 5228-1 and BS 5228-2 should be followed.

12.3.11.2 Solids

Solid materials should be handled in accordance with instructions devised following identification during the survey (see 7.4.2) and, where appropriate, disposed of at an approved site. Only inert materials should be used as fill material within the demolition site.

Adequate security, including site boundary fencing, should be provided and maintained at all times (see 11.4) to prevent materials of unknown source being deposited on site, e.g. due to fly-tipping. However, if such materials are found they should be identified before handling and disposal.

Measures should be put in place to prevent materials being inadvertently taken off site on the wheels of vehicles, e.g. providing wheel washing facilities (see also 12.3.11.3).

12.3.11.3 Fluids

The most common cause of pollution to land arises from the draining of containers such as tanks, sumps and transformers. All liquids from such vessels should either be retained within their original containers or transferred to other containers for safe transportation, and disposal or treatment, unless analysed and shown to be acceptable for disposal on site, e.g. via the sewers, in which case the local water company or sewerage undertaker should be contacted.

Sumps that could contain contaminated water [including wash waters of any kind, e.g. water used to wash out a tank or wheels (see also 12.3.12)] should be emptied into tankers for transport to a suitable disposal site.

12.3.12 Water courses

No liquid or solid materials (see also 12.3.11.2 and 12.3.11.3) should be discharged to any water course other than under a discharge consent or agreement issued by the appropriate authority, e.g. the Environment Agency, or SEPA in Scotland.

12.4 Flora and fauna

Compliance with the provisions of the Wildlife and Countryside Act 1981 [56] and the Countryside and Rights of Way Act 2000 [57] could delay demolition or dismantling activity, as they make it an offence to, for example, disturb a nesting bird. Such delays should be provided for in the work programme to avoid the potential for disturbance.

The following organizations may be contacted for advice on flora and fauna (see Annex C).

- a) Natural England.
- b) Scottish Natural Heritage.
- c) The Countryside Council for Wales.
- d) Council for Nature Conservation and the Countryside (Northern Ireland).
- e) Local Wildlife Trusts.

The client should determine whether the site is in a conservation area and, if necessary, explain this in the tender and contract documents and on a drawing.

Sensitive areas, habitats and/or species that are to be protected, including vegetation that is to be retained, should be protected from damage by such features as suitable fencing.

BS 5837 should be followed when working in proximity to trees. Trees to be retained should not be used to assist demolition operations. Heavy vehicles should be kept sufficiently clear of trees to avoid damage to branches and also to roots by compaction of the soil. If excavation has to be carried out within the spread of foliage, damage to roots should be avoided.

The controls on disposal of materials containing invasive plant species as defined by the Environment Agency, such as Japanese Knotweed, Himalayan Balsam and Giant Hogweed, should be taken into account.

Where necessary, advice should be obtained from an ecologist to enable the work to be undertaken in accordance with good environmental practice and the relevant legislative requirements as appropriate.

12.5 Protection of property

The protection of adjacent property, particularly structures, should be planned at an early stage and detailed in the method statement (see 5.2.3). Permanent or temporary support should be provided in accordance with Clauses 14, 15 and 16. In addition to structural matters, appropriate protection from the weather, debris, dust and liquids should be provided. As necessary, protection should be provided against the possible dislodgement of materials, such as soot which can block flues in adjacent properties. The effects of air overpressure and vibration should also be considered (see 12.3.9.2 and 12.3.9.3).

NOTE 1 See also 5.1 for advice on planning for, and monitoring of, the property for damage.

Working methods should ensure that the support of remaining foundations, structures or land is not disturbed during the excavation of existing foundations or basement floors.

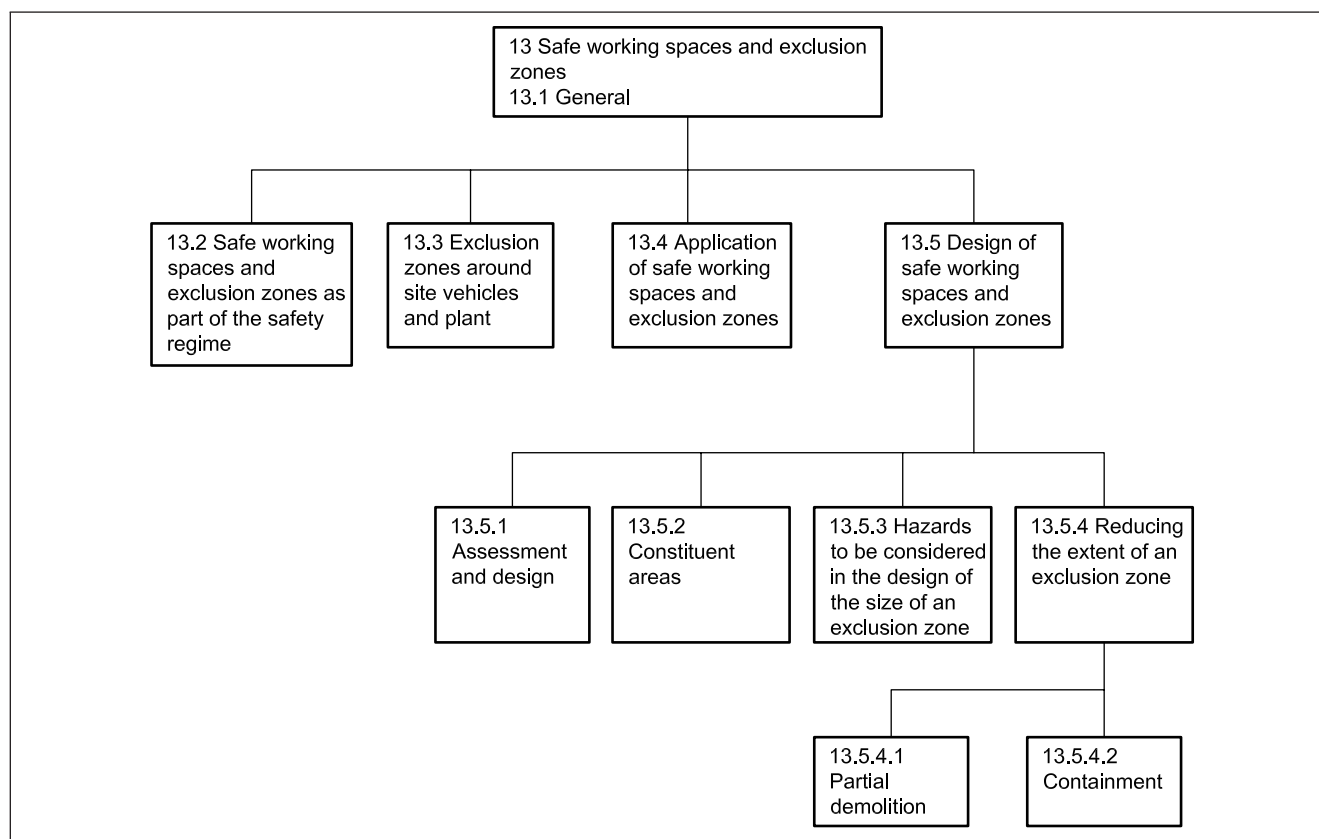
Soakaways should be provided after basements and cellars have been cleared.

NOTE 2 Precautions might be necessary to prevent water penetration to adjoining buildings.

Where watertight basements remain in ground having a high water table, measures should be put in place to prevent flotation. Precautions should be taken to prevent accidental access to basements that are filled with water.

13 Safe working spaces and exclusion zones (see Figure 11)

Figure 11 Route map for Clause 13



13.1 General

Activities for demolition and partial demolition, including those for structural refurbishment, should generally be provided with exclusion zones. An assessment should be made of the extent and type of exclusion zones to ensure that persons outside the zone are not exposed to physical, chemical or biological hazards or to noise, vibration and dust as a result of any demolition activity, including any processing of materials.

NOTE An example of a position of safety or a safe working space is a machine driver operating within the buffer area and provided with a suitable protective cab structure.

Where personnel directly involved in the demolition work need to be within the exclusion zone, they should be located in a position of safety appropriate to the stage of demolition, which has been assessed within an overall planned and monitored safe system of work. These personnel should not be permitted nearer the work than within the designated buffer area. Such work should only be permitted when it is inappropriate to work from outside the exclusion zone.

The extent of the exclusion zone should be varied according to the demolition activity and rate of progress, and it can cover part of the site or even extend beyond the site boundary. In the latter case the consent of the adjoining owner(s) should be obtained. If the site is restricted by space, e.g. a city centre location, the extent of the designed exclusion zones, should be reassessed if there is a need to reduce the size, but only if adequate containment is provided (see 13.5.4).

13.2 Safe working spaces and exclusion zones as part of the safety regime

Exclusion zones should be part of an overall managed health and safety regime and should be included in the method statements. The location of the boundaries of any exclusion zones should be determined after assessing a number of parameters (see 13.4, 13.5 and the examples given in Figures 12 to 16).

13.3 Exclusion zones around site vehicles and plant

The work activity on site should be designed so that pedestrians and machines on site can move around without risk of collision. Safe operating spaces should be provided for all machines. The use of plant and machinery such as excavators and cranes should be planned so that their operation does not present a risk to those nearby.

In addition, the extent and location of the exclusion zone around a machine should take account of, for example, any crushing hazard between part of the machine and stationary objects or structures, or inadvertent movement of the machinery.

Pedestrian and machine movements on site should be controlled by designed and clearly delineated traffic routes that segregate their movements.

13.4 Application of safe working spaces and exclusion zones

An appropriate exclusion zone should be instigated when any person could be at risk from, or as a result of, any demolition activity. Exclusion zones should be assessed and established for all types of collapse, irrespective of the method of demolition and size of the planned collapse. Each demolition activity should be individually assessed and new assessments should be made and used for different demolition activities and differing types of situation (see 13.5.3 and Table 6). Exclusion zones should be applied when a whole structure or part of a structure is being demolished and should include areas where demolition machines are operating, and where arisings from the demolition can be deposited or otherwise handled, including controlled areas for soft strip materials (see 19.2.2).

Table 6 Areas of an exclusion zone

Area ^{A)}	Description
Plan area	The area of the structure or part of the structure that is to be demolished and is the subject of the assessment
Designed drop area	The immediate hazard area where the principal mass of the collapsing structure is planned to drop. Also included in this area is the plan area.
Predicted debris area	The perimeter of this second hazard area is the predicted limit or extent to which any debris from, or secondary material resulting from, the structure being demolished will travel and come to rest.
Buffer area	A hazard area that is planned to allow for any unpredictable events. People beyond the external perimeter of this area (the theoretical boundary of the exclusion zone) are safe from the effects of the demolition activity.

^{A)} Examples of these areas are shown in Figures 12 to 16.

NOTE The term “structure” also means part of a structure, where applicable.

Figure 12 Terminology of designed exclusion zone and its constituent parts (typical for controlled explosive demolition)

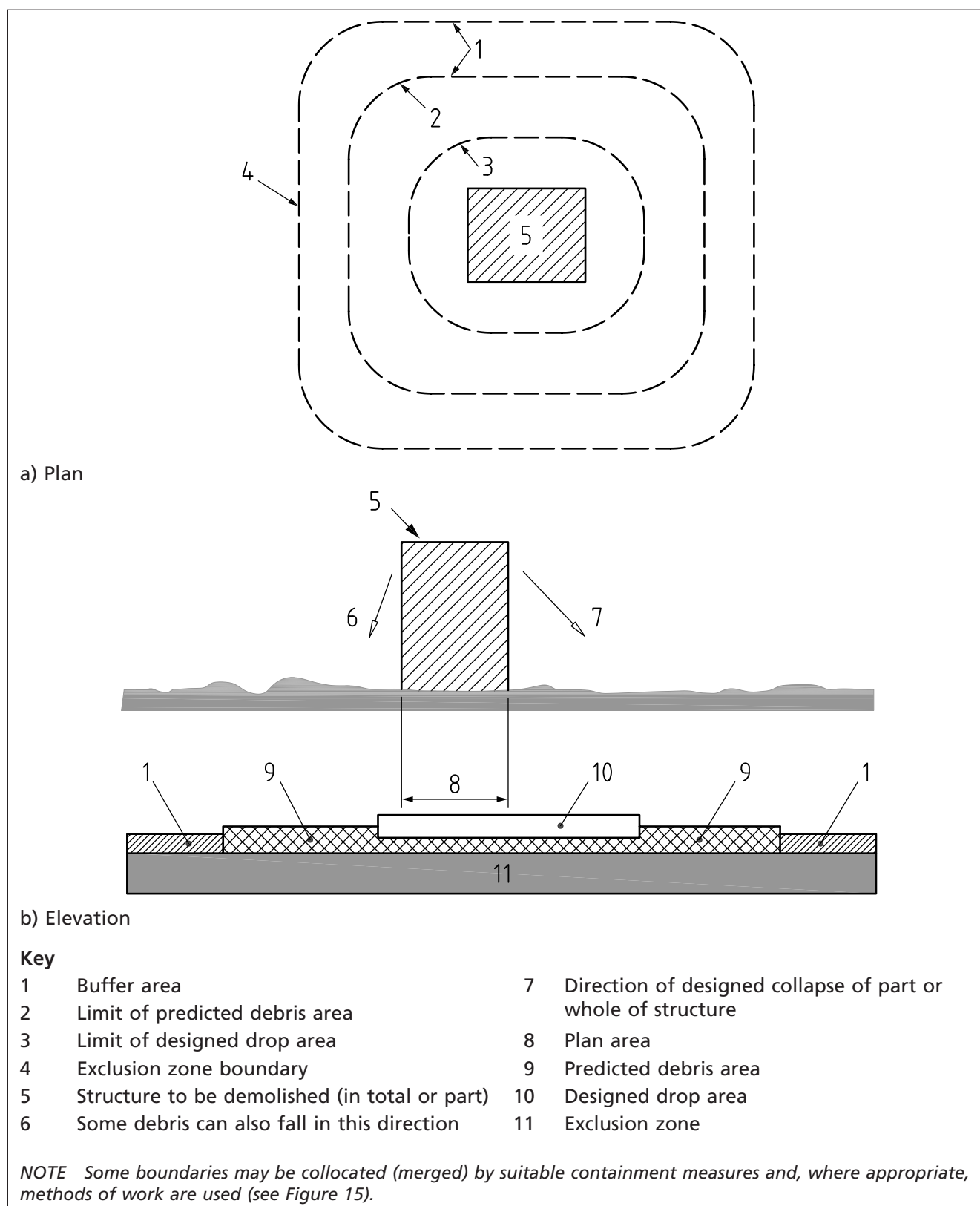


Figure 13 Example of designed exclusion zone showing practical application (typical for controlled explosive demolition)

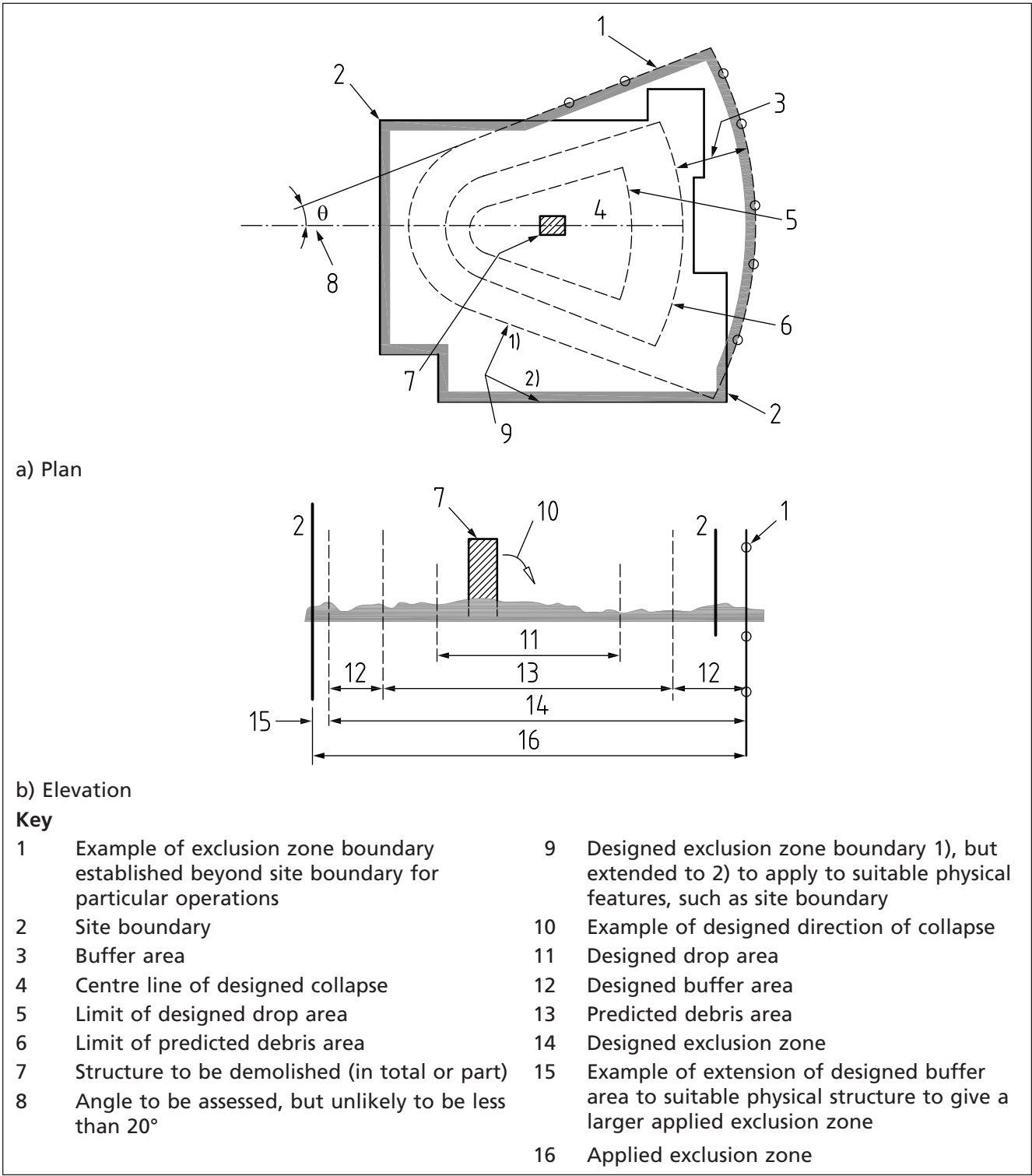
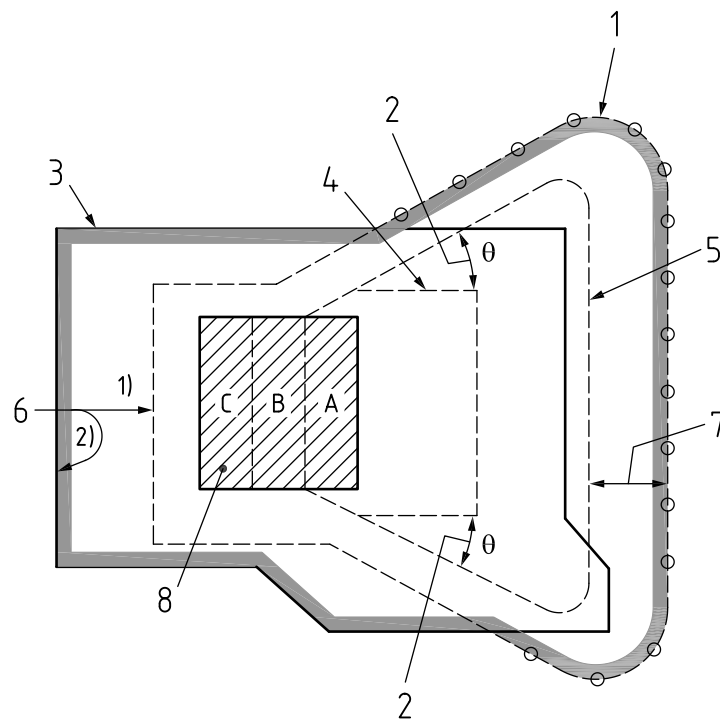


Figure 14 Example of designed exclusion zone showing phased and partial demolition (typical for controlled explosive demolition)



Key

- | | | | |
|---|--|---|---|
| 1 | Designed temporary exclusion zone boundary for particular operations, applied beyond site boundary | 6 | Designed exclusion zone boundary 1), but extended to 2) to apply to suitable physical features, such as site boundary |
| 2 | Angle to be assessed, but unlikely to be less than 20° | 7 | Buffer area |
| 3 | Site boundary | 8 | Structure to be demolished, showing possible stages |
| 4 | Limit of designed drop area boundary | | |
| 5 | Limit of predicted debris area | | |

NOTE The location of the designed exclusion zone boundary and its constituent parts can vary as different phases of the work are undertaken - boundaries for stage A are shown.

Figure 15 Example of reduced exclusion zone by the use of containment (typical for floor-by-floor or top-down demolition)

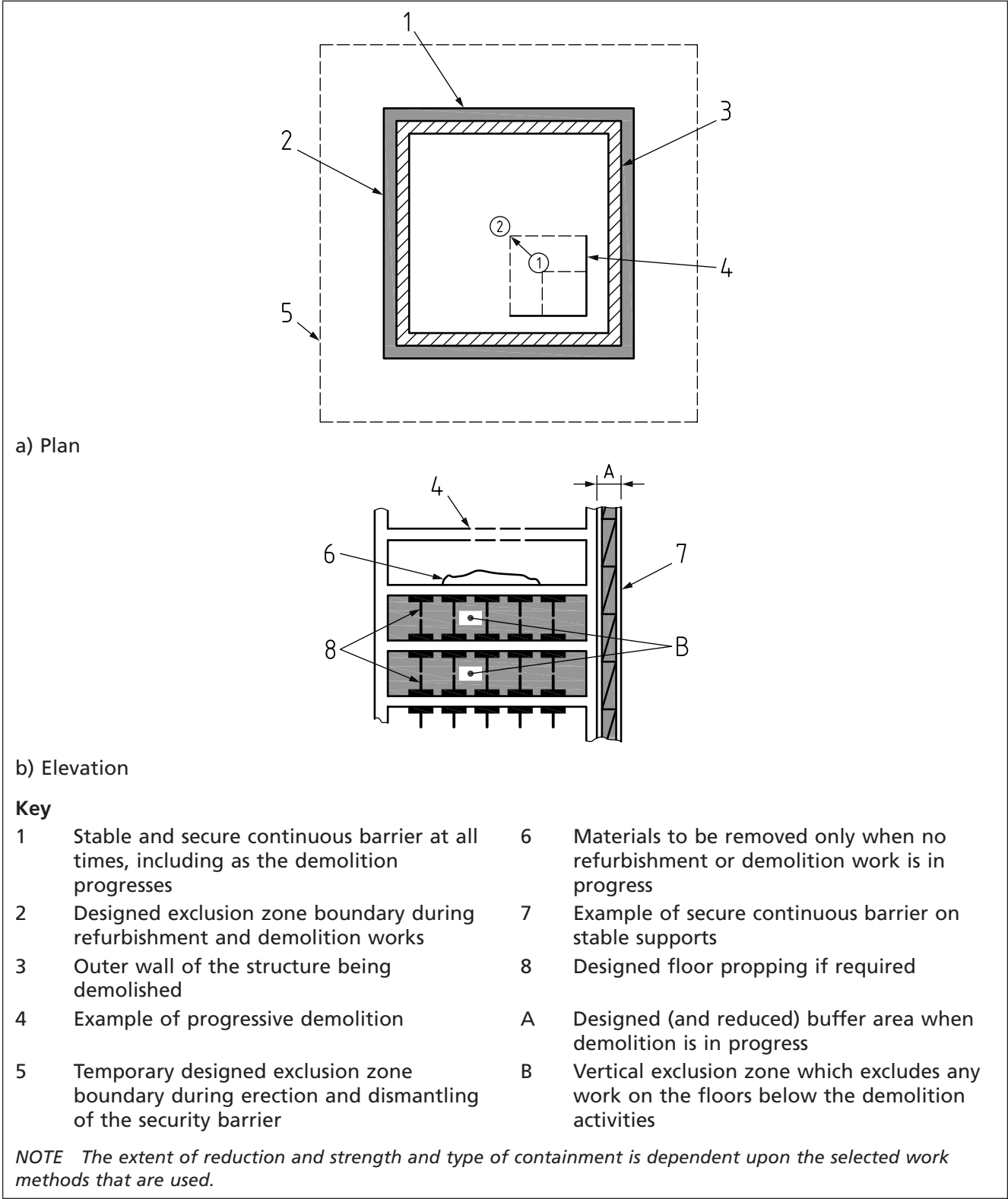
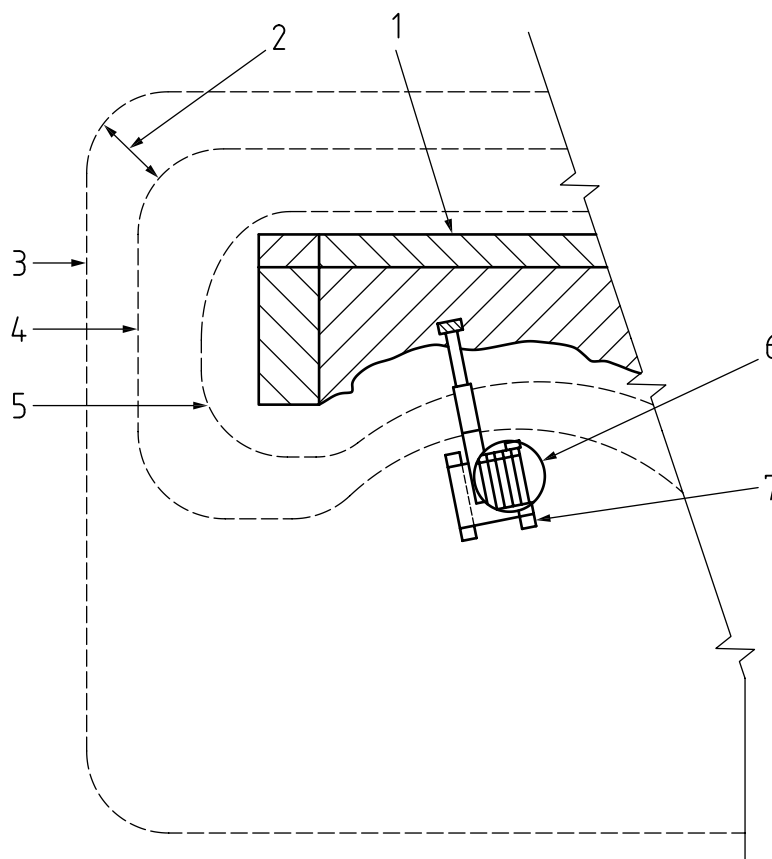


Figure 16 Example of safe working space within an exclusion zone (typical for mechanical reduction or top-down demolition employing mechanical plant, etc.)



Key

- | | | | |
|---|--------------------------------|---|--|
| 1 | Structure being demolished | 5 | Limit of designed drop area |
| 2 | Buffer area | 6 | Safe working space for operator in protected cab |
| 3 | Exclusion zone boundary | 7 | Demolition machine |
| 4 | Limit of predicted debris area | | |

NOTE 1 The safe working space is in a protected area within the buffer area and is therefore beyond the limit of predicted debris.

NOTE 2 See also Figures 17, 18 and 19, which demonstrate aspects of machine work.

Figure 17 Plan of typical progressive demolition sequence, column-to-column maintaining a “square” to provide lateral support

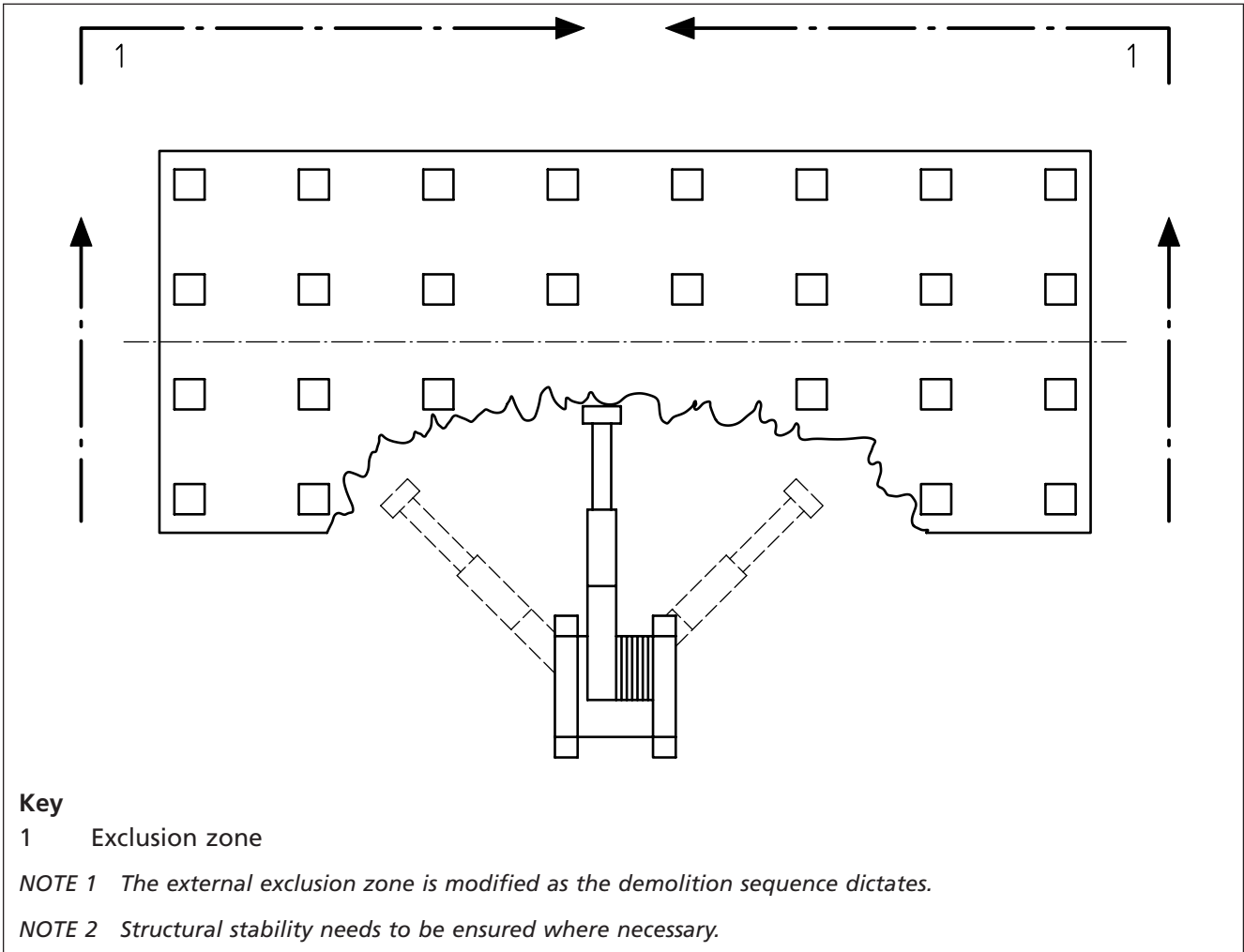


Figure 18 Elevation: typical multistorey structure demolition sequence working “top down” outwards towards the shear walls (strong points), i.e. lift shafts and stairwells

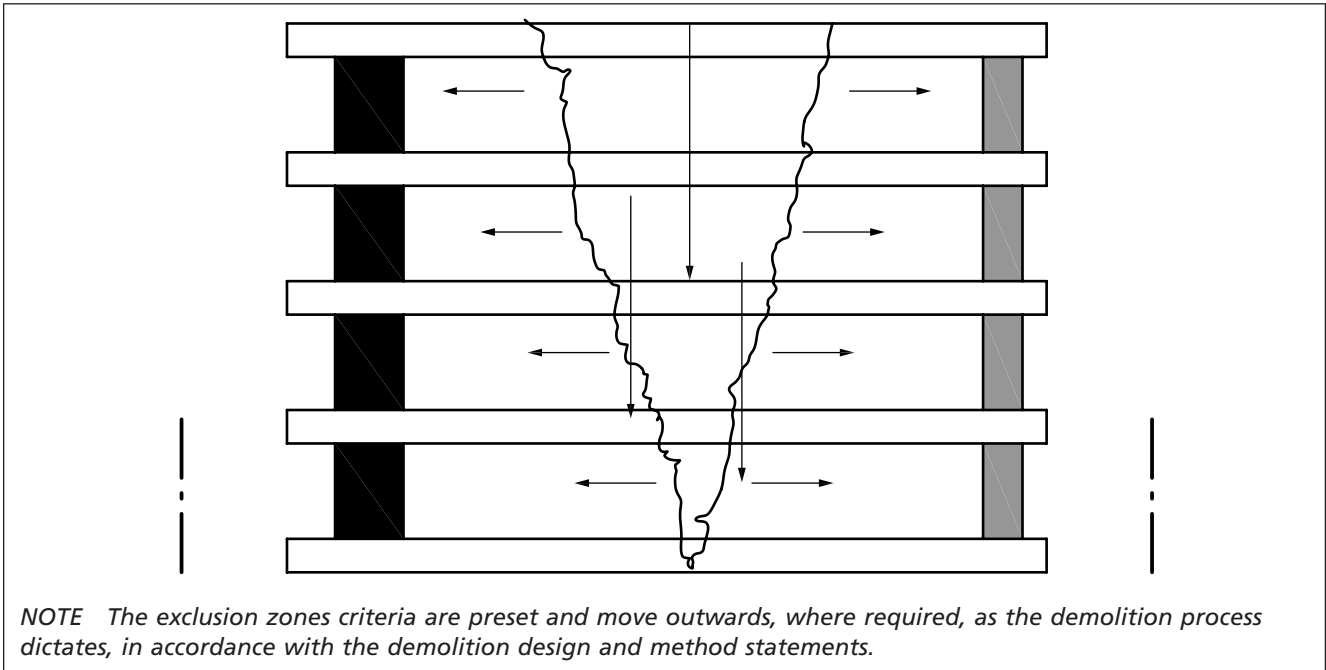
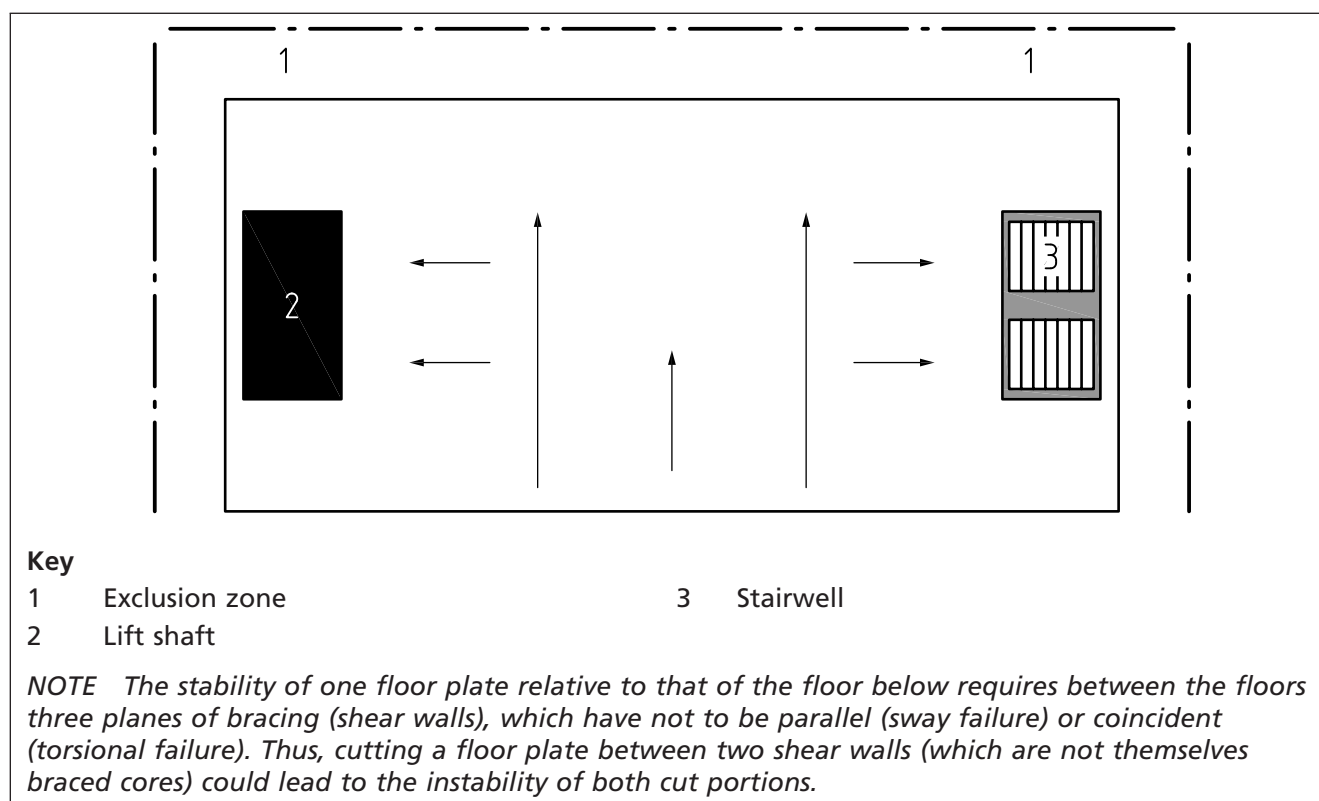


Figure 19 Plan of demolition sequence working inwards and outwards towards the structural elements providing stability, such as shear walls



13.5 Design of safe working spaces and exclusion zones

13.5.1 Assessment and design

The assessment and design for the safe working spaces and exclusion zones should be undertaken by people competent to do so. The exclusion zones should be designed by building up the overall size by assessing each constituent area (see 13.5.2) and summing each to formulate the result. A more detailed assessment should be undertaken for some methods of demolition, e.g. exclusion zones for demolition by explosives should be designed in accordance with BS 5607.

The influence of the following should be accounted for in the design of exclusion zones.

- The site, including its topography.
- The structure (including its height) and construction materials.
- The surrounding environment (where applicable).
- The proposed methods of demolition or partial demolition (including the machines to be used).
- The type of ground.
- The landscape features.
- Visual distraction for those not on site (e.g. to drivers on adjacent roads).

13.5.2 Constituent areas

The exclusion zone should be designed as a number of constituent areas as shown and described in Table 6 and Figures 12 to 16.

13.5.3 Hazards to be considered in the design of the size of an exclusion zone

The hazards related to particular areas of exclusion zones given in Table 7 should be used during the design process. The exclusion zone should be designed to include machines, giving them sufficient space to manoeuvre and operate safely (see 13.3).

When a method of deliberate collapse is used, a space for the fall should be assessed, with the space extending at least 20° either side of the designed line of collapse (see Figure 13 and Figure 14).

The extent of the designed drop areas and the predicted debris areas, the alignment of the line of fall and the allowed deviation from that line for structures, including chimneys, should be determined by taking into account such factors as the following.

- a) The height of the structure to be felled.
- b) Any variation in cross-section, e.g. shape and wall thicknesses throughout height.
- c) Any apertures, e.g. flue entries at the base or in the height to be felled, including those that have been filled in (including the effectiveness of the infill).
- d) The extent of any deterioration of the materials.
- e) The predicted break-up and fragmentation pattern of the structure as it falls.
- f) Materials that can become loose, such as rooftop structures or metal rings that can roll or be projected a further distance after the structure hits the ground.
- g) Break-up of the structure on impact, including potential for “fly” of material.
- h) The surrounding environment.

Table 7 Examples of hazards related to the areas of an exclusion zone

Source of material	Area affected ^{A)}	Cause of hazards	Examples
1. Structure	Designed drop area	Gravity	Material from the structure dropping to ground or surface with little further movement
2. Structure	Designed drop area plus predicted debris area and possibly the buffer area	Gravity	Dropped material from the structure with onward movement, including possible upwards trajectories, e.g. chimney rings, fire brick linings, other structure parts
3. Structure	Designed drop area plus predicted debris area and possibly the buffer area	Forced propulsion, e.g. by explosives, structural distortion, fluids under pressure	Fragments of structure, such as pieces of steelwork, cast iron, rivet heads, concrete fragments of varying size, masonry, blast material and blast protection debris, which eject from the blast area
4. Non-structure	Designed drop area plus predicted debris area and possibly the buffer area	"Slap effect" due to impact on landing area such as ground, hard-core cushion, fill area	Clods of earth, pieces of hard-core cushion, water surge; fragments of structures, such as pieces of steelwork, cast iron, rivet heads, concrete lumps and masonry ejected from the landing area
5. Non-structure	Designed drop area but preferably not predicted debris area and buffer area	Work on site initiating noise, air overpressure, ground vibration	Indirect effects such as distraction, shock, damage to critical services, dust
6. Non-structure	Designed drop area plus predicted debris area but preferably not the buffer area	Mechanical work on site releasing hazardous substances	Chemicals or biological agents from an inadequately decommissioned plant and associated structures (see Clause 8)

^{A)} See Figures 12 to 16 and Table 6.

NOTE 1 In general, there is no need to mark individual area boundaries, except for the perimeter of the exclusion zone and possibly the outer boundary of the predicted debris area (see 13.1).

NOTE 2 Account has to be taken of activities where other trades might be involved or might need entry to vulnerable areas.

13.5.4 Reducing the extent of an exclusion zone

13.5.4.1 Partial demolition

Where a reduction in the extent of an exclusion zone is desired or required, consideration should be given to the removal during the initial stages of, for example, parts of the structure [see 13.5.3, items f) and g)] that can become detached during the main demolition process (see also 17.2.4).

13.5.4.2 Containment

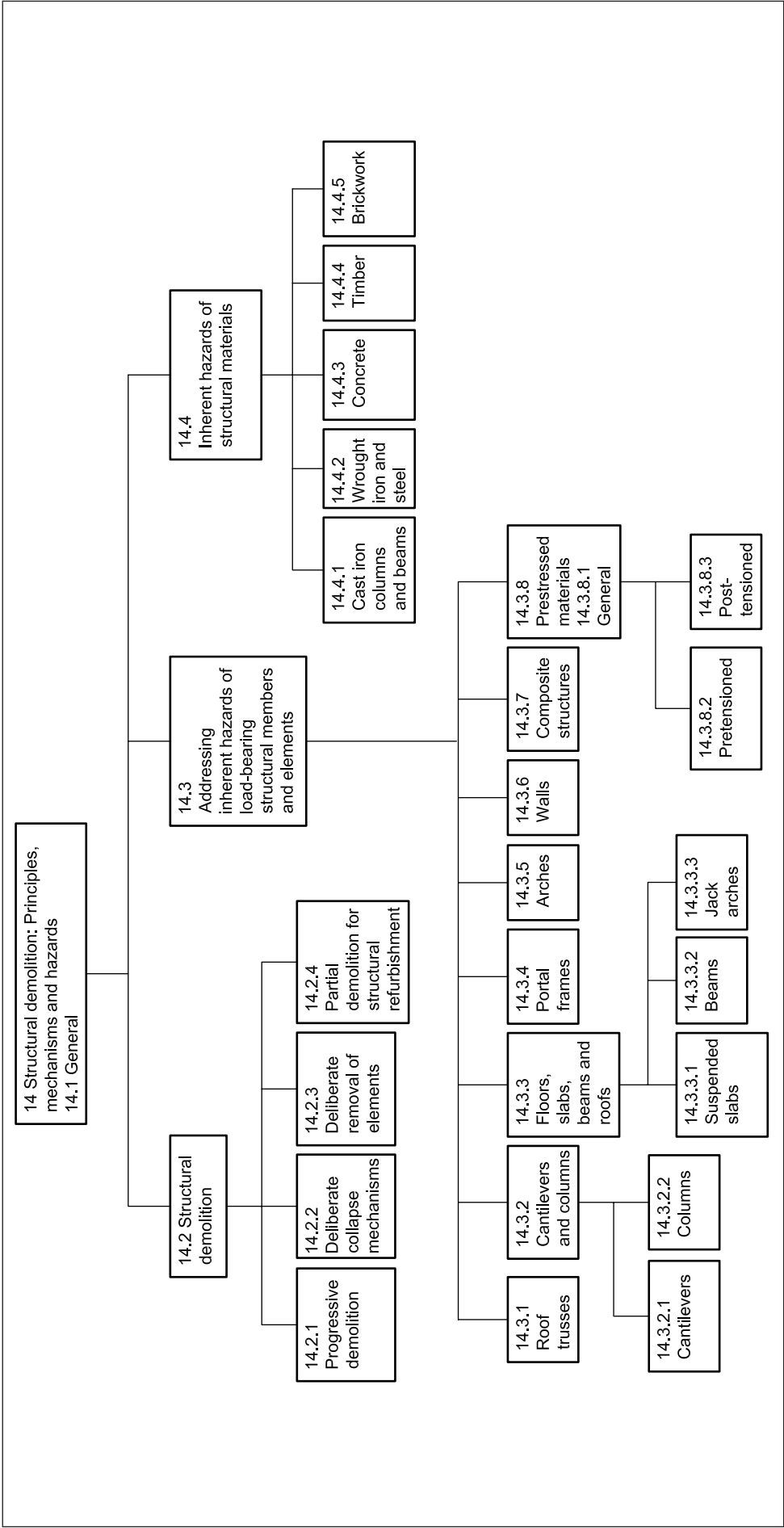
To enable the extent of the safe working area or exclusion zone to be reduced, existing physical features should be used, or new features specially constructed. Barriers that may be used include:

- a) a specially designed bund to retain elements which would otherwise roll along the ground; and

- b) on constricted sites, containment measures such as the use of appropriately sheeted scaffolding, where the reduction in the extent of the exclusion zone should be by the collocation of appropriate constituent area boundaries (see Table 6, **11.16.3** and Figure 15).

Those features that are scheduled for demolition should therefore be retained until they have been used for this purpose. In addition, consideration should be given to the construction of physical barriers specifically for the demolition activity to enable the predicted debris area size to be reduced (see Figure 15).

Figure 20 Route map for Clause 14



14 Structural demolition: Principles, mechanisms and hazards (see Figure 20)

14.1 General

Any demolition method, full or partial, should be based on a complete understanding of the nature of the structure, the interdependence of all structural elements, and the interrelationships with adjacent structures and the surrounding environment. This information should be obtained from site and building surveys appropriate and necessary for the project (see Clause 7).

Load paths and the strategic use of inherent structural interrelationships should be fully understood and considered before any demolition activity is undertaken. Auxiliary works, temporary structures and the construction of new permanent structures and structural elements should be designed to ensure stability during the works.

During partial demolition for structural refurbishment, any parts of the existing structure to be preserved should be properly protected, and the design of the alterations, temporary supports and progress of partial demolition should be planned in advance to ensure the continuing stability of the structure. Provision should be made for dealing with unexpected construction details or unknown past structural alterations exposed during demolition works, so that the stability of the structure and appropriate construction processes can be ensured.

Provision should be made to ensure there is no instability of the structure at any stage of the works.

The basic principles of structural demolition, i.e. progressive, deliberate collapse or deliberate removal, should be applied as appropriate, whether full or partial demolition or structural alterations are to be carried out, such as in structural refurbishment projects (see also 4.6).

Whenever practically possible, a remote mechanical process should be used to minimize the risk to workers.

14.2 Structural demolition

14.2.1 Progressive demolition

Progressive demolition should involve the controlled removal of sections of the structure, whilst retaining the stability of the remainder and avoiding collapse of the whole or part of the building to be demolished or refurbished. Where progressive demolition is adopted, the key structural members on which the stability of the structure relies should, together with their sequence of removal, be clearly indicated in the method statement and also on site. Departure from the method statement to suit site conditions should only be considered after obtaining appropriate engineering advice and confirmation.

Progressive demolition should be employed at the majority of sites, particularly in confined and restricted areas.

Where progressive demolition is dependent on the sequence of operations, the essential elements of the sequence should be communicated effectively, using for example a precedence network diagram.

14.2.2 Deliberate collapse mechanisms

Demolition by deliberate collapse should involve the removal of key structural members to cause complete collapse of the whole or part of the building or structure. Where deliberate collapse demolition is adopted, the key structural members to be removed should be clearly indicated, together with the sequence of removal, in the method statement (see also 5.2.3 and Clause 17) and also on site.

Where parts of a structure are to be demolished by deliberate collapse in separate operations, provision should be made to ensure there is no potential instability of the remaining structure that could cause a hazard to personnel on the site or to other people near the structure being demolished. A designed collapse initiation procedure or mechanism should be in place so that collapse is deliberately triggered in a controlled manner. Removal of elements or pre-weakening should not leave the structure vulnerable to unplanned collapse.

14.2.3 Deliberate removal of elements

The deliberate removal of elements should involve the removal, dismantling or deconstruction of selected parts of the structure. This method should be used, for example, in the lead-up to deliberate collapse or as part of structural refurbishment or modification work. The elements to be removed should be identified and the effects of removal on the remaining structure fully understood and included in the method statement, with the elements to be removed marked on site.

Sections of the structure should not be removed if instability of any of the remainder could result in a possible risk to personnel on the site and to other people nearby. Expert advice should be sought.

For partial demolition for structural refurbishment, new supporting members or elements should be provided, as necessary, to maintain the stability of the remaining part(s) of the structure or building. The new members or elements may be temporary or part of the new permanent structure. Alternatively, existing elements or members may be modified or strengthened.

14.2.4 Partial demolition for structural refurbishment

Structural refurbishment involving any alteration to an existing building or structure should involve changing the existing structure, including the removal (or addition) of structural elements or members, dismantling, or partial demolition of the existing structure. Partial demolition involves carrying out work only on parts of the structure, but should ensure that the structural stability of the remaining parts of the structure are maintained during and after the demolition works. Structural stability should be ensured by one or more of the following methods.

- a) Adequate structural analysis to ensure that the remaining structure is stable and not overloaded.
- b) The provision of temporary supporting structures.
- c) The provision of strengthened or new structural elements or members.
- d) Adequately planned and sequenced partial demolition operations.

14.3 Addressing inherent hazards of load-bearing structural members and elements

14.3.1 Roof trusses

Where a pitched roof is to be removed progressively, the roof structure should be removed to wall plate or pad level. Enough purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.

Temporary bracing should be added where necessary to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame, should be independently and securely guyed or otherwise braced in both directions before work starts. Generally, the bottom ties of trusses should not be cut *in situ*.

NOTE Large trusses might need to be propped to allow sectional removal.

If sectional removal is to be considered, particularly the removal of larger trusses such as in industrial buildings, a full structural assessment should be undertaken before preparing the method of work, particularly as additional temporary support might be required.

14.3.2 Cantilevers and columns

14.3.2.1 Cantilevers

Cantilevers such as cantilevered retaining walls, propped cantilevers, balanced bridge constructions, canopies, cornices, staircases and balconies rely for their stability on balancing restraining loads. Such members should be either demolished or supported before the counterbalancing, tailing-down or balancing loads are removed.

14.3.2.2 Columns

The engineered removal of columns can aid efficient demolition, but the degree and type of fixity of the connections at the top and bottom should be determined as these can be crucial to the predictability of collapse patterns and thus the safety of the demolition.

14.3.3 Floors, slabs, beams and roofs

14.3.3.1 Suspended slabs

NOTE For a suspended slab it is important to establish what walls or other forms of support the slab relies on prior to its demolition, particularly if the reduction process is by hand.

Before demolition is commenced the load-bearing characteristics of the slab should be confirmed by first establishing the reinforcement details including the direction of the main reinforcement by, for example, electronic sensing or by making small trial holes. The strength and quality of the concrete should also be determined. The method of demolition should take into account the pattern of reinforcement, e.g. whether it is one-way or two-way spanning.

Additionally, account should be taken of any stress reversal, which can occur in slabs or beams propped at, for example, midspan, because the main steel reinforcement might not be situated in the appropriate position to form part of a continuous structure.

CAUTION: Absence of reinforcement makes a suspended slab liable to sudden collapse as a result of minor disturbance.

14.3.3.2 Beams

When removing beams by cutting or dismantling, the method adopted should ensure that, for example:

- any weakening of the structure by, for example, increasing the effective length of columns or walls, is taken into account;
- before lifting and lowering, temporary support is provided, if required, and, if dropping is planned, the dynamic effects are taken into account; and
- the effects of stress reversal, if continuous beams are being reduced to shorter lengths, are taken into account.

14.3.3.3 Jack arches

Where tie rods are present, they should not be cut until the horizontal thrusts have been removed by, for example, removal of the arch or series of arches in the floor. The floor should be demolished in strips parallel to the span of the arch rings (i.e. at right angles to the beams supporting the arches).

CAUTION: Jack arches built of deteriorated timber beams are particularly prone to collapse when disturbed.

14.3.4 Portal frames

A single portal frame is a combination of two columns and a beam (which can be continuous or pin-jointed) forming a frame in a vertical plane, where the joint between each column and beam is designed to be moment-resisting. The type of rigidity at the base can vary, as can the rigidity of the connection where the lengths of beam are joined, so these should therefore be established.

14.3.5 Arches

Arches carry load by exerting horizontal thrusts outwards at their springing points over the length of the construction. To ensure the stability of an arch during demolition the balance of the forces should be preserved by, for example:

- a) shoring to transmit horizontal thrusts to the ground;
- b) building in temporary tie bars;
- c) reducing vertical imposed loads;
- d) demolition of the arch in whole strips; and
- e) some combination of a) to d).

CAUTION 1: Vaulted masonry roofs/floors of axial form can often be treated as a single or multi-span arch so long as account is taken of any loss of abutment mass due to removal of, for example, walls above. Compound vaulted structures often need specialist consideration and might need multipoint propping to preserve, repair or demolish them.

CAUTION 2: Failures in arches can occur both because the horizontal resistance has been removed or reduced and because horizontal forces have increased as a result of increased downward loads. Ultimately, resistance to these loads might be at some distance from the arch being considered, such as at the end arch when multiple arches are present.

Caution should be exercised when transmitting horizontal thrusts to the ground. The vertical component of raking members should also be catered for by applying appropriate kentledge, e.g. keying into masonry at a level lower than the high end of the raker via soldiers, and needles if insufficient kentledge is unavailable above the point of contact.

14.3.6 Walls

The condition and stability of walls should be ascertained, load-bearing walls identified and the security of bonding at the ends of crosswalls established. The type of construction should be identified, including solid walls, cavity construction, ashlar construction or rubble-filled cavities. The structural condition of walls which are to remain, including the walls of any adjoining property, should be established. This should also be applied where walls have been cracked or fractured, e.g. by settlement or heave or by adjacent piling work. The possible effect on the remaining structure of the removal of buttressing walls should also be considered with particular regard to wind loading.

Consideration should be given to possible local instability, including buckling failure, of the wall due to removal of parts of the structure providing bracing, such as walls, floors or roofs.

CAUTION: Types of wall construction can vary from masonry to large precast concrete panels in industrialized system building structures (see 19.2.3).

The method selected for demolishing cantilevered retaining walls should take account of their dependence on loading from above, or the propping action from floors or other structural members which can affect their stability (see 14.3.2 and 19.8).

14.3.7 Composite structures (slabs and beams)

Because some basic structural elements rely for their strength on the composite nature of complementary members, which can be broken by early demolition activities, the need for temporary supports should be assessed.

Any demolition sequence involving composite structures should take account of such factors as the following.

- a) Prior to achieving composite action, steel beams will probably have been checked for their ability to support, unpropped, the loads on them during the construction phase, but this should not be relied upon and further assessments should be carried out.
- b) Lateral restraints to the compression flange provided possibly by the slab (whether *in situ* concrete or precast units) or by temporary bracing during the construction phase.
- c) Restraint or composite action can rely upon, for example, friction between the slab and the top flange.

Steel beams in which the lower flange is prestressed by encasement in high-grade concrete should usually be removed intact from their working position before being processed. When lifting the overlying slabs prior to removing the beams there can be movement of the beams, which should be taken into account in the proposed method of work.

The method of dealing with flitched beams should take account of the presence of the vertical metal plate placed between the timbers forming the beam.

14.3.8 Prestressed materials

14.3.8.1 General

The nature of prestressing is such that effective measures should be taken during the demolition of any structure or elements containing prestressed materials to ensure the control of inherent stored energy.

NOTE Summaries of the methods for recognizing different forms of prestressed materials and the safety aspects to be considered during demolition are given in Annex F.

In selecting a demolition technique, the potential consequences of sudden release of stress within the immediate working area (and also beyond) should be considered (see Clause 13).

14.3.8.2 Pretensioned members

Consideration should be given to demolition by lifting down elements after the removal of any covering materials for breaking up away from the structure. Cut strands should re-anchor a short distance from any cut points because the strands or wires should be fully bonded to the concrete. The cut pieces should remain prestressed.

Where *in situ* demolition is deemed appropriate, consideration should be given to the use of temporary support systems, and the effects of the release of prestress on supporting structures such as walls and columns should be assessed.

14.3.8.3 Post-tensioned members

Post-tensioned members should be removed and broken up under the instructions of an engineer experienced in this type of design.

CAUTION: Post-tensioned tendons contain significant stored energy which can make demolition hazardous. This is particularly the case when the tendons are unbonded or partly bonded, since it is the bond between the grout and tendons and duct walls which prevents the release of energy, thus stopping anchorages being ejected from the ends of the members (see Annex F).

14.4 Inherent hazards of structural materials

14.4.1 Cast iron columns and beams

The type of iron should be identified because sudden collapse can occur due, for example, to brittle failure in cast iron. Explosives should not generally be employed in the demolition of this type of construction unless it is proposed to demolish the building as a whole (see 17.11).

CAUTION: Historically, metals used in columns can differ from those used in beams. Cast iron columns usually occur with either cast or wrought iron beams and load-bearing brickwork. The strength of columns can vary, e.g. because of variable casting quality giving unequal wall thickness. Beams usually support either jack arch construction or timber floors. Filler joists and jack arch beams are particularly susceptible to corrosion.

14.4.2 Wrought iron and steel

Wrought iron and steel can have varying degrees of carbon content, which affects their ductility. Under load, they deflect before failure occurs in a structural member. Care should be taken to identify the type and condition of any steel connections to avoid catastrophic failure at these points, which can occur without warning.

14.4.3 Concrete

Unreinforced or over-reinforced concrete can result in sudden failure and collapse if subjected to tensile stresses greater than its moment resistance. The potential for concrete to be weaker than might appear from external inspection, e.g. because of voids from honeycombing, should be assessed and taken into account.

CAUTION: Concrete reinforcement methods using, for example, steel or polypropylene fibres are prone to sudden failure when overloaded. Fire-damaged concrete reinforced with plastics fibres usually have to be treated as though unreinforced.

14.4.4 Timber

The potential for timber to be weaker than might appear from external inspection because of, for example, internal deterioration due to beetle attack or rot due to poor drainage, should be assessed and taken into account.

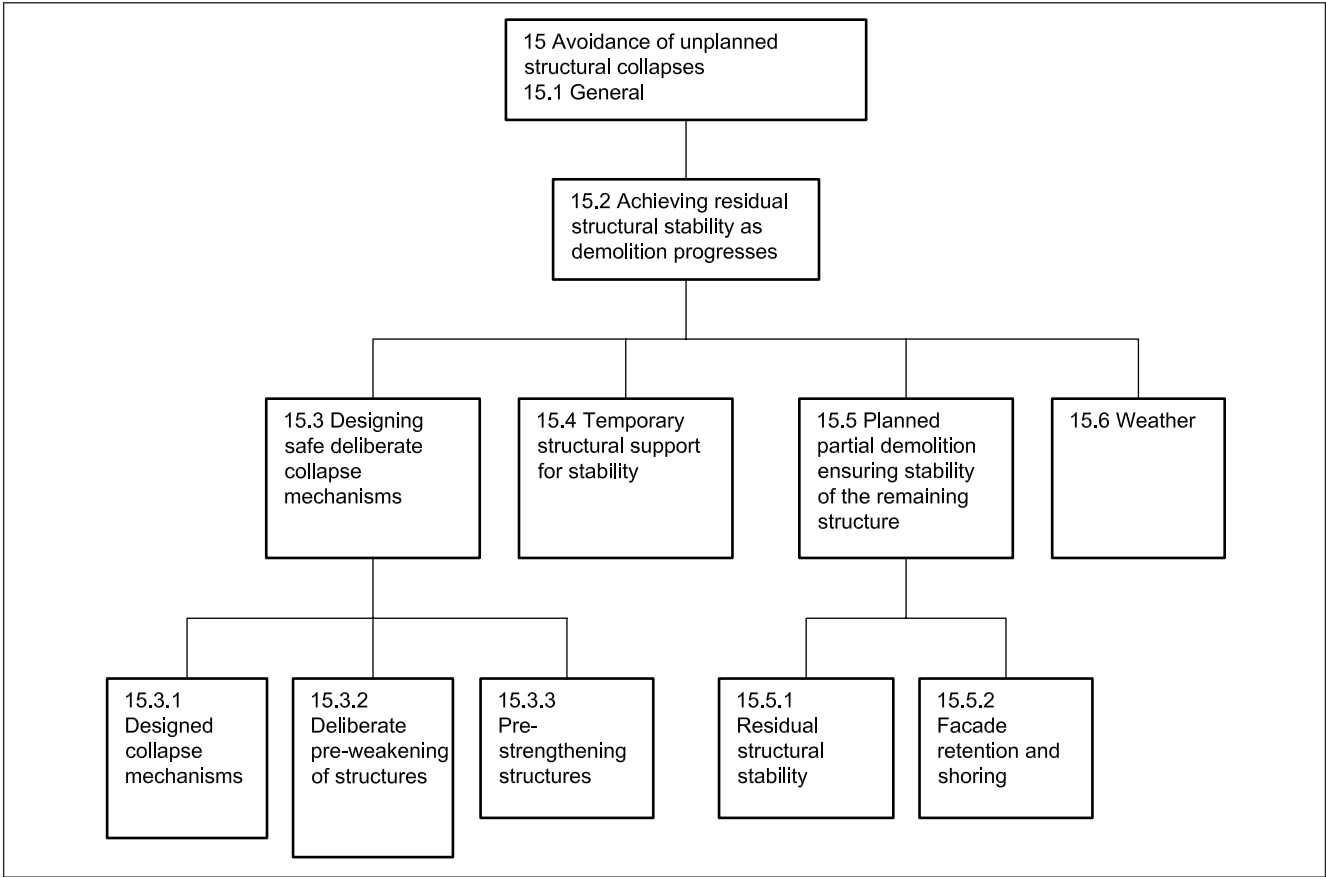
NOTE Timber structural members hidden within the construction of the building can suffer damage due to poor environmental conditions (excessive damp or dry conditions) or overloading. Timber joists at their bearings in external walls might be particularly susceptible.

14.4.5 Brickwork

The performance of weathered brickwork should be assessed as this is variable and is likely to be most severe in exposed locations such as parapets, gables and chimneys. Saturated brickwork should be checked for spalling or delamination arising from frost action. Brickwork in chimneys should be checked for the effects of acidic combustion gases which can attack both the bricks and the mortar. The performance of weathered mortar should also be assessed as it can become powdery throughout the wall thickness and so provide no tensile resistance.

15 Avoidance of unplanned structural collapses (see Figure 21)

Figure 21 Route map for Clause 15



15.1 General

To identify the possibility of premature and unintentional collapse, and to understand why such an event might occur, an assessment of the structure should be undertaken and the effects on the structure of the proposed methods and sequences of work determined before work commences.

The potential for unplanned structural collapses should be avoided by planning suitable methods and sequences of demolition activities, including those for structural refurbishment projects. These should be incorporated into the method statement and managed competently on site.

NOTE Unplanned collapse, including the collapse of an entire structure or, more likely, parts of a structure or building, generally occur:

- a) *prematurely (i.e. unintentional at that time) because of inadequate residual structural stability, e.g. when pre-weakened; and/or*
- b) *unintentionally (i.e. not intended for demolition) because of inadequate stability resulting in part of the structure or building collapsing or falling.*

CAUTION 1: The size of the collapse can be disproportionate to the initiating event.

Methods of managing the avoidance of unplanned collapses should be based on a sound knowledge of the structure (see Clause 9) and the way it acts to transmit the loads to the ground.

Floors should not be overloaded with machinery and/or debris resulting from the demolition process.

CAUTION 2: Some floor slabs are weaker in one direction and are therefore sensitive to the orientation of loading from machines, and thus more susceptible to unplanned premature collapse (see 14.3.3.1).

15.2 Achieving residual structural stability as demolition progresses

The ways loads are transmitted to the ground (i.e. the load paths) should be assessed prior to the work methods being established. The proposed method of work should take account of the assessment of residual structural stability at all locations, both in whole and in part, and at all times once work has commenced. During demolition, the behaviour of the structure and its elements vary; this behaviour should be understood. As the imposed loads need to be resisted, the load paths and resulting stability should be predicted by engineering principles for the continually changing state of the structure (see also 9.1).

Assessments should take into account both the structure and the materials of any structural features that are uncovered as demolition proceeds which were not obvious during the survey described in Clause 7. Assessments should include checks on the residual strength of the materials, the effects of any deterioration, and the effects of any additional loading caused by debris and plant.

At each stage before and during demolition:

- a) the residual structural stability should be known;
- b) the specific weaknesses and their positions should be identified; and
- c) the effects of a) and b) should be taken into account.

When assessing the potential causes of structural instability, the significance of such features as unbalanced thrusts and critical bracing elements, the retaining action of the basement walls on adjacent properties, and backfill on the stability of adjacent basement walls should be determined (see Clause 9 and Clause 19).

Where the interruption of a load path has been identified, the inability of the rest of the structure to support the redistribution of remaining forces in other load paths should be addressed by the provision of, for example, temporary supports and/or bracings (see 15.3.2 and Clauses 16 and 19).

15.3 Designing safe deliberate collapse mechanisms, including pre-weakening

15.3.1 Designed collapse mechanisms

As creating instability in a structure to initiate collapse or partial collapse is a fundamental principle of demolition, deliberate pre-weakening or pre-strengthening should be competently designed following assessment of the risks, including structural assessment (see 15.2). The conditions encountered on site should be checked to ensure that they conform to the designer's initial proposals for pre-weakening.

CAUTION: This activity is potentially hazardous, so effective control and monitoring systems should be implemented to ensure that the designed requirements are followed.

15.3.2 Deliberate pre-weakening of structures

Consideration should be given to the removal of load-bearing members or walls, as necessary, to ensure a successful full or partial demolition of structures that are inherently strong. Where structures are taken down mechanically, i.e. by standard or extended reach demolition rigs, this process should be planned in advance following a detailed survey of the structure to understand its construction, the location of any shear walls and strong points and the setting of adequate exclusion zones outside of the limit of the predicted debris zone. Demolition operations involving traditional floor-by-floor demolition or controlled explosive demolitions that require the disturbance or removal of key elements should be fully assessed, with calculations carried out by a competent engineer to obviate the danger of unexpected or premature collapse. Calculations confirming stability after the section is removed should be provided in advance. The dimensions of the section to be removed should be clearly marked on site to avoid overbreaking or removal of incorrect elements.

Steel sections may be cut to assist the collapse mechanism, but this type of work should only be carried out by operatives who are experienced and familiar with the technique. Where flame cutting is used to weaken a structural member, shims should be placed into the resulting void to prevent movement, distortion and reconnection, such as prior to placing of explosives.

Concrete shear walls may be kept in place until immediately prior to the demolition, when they should be removed by remote means, e.g. explosives.

15.3.3 Pre-strengthening structures

Consideration should be given to carrying out structural strengthening before demolition work begins in order to enhance temporary stability. Such temporary works should be designed by a competent engineer experienced in this type of work, and may include, for example, localized strengthening to steel columns.

15.4 Temporary structural support for stability

Where necessary, temporary structural support should be provided to resist forces in any direction and avoid premature collapse. All such temporary structural supports should be planned, designed, constructed and installed in accordance with Clause 16. Those responsible should ensure that there is residual stability during and after the installation.

Such support, including that to floors, should be secured to prevent movement during demolition operations, so that it continues to be effective.

Checks should be made to ensure that reverse loads are not induced into the structure or, if they are, that the effects are taken into account. The effects on the temporary structural supports should be assessed to ensure that they remain adequate with any changing load patterns, including any induced reversal of stresses in the structure as demolition progresses.

15.5 Planned partial demolition ensuring stability of the remaining structure

15.5.1 Residual structural stability

When partial demolition of a structure or removal of any loadbearing element is undertaken, the structural stability of the remaining parts of the structure and any adjacent structures should be maintained. A detailed assessment of all imposed loads acting on the remaining part of the structure should be made. Environmental loadings, such as wind and snow, should be assessed. Vibration and impact from traffic or adjacent demolition activities should also be considered. Foundation details of load-bearing and retaining walls should be established.

15.5.2 Facade retention and shoring

The need for facade retention and shoring should be determined when partial and, for example, phased demolition takes place in order to maintain the stability of:

- a) the remaining parts of the structure; and
- b) any adjoining structures.

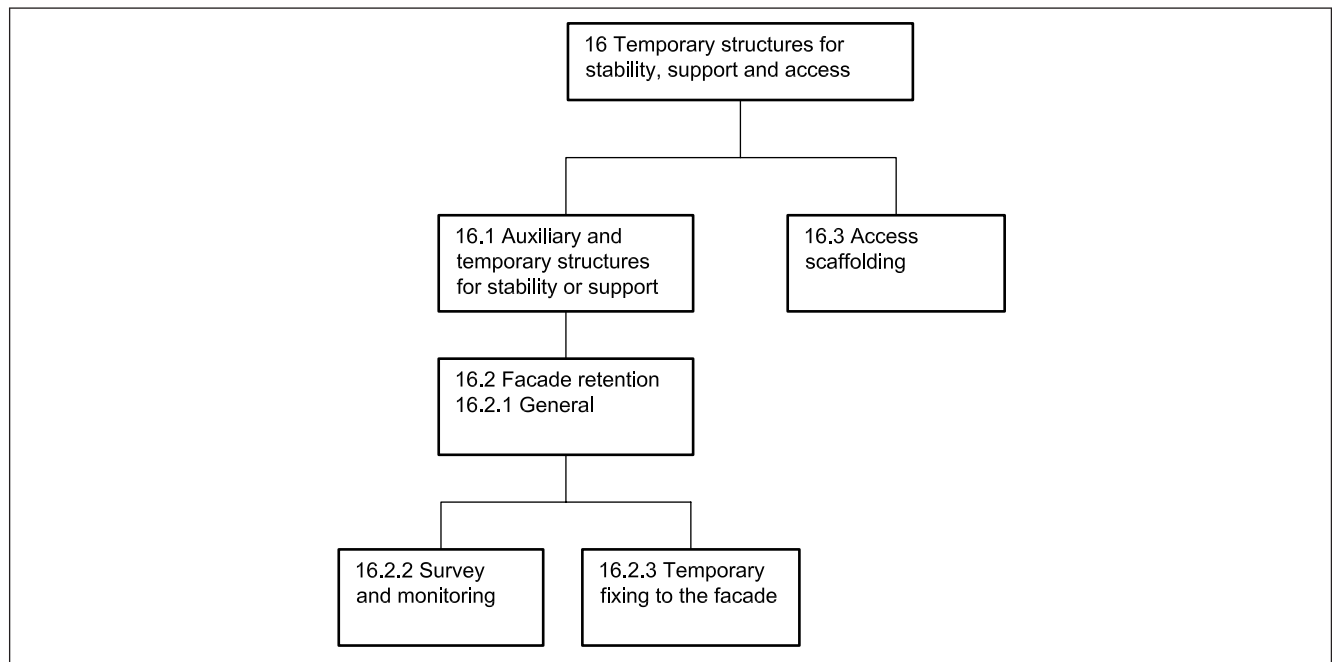
Facade retention and temporary shoring should be designed, built and maintained, including any modifications required due to the progress of the work and site conditions, in accordance with Clause 16. Any modifications should be evaluated against the original design.

15.6 Weather

When the structure is weakened in the demolition process (e.g. by the removal of internal bracing members) and work cannot be completed during the working day, the structure should be left in a condition capable of withstanding appropriate wind loads, which may take into account seasonal and probability factors (see BS EN 1991-1-4, BS EN 1991-1-6 and the BCSA *Guide to Steel Erection in Windy Conditions* [58]). Any reduction in the maximum wind force should be carefully considered and take into account local conditions and the possible effects of a premature collapse.

16 Temporary structures for stability, support and access (see Figure 22)

Figure 22 Route map for Clause 16



16.1 Auxiliary and temporary structures for stability or support

Auxiliary and temporary structures should be provided, as appropriate, to ensure safe partial or full demolition of a structure. They should be an “engineered solution” and, as such, should be designed, erected, maintained and dismantled in accordance with the appropriate standards (e.g. BS EN 12811-1, BS EN 12811-2, BS EN 12813, BS EN 1993-6, BS 5975 and HSE document: *The Management of Temporary Works in the Construction Industry* [59]). They may comprise:

- a) shoring/propping for vertical loads:
 - 1) single props, either mechanical or hydraulic;
 - 2) towers;
 - 3) spanning beams and trusses;
 - 4) needling beams;
 - 5) back propping; and
 - 6) underpinning;
- b) shoring/propping for horizontal loads:
 - 1) raking props, transferring the horizontal load to a lower level;
 - 2) flying shores, horizontal props transferring the load to a stiff point at the same level such as a lift core or return wall;
 - 3) braced towers; and
 - 4) facade retention systems.

Material used for temporary or auxiliary structures may include:

- i) steel tube and fitting scaffolding;
- ii) proprietary equipment, screw jacks, props, beams, system scaffold;

- iii) structural steelwork; and
- iv) structural timber.

Structures resisting actions in temporary states should also be provided where necessary as temporary or auxiliary works. The same degree of consideration and care should be given to the design and construction of temporary works as to the design and construction of the permanent works in accordance with BS EN 1991-1-6.

Temporary or auxiliary structures should be in position prior to the disturbance or removal of the existing supports which are taking vertical or horizontal structural loads. They should be sufficiently robust and founded on secure and effective footings, be adequately laced and braced, and, if appropriate, capable of resisting dynamic loadings. They should be designed not to interfere with subsequent demolition or construction and should be checked both prior to and during demolition for effectiveness, including for the effects of vibration.

All possible loads and load combinations should be assessed in detail for each stage of the demolition process. The temporary or auxiliary structures should never be loaded in excess of the design limits, which should be within those actually imposed.

Proprietary systems should be designed and constructed in accordance with the manufacturer's recommendations.

Responsibility for structural stability should be correctly allocated and made known to those working on the site. This is particularly important if several design organizations are involved in the design of a single element. For example, an organization may be responsible for the design of a temporary support structure, but not for the foundations or the adequacy of the supported structure to span between the points of support.

In order to ensure safety the design, erection, maintenance and dismantling of temporary and auxiliary structures should be under the supervision of suitably competent persons.

Sufficient procedural control of all temporary works, including the temporary and auxiliary structures, should be implemented, including the appointment of a temporary works coordinator responsible for ensuring that structural stability is maintained throughout operations and that no unplanned collapses occur.

NOTE BS 5975, particularly Section 2, covers the "procedural control of temporary works".

16.2 Facade retention

16.2.1 General

As demolition proceeds in the vicinity of facades that are to be retained, methods of support such as temporary structures should be installed to ensure that stability is maintained. Structural engineering advice should be obtained for the design of temporary facade supports, with account being taken of the stability of the facade and the shorings as the demolition proceeds.

The facade retention system should be either independent or mutual.

- a) In an independent system, raking shores or cantilever towers are used to fully support the facade.
- b) In a mutual system the different retained elements are linked together with horizontal shores so that they act compositely together.

The effects of, for example, hoardings, site cabins, signs and stored materials that are to be incorporated into the facade support should be considered in the design, together with the possible need for prevention of accidental vehicle impact.

Prior to carrying out work that affects the footway or road the location of all services should be ascertained and adequately protected, and access to them maintained.

16.2.2 Survey and monitoring

To monitor any potential movement of a facade an initial survey should be carried out, such as spatial coordinates of a series of points lying on a grid on its surface. Surveys should then be repeated at regular intervals throughout the contract, and all results from the monitoring should be used for assessment of the stability of the facade and the retention system, and made available to all parties concerned.

16.2.3 Temporary fixing to the facade

The method of fixing the temporary support system to the facade should ensure that no damage is caused to the facade. Account should be taken of movement of the facade that could occur before, during or after demolition operations.

All fixings should be regularly checked throughout the period of the contract to ensure that they remain effective in providing the level of continuing stability that is required, also taking into account the required stability as demolition activities progress.

Demolition work should be carried out so as not to damage the facade. All elements which are built into the facade structure should be carefully cut away.

The temporary support system should not be weakened by removal of components until the facade in that location is fully supported either by the new structure or by an alternative, temporary structure.

NOTE See CIRIA C579 Retention of masonry facades – best practice guide [8] and CIRIA C589 Retention of masonry facades – best practice site handbook [9].

16.3 Access scaffolding

Two basic types of access scaffold may be used for demolition.

- a) Independent tied scaffold, in which all the vertical loads (access and self weight) are resisted independently of the accessed structure, but with the horizontal restraint provided by the accessed structure.
- b) Freestanding scaffold, which is completely independent of the accessed structure. Lateral stability is provided by kentledge, tying down, buttressing or a birdcage scaffold.

Independent tied scaffolds conforming to BS EN 12811-1 or the NASC guide TG20:08 [48] should be used. Other scaffolds should be designed using the same general requirements and in accordance with BS 5975.

System scaffolds should be designed and used in accordance with the supplier's user guide and technical information.

When completed, scaffolds should be left in a condition suitable to perform the function for which they were intended.

NOTE The condition of scaffolding is covered by statutory regulations and local authority requirements.

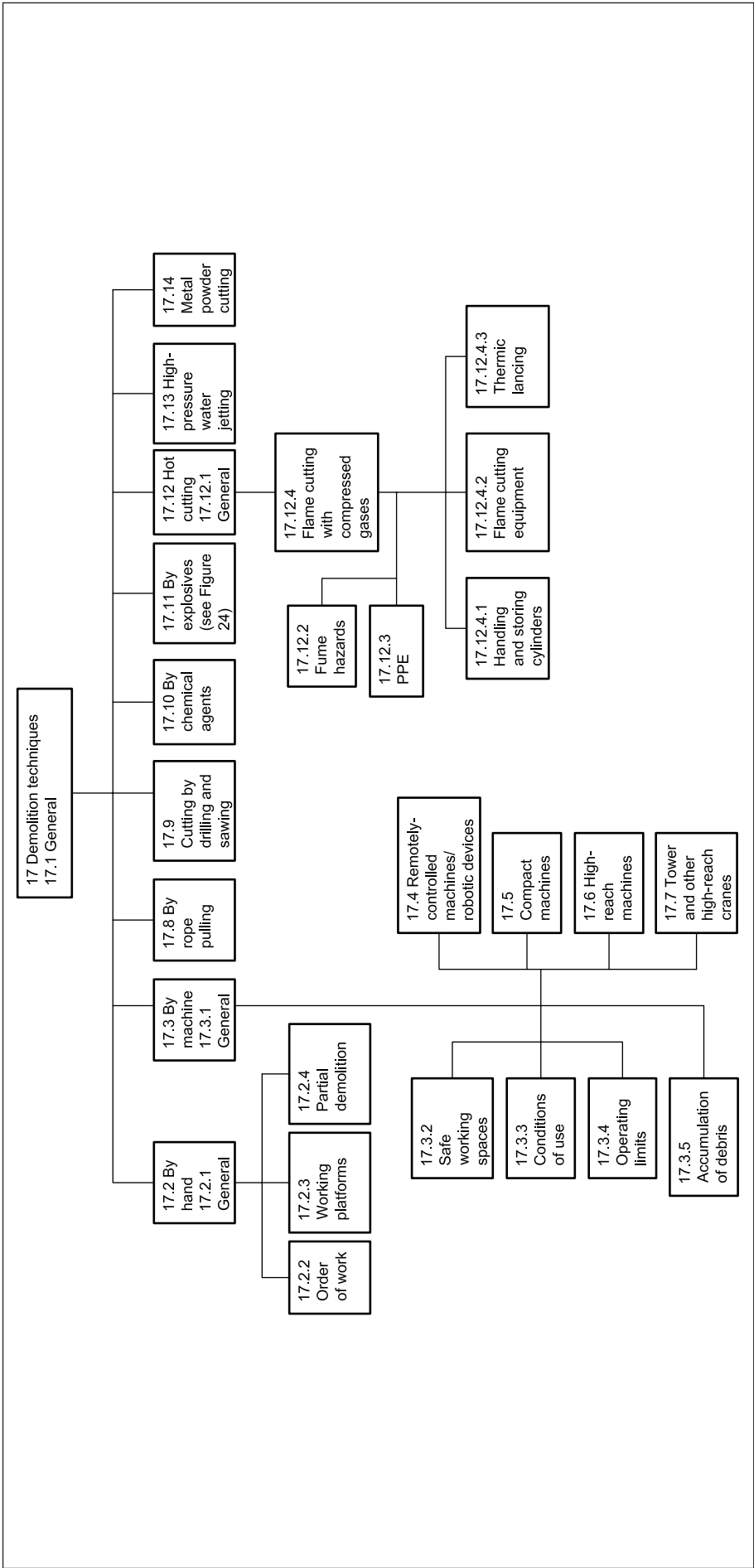
The scaffold should be inspected by a competent person whenever necessary and at the following stages.

- 1) Before being taken into use for the first time.
- 2) At regular intervals not exceeding seven days since the last inspection, with a report being prepared for site management after each inspection.
- 3) After substantial addition, dismantling or any other alteration.
- 4) After adverse weather conditions, i.e. high winds, etc.
- 5) After any event likely to have affected its strength or stability.

In addition:

- i) measures should be taken to ensure there are no unplanned removal of scaffold ties;
- ii) any debris collecting on a scaffold should be minimal and should not exceed the calculated loading for the design of the scaffold or obstruct access ways or working areas;
- iii) measures should be taken to prevent debris from being accidentally dislodged onto or from the scaffold (see also **11.16**);
- iv) arrangements should be made for the scaffold to be adjusted as necessary and removed in a progressive and planned manner as the work proceeds, to ensure its continued stability; and
- v) the scaffold should be close boarded against the building facade, particularly for high-rise structures where ejection of debris from top levels could endanger the site operatives and or public below.

Figure 23 Route map for Clause 17



17 Demolition techniques (see Figure 23)

17.1 General

There are a number of demolition techniques available, specific precautionary measures for which should be taken to enable the operators to execute safe demolition. Several methods of demolition may be used in combination or at different parts of the demolition site. The methods of work should be established after completion of risk assessments (see 5.2.2.2).

Safe working spaces and exclusion zones should be established and maintained in accordance with Clause 13. Safety precautions relevant to the method of work should be clearly shown in the method statement for the work. All personnel on site should be made fully aware of the requirements of the method statement.

In general, the choice of technique should enable the reuse and/or the recycling of materials arising from the demolition (but see 12.3.6).

Irrespective of which demolition method is adopted, its choice should be based on minimizing the risk to personnel. All personnel should be familiar with, and appropriately trained in, the use of plant and machinery which they will be required to operate for appropriate demolition techniques (see 5.3 and Annex A).

CAUTION: The method of collapsing structures by the deliberate burning of timber props acting as temporary supports during pre-weakening can have unpredictable results and is not recommended.

17.2 Demolition by hand

17.2.1 General

Progressively demolished structures or elements of structures may be demolished by operatives using hand-held tools, though risk assessments usually demonstrate that remote demolition techniques, e.g. by machine, are more appropriate. Mechanical assistance should be considered to assist with any hand demolition, such as hydraulic or air-operated shears and/or lifting appliances for the lifting and lowering of elements once they have been released (see also 18.4). The outcome of risk assessments should indicate the extent to which such assistance should be utilized.

17.2.2 Order of work

The order of demolition for structures should be progressive, e.g. storey-by-storey, having regard to the type of construction, the building materials used and the intended methodology, and should be clearly shown in the method statement.

CAUTION: Any scaffolding erected to facilitate the demolition, including ties, should only be removed in accordance with the method statement (see 5.2.3 and 16.3).

17.2.3 Working platforms

Where it is necessary to work at height and this cannot be done safely from part of a building or structure, a secure and safe working platform should be provided.

The type of platform to be provided should be appropriate to the nature and duration of the work being undertaken and may include, for example, the following.

- a) Independent scaffolding.

- b) Suitably-designed special scaffolds.
- c) Specially-designed working platforms.
- d) Mobile elevating work platforms.
- e) A man riding cage suspended from a crane or telehandler.

Preference should be given to the provision and wearing of a securely-anchored harness when working from platforms other than, for example, rigid platforms such as scaffolds.

Ladders should not be used as a workplace from which to undertake demolition work (see Clause 11).

17.2.4 Partial demolition

When only a portion of a structure is to be demolished, the stability of the part to remain should be monitored regularly during demolition activities and for a suitable time afterwards (see also 15.3).

17.3 Demolition by machine

17.3.1 General

Structures and elements of structures should preferably be demolished using a demolition machine operated either from a protected cab or remotely, using for example umbilical cable control or robotic devices (see 17.4).

Any plant and equipment used should be:

- a) of a type and condition appropriate to the location and type of work involved;
- b) in the control of a competent operator, who holds a valid certificate of training achievement where appropriate; and
- c) maintained in good working condition at all times.

Any attachments should be properly fitted to machines of adequate power and stability for the intended use.

The following attachments may be used during demolition work.

- 1) Impact hammer.
- 2) Hydraulic shears.
- 3) Pulverizer.
- 4) Demolition pole.
- 5) Grapple.
- 6) Multi-purpose hydraulic attachments, e.g. interchangeable jaws.
- 7) Demolition ball.
- 8) Magnet.

Plant should only be operated on a surface strong enough to support it. Where necessary, soft ground should be excavated and replaced by, for example, compacted hard core to provide a suitable base. Where appropriate, adequate support for cranes and other machines should be provided where there are basements and other below-ground voids, ducts, etc., by, for example, breaking into them and backfilling with hard core.

NOTE A quick hitch (also known as a quick coupler) on an excavator or other earth-moving plant is a latching device that enables buckets and other attachments to be attached and detached rapidly from the dipper arm, as required. There are three methods of operation of a quick hitch, namely manual, semi-automatic and fully automatic; all incorporate either a manual or an automatic locking/safety pin to hold the latching mechanism in the closed position and thus prevent the inadvertent dislodgement of the bucket or attachment. Industry guidance recommends that the machine operator physically checks that all quick hitches are securely locked before starting work with a newly attached bucket or attachment (Strategic Forum for Construction Best Practice Guide, Safe Use of Quick Hitches on Excavators [60]).

17.3.2 Safe working spaces

Exclusion zones should be applied in accordance with Clause 13.

Where it is necessary for demolition machines (including their operators) and any personnel directly involved in the operation, e.g. lookouts, to be located within the exclusion zone, they should be in a safe place located:

- a) outside the limit of predicted debris (see also 13.2);
- b) away from the deleterious effects of potential machinery or equipment failure, e.g. rope pulling (see 17.8); and
- c) outside the operating space of the machine and the effects of its operations.

Self-propelled mobile plant being operated on site should be fitted with amber warning beacons as a visible alert to pedestrians and other users of plant and equipment within the immediate vicinity.

Operated plant should be fitted with mirrors that allow the operator 360° vision for a minimum of a metre around the machine. Where mirrors might be impractical, the machine should be fitted with a CCTV system that has a viewing screen placed in a prominent position in the cab.

Wheeled operated plant, i.e. loading shovel, articulated dump truck, etc., should be fitted with a CCTV system and audible warning system for reversing on site.

17.3.3 Conditions of use

All machinery, equipment and attachments should be used, inspected and maintained in accordance with the manufacturer's recommendations. The machine should not be overloaded. The attachment's weight and payload should remain within the lift capacity of the machine.

Lifting appliances should be thoroughly examined before use for demolition, and again before being put back into use for traditional lifting duties.

NOTE 1 Such examination is covered by the requirements of LOLER [61].

Any plant operator undertaking demolition should be trained and competent, with prior practical experience of the same type of machine in similar applications. The operator should ensure that the working radius of the machine is not exceeded, as this can cause instability and the machine to overturn. Erratic and/or sudden movements of the machine should be avoided during the cutting, handling, removing and processing of items such as steel, concrete and plant.

Bespoke equipment for use in a demolition orientated environment, and which has been designed and tested to perform to the highest standards of safety and efficiency, should be used, as opposed to standard construction equipment which is not designed to withstand the rigours of a demolition site. In the event that an operator is using a modified excavator or loader, it should be modified to ensure the protection of the operator and the machine from falling debris. All operated plant should be fitted with a demolition cage when in use on a demolition site (see Figure 2).

When using attachments to weaken and remove elements, the method of work should ensure that neither the attachment nor the machine are overloaded in any way, such as heavy side loading on to the attachment which can overcome the rotating facility if fitted.

NOTE 2 This can occur, for example, when loads are trapped, when they are not completely freed from the jaws or when they are lifted eccentrically.

The operator should be aware at all times of the movement and of the operation of the attachment and of the progress of the demolition by:

- a) direct vision;
- b) the use of a CCTV system;
- c) information provided by a signaller; and
- d) a combination of any of these.

17.3.4 Operating limits

The machine, and the attachment it is planned to use should be appropriate for the height of the structure to be demolished. Consideration should be given at the planning stage either to building up the ground levels (see also 17.3.1) or to reducing the structure height by other means to achieve the required safe working height if necessary.

For the demolition of attached buildings, the structure to be demolished should first be detached as appropriate, ensuring at all times the stability and safety of the remaining buildings (see Clause 15). A clear space should be provided which is wide enough to ensure that the retained buildings are not damaged by the demolition process, including the transmission of vibration.

The plant should not be worked from or over a roadway without permission as there can be restrictions on use.

An exclusion zone should be applied in accordance with Clause 13.

17.3.5 Accumulation of debris

Debris should not be allowed to accumulate to such an extent that it imposes loads on the structure in excess of that which it has been calculated to carry safely (see 17.3.1).

17.4 Remotely-controlled machines and robotic devices

Remotely-controlled machines and robotic devices should be used where appropriate, particularly when hazardous or potentially dangerous situations arise, thus isolating the operator from the work area and position of risk. (See also 17.3.1.)

17.5 Compact machines

When compact machines (e.g. mini-demolition rigs and skid-steer loaders) are used for demolition on the upper floors of buildings, an assessment of the strength of the floor should be made, taking into account the possibility that the machine and a quantity of debris could eventually be supported on part of the floor before being removed, e.g. to the floor below. Account should be taken of the weakening effects on the structure by the progressive removal of elements (see also Clause 15). The extra loading caused by any temporary access ramps should also be taken into consideration.

The following solutions may be applied.

- a) Adequately designed and correctly installed and maintained back-propping.

- b) Methods of spreading the load of vehicles, e.g. by the use of designed temporary roadways.
- c) A combination of a) and b).

Appropriate methods of lifting the machine for use should be employed (see Clause 18 for guidance on the safe use of cranes).

Compact machines should be fitted with appropriate capacity hydraulic attachments that can be used, for example, for breaking out and cutting, handling, processing and soft stripping.

Precautions should be taken to prevent machines used for this method of demolition from falling down holes in floors or falling from the edges of buildings, through operator awareness by detailed instruction and by the provision of adequate:

- 1) edge protection; and
- 2) restraint systems.

17.6 High-reach machines

NOTE 1 It is generally considered that any demolition requiring mechanical reduction over a notional height of 15 m falls within the category of high-reach.

High-reach machines may be used to take down high-rise buildings and structures, and dramatically reduce the necessity for persons to work at height to reduce a building or structure. Any high-reach machine should be used in accordance with the manufacturer's instructions and it should be ensured that the attachments, i.e. shears, pulverizers, grabs, etc., are correctly fitted and of a weight to which the machine is designed to carry at its various height stages.

When positioning any such machine for work, the track frame should face on to the building or structure with the track motors to the rear. The angle of the boom should be limited in accordance with the manufacturer's instructions to ensure the safe operation of the machine.

When managing demolition activities with a high-reach machine, the following should be considered.

- a) Scoping and assessing the job.
- b) Equipment and operator.
- c) Site investigation and preparation.
- d) Setting up, working and shutting down safely.
- e) Appropriate all round visibility, including boom-mounted cameras where appropriate.

NOTE 2 This is particularly important for some super high-reach machines in excess of 60 m. Further information and guidance on the use of high-reach equipment is available in the NFDC High Reach Demolition Rig Guidance Notes [62].

Operators of high-reach machines should be provided with specialist training over and above that required for operating standard reach demolition rigs. Accepted training and assessment protocols should be used.

Subject matters and information within this additional and specialist training should cover the following.

- 1) Increased weight of the machine.
- 2) Increased ground-bearing pressure.
- 3) How stability characteristics differ from other demolition machines.
- 4) Fitting, safe use and removal of attachments.

- 5) Use of variable width tracks (where fitted).

NOTE 3 See Annex A.

17.7 Tower and other high-reach cranes

The installation, operation and dismantling of tower and other high-reach cranes requires specialized skills and should be planned and managed in accordance with BS 7121 (Parts 1 to 5) (see also Clause 18).

The use of such cranes for deconstructing high-rise structures should be considered for the removal of structural elements and of debris by skip as an alternative to dropping of materials.

NOTE See Note 2 to 17.6.

Tower cranes are designed for lifting freely-suspended loads and should not be used for balling operations.

17.8 Demolition by rope pulling

NOTE This method of mechanical demolition involves attaching ropes, usually of steel, to a structure and pulling the pre-weakened structure to the ground by winch or tracked plant.

The results of risk assessments and the availability of many other demolition methods should demonstrate whether rope pulling is appropriate.

The following should be considered.

- a) Rope pulling should only be used on structures where it is possible to safely attach the ropes.
- b) A second (standby) rope should be provided in case the first rope breaks or becomes detached.
- c) Ropes should be attached prior to any pre-weakening.
- d) Only appropriate ropes should be used, and these should be inspected to ensure they are fit for the purpose.
- e) Restraining ropes should be provided to prevent premature collapse before the pull commences, from before pre-weakening until it has been completed.
- f) The designed exclusion zone should take into account the possibility of the failure of the ropes or anchorages (see Clause 13).
- g) A pulley/snatch block may be used, so that the pulling machine and operator(s) are removed and offset from the direct line of fall of the structure.
- h) The pulling machine operator should be protected against failure of the rope system, as well as projected demolition material, by suitable positioning, possibly within an enclosure.

If attempts to cause collapse are unsuccessful, an alternative remote method of demolition should be selected and used, following an assessment of the current state of stability of the structure.

CAUTION: It could be dangerous for anyone to approach the structure.

17.9 Cutting by drilling and sawing

NOTE Drilling and sawing methods are used to weaken and/or remove parts of (or complete) structures, including where work is in confined spaces, in locations where a high degree of accuracy is needed, or where the noise, dust, smoke and vibration resulting from other methods would be unacceptable or inappropriate.

When water coolant is used, an appropriate method of disposal should be established. Drilling and sawing work should be planned in accordance with the Drilling and Sawing Association code of safe working practice [63].

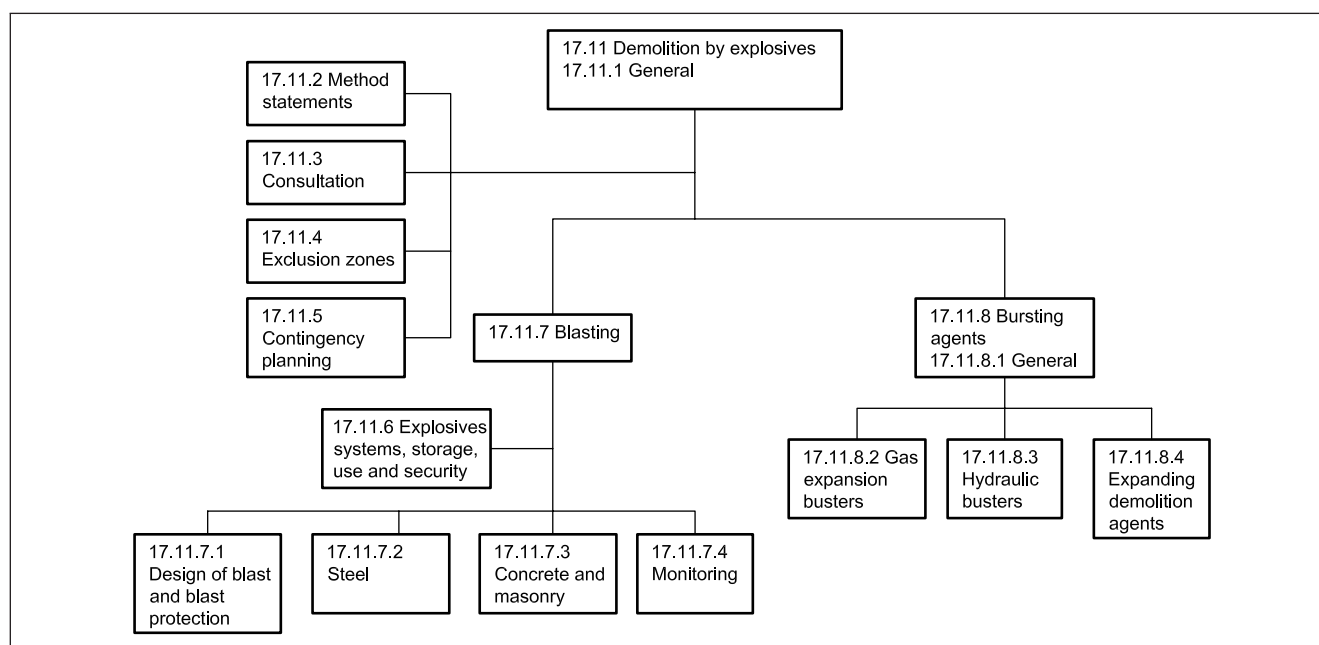
Although commonly referred to as “cold cutting” methods, these can generate heat and the general recommendations of 17.12 should be followed where appropriate.

17.10 Demolition by chemical agents

The selection and use of chemical agents such as explosives (17.11), bursting agents (17.11.8) and combustible gases (17.12) should be undertaken only by, or under the supervision of, appropriately trained personnel as they are highly specialized activities.

17.11 Demolition by explosives (see Figure 24)

Figure 24 Route map of 17.11



17.11.1 General

When explosives are used in demolition, specific consideration should be given to, for example, the suitability of the structure for demolition by explosives, techniques appropriate to the structure and location, and associated exclusion zones. Where explosives are being used, the whole operation should be under the close control of a competent explosives engineer. Explosives should be used in accordance with BS 5607. Only explosives engineers who can demonstrate that they have the necessary qualifications, experience and training in accordance with BS 5607 should be employed on such work.

Explosives should be used in demolition, including partial demolition, for the:

- deliberate collapse of concrete and masonry structures;
- deliberate collapse of steel structures;
- deliberate collapse of structures containing combinations of steel, concrete and masonry;
- breaking or shattering of objects such as concrete blocks and foundations; and
- full or partial removal of structural elements.

The use of explosives should be considered in order to achieve the effects of cutting, kicking and shattering on structures and their members.

Each blast should be designed taking into account a number of factors, including the following.

- 1) The effect to be achieved.
- 2) The appropriate explosives types and system.
- 3) The number and weights of charges.
- 4) The method(s) of installation.
- 5) The locations of charges, including the heights of placement.
- 6) The mass, types and strengths of materials to be displaced.
- 7) The sequential nature and effects of collapse initiation on other parts of the charged structure.
- 8) The probability, amount and extent to which debris will be projected.
- 9) Types and extent of blast protection (see 17.11.7).

The design should be optimized for the most efficient use of explosives, e.g. by structural pre-weakening (see 15.3.2). The design should also be engineered to control fly of material, rather than relying solely on blast protection. Test blasts should be made to increase knowledge of the materials to be blasted and to allow the blast design to be confirmed or modified as required. The extent of the exclusion zones (see Clause 13 and 17.11.4) should be determined taking into account the factors in items 1) to 9).

Consideration should be given to placing charges in, or on, the internal members of the structure to enable the perimeter of the structure to contribute to an efficient blast protection design, e.g. in multistorey buildings with internal columns.

17.11.2 Method statements

Before any work commences on site, a method statement based on the blast design and associated risk assessments should be prepared (see 5.2.3). Particular attention should be given to the following for inclusion in the method statement, unless risk assessments indicate otherwise.

- a) Collapse mechanisms.
- b) Pre-weakening.
- c) Drilling.
- d) Charging and delay sequences.
- e) "At source" and remote protection (see following paragraph).
- f) Exclusion zones (see Clause 13 and 17.11.4).
- g) Evacuation procedures on site or off.
- h) Crowd control and personnel control.
- i) Road closures.
- j) Defined internal access ways.
- k) Sequence of events.
- l) Misfire procedures.
- m) Contingency plans.
- n) Arrangements for monitoring (see 17.11.7.4).

- o) Management structure.
- p) Communications methods and procedures.
- q) Protection of vulnerable services and structures, including those in the ground.

Details of “at-source” protection and any remote protection, including that applied to, for example, underground services and nearby properties, should be included. The predicted air overpressure and ground vibration measured in decibels and peak particle velocity (PPV), respectively, should be used to determine the protection measures to be applied.

17.11.3 Consultation

Prior to carrying out the works, the explosives engineer should contact appropriate bodies/people, e.g. those listed in **11.3**, to discuss the proposed system of work and whether the exclusion zones are planned to extend beyond the site boundary.

17.11.4 Exclusion zones

The dimensions of exclusion zones should be determined by the person directly in charge of the explosives operation, usually the explosives engineer, after taking account of all existing conditions and the planned methods of work. All site personnel and the public should be excluded during demolition activities, except in certain circumstances when key operational personnel are required to remain within the zone provided they are in a position of safety (see Clause **13**).

The distance from the blasts to the exclusion zone boundary should be established following a risk assessment.

The zone should be established after taking account of the risk of flying debris and air overpressure as a result of the detonation of the explosives and material projected as a result of the structure breaking up. Details of at-source protection and remote protection to surrounding properties should be taken into account.

Account should also be taken of the ground onto which the structure is to be dropped. This area should be clear of debris, mud or any other material that can be projected by the impacting structure.

Weather conditions prevailing at the time should be taken into account and, if necessary, the size of the exclusion zone should be increased to give a new boundary (see **17.11.5**).

17.11.5 Contingency planning

A contingency plan should be established and included in the method statement (see **5.2.3**). The plan should address the possibility of the “blowdown” not proceeding as intended. The plan should be agreed by all those with authority to instruct or direct. A clear statement should be included in the plan, indicating who will take control and what equipment and procedures will be available for use. The plan should provide for an initial cooling-off period after the firing or an attempted firing when the planned results were not achieved. During this period, nobody should be permitted to approach the structure. The implications of the failure should be considered and a revised strategy, including timescales, should be developed, agreed and implemented. This should follow reassessment and consultation based on the site conditions at that time.

17.11.6 Explosives systems, storage, use and security

Explosives should be stored in accordance with BS 5607.

During placing of explosives and detonators a log should be kept of the quantity of materials used, which should be balanced against the quantities of materials remaining. This log should be the responsibility of the senior explosives engineer, who should complete and sign it on a daily basis. The log should be available on site at all times. Any discrepancy should be investigated immediately and resolved. The senior site manager should be informed without delay of the incident and then of the outcome of the investigation.

Security needs to be effective when explosives are on site, including when they are in position in the structure, so provision should be made for the following.

- a) An adequate number of authorized security guards to be on duty (see also the Control of Explosives Regulations 1991 [64]).
- b) A system of communications to provide contact with the police explosives liaison officer or security control centre.
- c) Floodlights to light the areas, as appropriate.

Arrangements should be made to ensure that explosives cannot be prematurely detonated, including any unintentional initiation, e.g. when positioning floodlights or using mobile telephones and radios. Where conventional electrical detonating systems are being used they should be split and shunted to prevent unintentional initiation. Contact with moisture should be avoided.

17.11.7 Blasting

17.11.7.1 Design of blast and blast protection

The blast design and the design for blast protection should be assessed with the design for the exclusion zone boundary to ensure that ejecta are contained within the predicted debris area, in accordance with Clause 13 (see also 17.11.1).

Blast protection using primary or secondary blast protection or a combination of both should be provided to prevent materials becoming projectiles (see 17.11.1 and BS 5607:1998, 6.2.5).

Any limitation of the containment ability of blast protection, e.g. for charges set at height (dependent on risk assessments), should be taken into account in the exclusion zone design to ensure that the exclusion zone boundary extends far enough to contain any ejecta.

Consideration should be given to placing charges in or on internal members of structures to enable the external walls to contribute to efficient blast design and protection, e.g. in concrete or on steel columns or walls.

The blast design should take account of the possible need to strengthen members to ensure that the force of the explosive is delivered as planned, resulting in the designed displacement being achieved without the member fracturing first.

The design of the detonation sequence and delay periods should ensure that, for example:

- a) mechanical disruption of undetonated charges does not occur;
- b) the structure is not weakened in the vicinity of undetonated charges; and
- c) the robustness of the blast protection is not compromised, especially in places where charges are still to be detonated.

The use of delayed detonation sequences to initiate the charges should, however, be considered as part of the measures to reduce potential high levels of air overpressure.

17.11.7.2 Steel

Kicking charges should be used to displace pre-cut supports, thereby removing structural support without causing fragmentation. Shaped cutting charges should be used to remotely cut steel supports.

Shaped cutting charges and kicking charges should be adequately secured to ensure that they act as planned. Detonation timings should be designed and installed so that displacement of cutting charges and kicking charges does not occur between detonations.

All ancillary fittings, such as cleats and parts of disconnected bracing, should be cleared from the vicinity of each kicking charge to avoid their being sheared off by the blast and forming projectiles.

17.11.7.3 Concrete and masonry

Shattering charges should be used to fragment the material. The charges should be placed in drilled holes inside the material and sealed in by adequate stemming.

17.11.7.4 Monitoring

Arrangements should be made to monitor the effects of the demolition, including for example air overpressure, ground vibration and debris scatter. The results obtained should be compared with the predicted effects in order to learn from the design assumptions.

17.11.8 Bursting agents**17.11.8.1 General**

Bursting techniques may be used for the demolition of concrete, masonry and rock, and should be considered, for example, where environmental constraints such as reduction of noise, dust and/or vibration need to be taken into account. However, the noise and vibration created by drilling holes for inserting the grout or paste should also be considered.

An estimate of when failure will occur should be made even though it can be difficult to predict the exact timing of structural failure because of the slow build-up of internal forces. Work should be planned so that when the structure or mass does fail, it does so in a manner that does not create a risk.

17.11.8.2 Gas expansion bursters

NOTE The effect of the burster is obtained by inserting it into a prepared cavity in the mass to be demolished. Upon being energized the resulting increase in pressure of the gas ruptures a diaphragm, releasing the gas into crevices in the surrounding structure which is then fractured.

A gas expansion burster should be effectively restrained within the prepared cavity in order to prevent it from becoming projected in an uncontrolled manner.

17.11.8.3 Hydraulic bursters

NOTE Hydraulic bursters work on the same principles as gas expansion bursters in that they use an expanding device to force apart a mass, but the process is not as rapid as in a gas expansion burster. Pistons or wedges are placed in a prepared cavity and are gradually jacked out under pressure, the resulting increase in size of the device fractures the surrounding material.

Work should be planned and controlled to ensure that dislodgement of the hydraulic bursting equipment is not a risk, e.g. when failure of the structure occurs.

17.11.8.4 Expanding demolition agents

NOTE This method of bursting employs expanding chemicals that are mixed, for example, with water to form a liquid or paste. The mixture is poured into pre-drilled holes in the material to be demolished, and expands to cause a fracture.

The handling, mixing, pouring and use of the chemicals should be undertaken in accordance with the manufacturer's instructions. An assessment of the products being used should form the basis for the selection and use of appropriate, safe methods of work, including the provision of PPE.

17.12 Hot cutting

17.12.1 General

NOTE Hot cutting techniques include any methods that can potentially generate sufficient heat, e.g. in the form of incandescence, friction, sparks or flame, to cause a fire. Such techniques commonly use oxy-fuel gases and disc grinders.

As a general principle, to reduce the risk of fire and/or explosion, methods other than hot cutting should be considered in preference.

Hot cutting should be selected only where the work system chosen avoids the risk of fire or explosion. Hot cutting should not generally be used in the proximity of flammable materials, gases and vapours (see also 19.7). In particular, work methods should prevent localized oxygen enrichment because of the attendant risk of explosion. Combustible and flammable material should be removed from the area where flame cutting operations are being carried out (see also 11.8.4).

Flame cutting techniques should commence only after the structure to be cut and the surrounding area have been made safe from the risk of fire or explosion (see also 11.7, 11.8.4 and 19.7 for further advice).

The manufacturer's guidance and recommendations should be followed, e.g. for lighting-up procedures. Work on site using flame cutting equipment and compressed gas cylinders should be undertaken with the necessary precautions and reference to IND(G) 297 [65] and HS(G) 139 [66], and by people with the appropriate training and experience.

Suitable fire-fighting equipment and trained personnel should be provided (see HS(G) 168 [34]).

The use of permit to work procedures should be considered, and may be required for hot cutting work (see 11.7).

17.12.2 Fume hazards

Work methods should be planned such that adequate precautions are in place to avoid fume hazards caused by flame cutting from, for example:

- a) nitrous fumes that can build up very quickly in poorly-ventilated areas, e.g. excavations, pits, small basements, tanks and metal containers;
- b) lead poisoning when cutting steel that is coated in lead-based paint or from tanks that have been used for the storage of lead-based products, including petrol (the Control of Lead at Work Regulations 1998 [67] apply);
- c) plated metal fumes such as from cadmium; and
- d) fumes from isocyanates (two pack paints).

Risk reduction using the following control techniques (see also 11.10 for working in confined spaces) should be considered.

- 1) Remote cutting methods.
- 2) Forced ventilation in poorly ventilated areas.

3) Appropriate approved respirator equipment.

17.12.3 Personal protective equipment (PPE)

Operatives who carry out cutting operations should wear appropriate PPE, including suitable eye protection and protective clothing. Suitable footwear should be worn to protect from the possibility of falling molten metal burning legs or feet. Wellington boots should not be worn (see 11.5).

17.12.4 Flame cutting with compressed gases

17.12.4.1 Handling and storing cylinders

Oxygen cylinders should not be stored with fuel gas cylinders. Cylinders on site should be stored in secure, adequately ventilated facilities to prevent dangerous levels of fuel gas or oxygen building up. Cylinders should always be secured in an upright position during both storage and use.

Cylinders should not be rolled along the ground or handled roughly as this might cause damage to the cylinder valve, resulting in a leak of fuel gas or oxygen. Cylinder trolleys should be used.

17.12.4.2 Flame cutting equipment

Connection of the equipment, safety checks on it and any repairs should be carried out by a competent person with the necessary training and experience.

Fuel gas and oxygen hoses should be checked daily at the commencement of work and as necessary during the day for signs of damage and badly connected sections of hose.

Hose length should be kept as short as possible. The routing of "trailing" hoses should be arranged to reduce the risk of mechanical damage or damage by the hot work itself. If lengths of hose have to be joined, e.g. after removal of damaged sections, appropriate hose couplers should be used to effect reliable repairs.

NOTE It is preferable to replace damaged hoses.

Non-return valves should be fitted to each hose on the burning guns and flashback arresters should be fitted to the gauges to help reduce the risk of flashback. The correct fuel gas regulator should be connected for the fuel gas being used and a correct coupler used to connect the hose to the cylinder regulator.

A naked flame should never be used to check cylinders and hose connections for leaks. Soapy water should be used instead.

CAUTION: A build-up of oxygen caused by leaking cylinders and hoses, or by deliberately releasing oxygen, e.g. to clear fumes from the air, is potentially dangerous as a spark could cause a sudden and fierce fire.

Oil and grease should be kept away from all parts of equipment used for oxygen service, including cylinders, regulators, gauges, hoses and cutting nozzles. Hands, gloves, work clothes and tools for use on the equipment should be kept sufficiently clean to prevent oil or grease being inadvertently transferred onto the equipment.

When purging hoses the area should be well ventilated to reduce the risk of flashback.

17.12.4.3 Thermic lancing

NOTE Thermic lancing is used to cut through materials including concrete. The tip of the lance is preheated to start an oxygen-lion reaction which produces an intense heat source that is then applied to the material to be cut. Once started it is self-supporting.

During thermic lancing, combustion typically produces molten material and thick smoke, so suitable precautions should be taken, particularly where there is limited ventilation.

17.13 High-pressure water jetting

NOTE The term "high-pressure water jetting" covers all water jetting processes including those using additives and abrasives where there is an energy input to increase the pressure of water. In demolition the process is used, for example, for cutting out concrete from around steel reinforcing bars where the latter are to remain.

High-pressure water jetting is highly specialized and should be carried out by suitably competent people in accordance with the Water Jetting Association's Code of Practice [68].

17.14 Metal powder cutting

NOTE Metal powder cutting is an oxygen cutting process primarily in use for cutting metals with a high oxidation resistance, i.e. stainless steel, cast iron, etc. Finely divided iron powder is injected into the cutting flame through a special opening in the torch tip. The iron particles are rapidly oxidized, which results in a sudden increase of heat on the metal surface melting and the flushing away of the refractory oxides that form on the metal surface.

Powder cutting produces significant amounts of smoke and heat, so suitable precautions should be taken for personal safety and health.

18 Materials handling and processing

18.1 General

The handling and processing of materials on site should be assessed as part of the demolition process. As site waste can significantly increase due to spoilage, damage and poor stockpiling caused by poor site discipline, good handling practices should be planned and adopted to minimize such wastes.

Assessments should take account of, for example:

- a) cutting and lifting (as one operation);
- b) separating materials for reuse and recycling (see Clause 12);
- c) lifting and transporting;
- d) creating a stable stockpile;
- e) removing from a stockpile; and
- f) personal health and safety (see Clause 11).

Attachments, including grapples, electromagnets, buckets, chains and slings, should be in a suitable condition for use. The balance and security of loads should be safe for movement, including transportation.

18.2 Transport arrangements

The management of traffic movements for the site should be carried out in accordance with the site arrangements (see HS(G) 136 [69]). Additionally, for partial demolition for structural refurbishment projects the transport of new materials coming to site for the rebuild operations should be planned and managed effectively.

18.3 Safe use of cranes

When a crane is used, the applicable recommendations of BS 7121 (Parts 1 to 5) should be followed. CIRIA 131 [70] should be consulted for further advice on crane stability.

18.4 Lifting and lowering

Before any lifting and lowering, the weight and position of the centre of gravity of the load should be determined to ensure that:

- a) an appropriate method of lifting is used; and
- b) a crane or lifting equipment of adequate capacity is used.

When lifting and lowering, the demolished elements should be of a size appropriate to the methods used.

Where necessary, cranes and/or lifting equipment should be used to support beams and columns while they are being cut and lowered to the ground. In framed structures, similar support should be given to members while joints are being severed. The load should be taken up before the final cuts are made. Precautions should be taken to prevent the load swinging out of the calculated radius. Any ground, base or anchorage on which the crane or lifting equipment relies should be stable and have sufficient strength to prevent instability and possible overturning.

As demolition proceeds, lifting equipment of adequate capacity should be considered for the support of any unrestrained members remaining, in order to control their movement and prevent unplanned falls.

A factor of safety corresponding with normal lifting practice should be applied when selecting the lifting accessories (e.g. slings, shackles or lifting beams) that are to be used. The lifting accessories should be inspected by the user prior to lifting (see also 17.3.3).

CAUTION: Deformed, damaged or worn slings, chains and wire ropes should not be used.

Slinging of loads should only be undertaken by a person trained in safe lifting. Only one nominated person should give directions to the crane driver and the system of signals to be used should be agreed on site before the lifting begins.

18.5 Free fall of demolition materials

A safe route for removal of debris from the structure should be determined and implemented.

Debris should only be allowed to fall freely to the ground, internally or externally, when an adequate exclusion zone (see Clause 13) can be provided and managed. Account should be taken of the effects of wind on falling debris, and also bouncing onwards after the initial impact. Whenever possible material should be dropped through chutes, e.g. proprietary interlocking sections or purpose-designed chutes, which terminate above skips.

CAUTION: As soon as openings are created, e.g. to dispose of debris, they should be protected by edge barriers such as guard rails and toe-boards to prevent inadvertent falls of people or materials.

Precautions should be taken to contain flying or falling debris by sealing off all openings in walls, including glazed areas, adjacent to the area of fall. Where debris above the first floor level is to be dropped to the ground or basement level within a building, sufficient openings should be formed in the floors to enable the debris to fall without accumulating on intermediate floors. The stability of the surrounding structure or any working platform should not be compromised (see Clause 15), e.g. if one or more joists (or beams) are to be removed to allow the free passage of debris.

To prevent excessive lateral pressure, fallen debris should be removed at planned intervals to prevent build-up against walls and, for example, in confined spaces such as lift wells and tall chimneys.

When material is being dropped, personnel should ensure the integrity of the exclusion by, for example, secure fencing. An effective system of communication should be established between the lookout(s) and persons dropping material to ensure that the exclusion zone is clear of personnel when dropping takes place.

As materials can become lodged on protrusions, an assessment should be undertaken before the area is confirmed as safe for the temporary removal of the exclusion zone to enable materials to be cleared.

18.6 Mobile plant for reprocessing materials

The generally considered good practice for reprocessing and recovering site won materials, such as bricks, tiles and concrete, for reuse on site should be appraised for each site.

Where materials are to be processed on site by crushing, any required permits should be obtained.

Whereas any materials transferred off site for recycling are considered waste, so that they are covered by the duty of care and have to be transported by a registered waste carrier, materials should be considered for reprocessing on site using mobile plant.

NOTE This requires a mobile plant permit from the local authority (SEPA in Scotland or the local council in Northern Ireland). In many cases the mobile plant permit accompanies the plant, but this needs to be checked with the supplier.

A typical local authority concrete crushing permit comes with Conditions to control and monitor emissions such as dust, so a log book should normally be kept with the plant at all times. Stockpiles should be constructed and managed to minimize airborne dust and may be conditioned with water to suppress dust. Staff should be trained and operations managed to control emissions, and plant should be cleaned and maintained to appropriate levels. Contractors may apply for a registered exemption which allows the storage of specified amounts of waste at the site where it will be crushed.

Figure 25 Route map for Clause 19

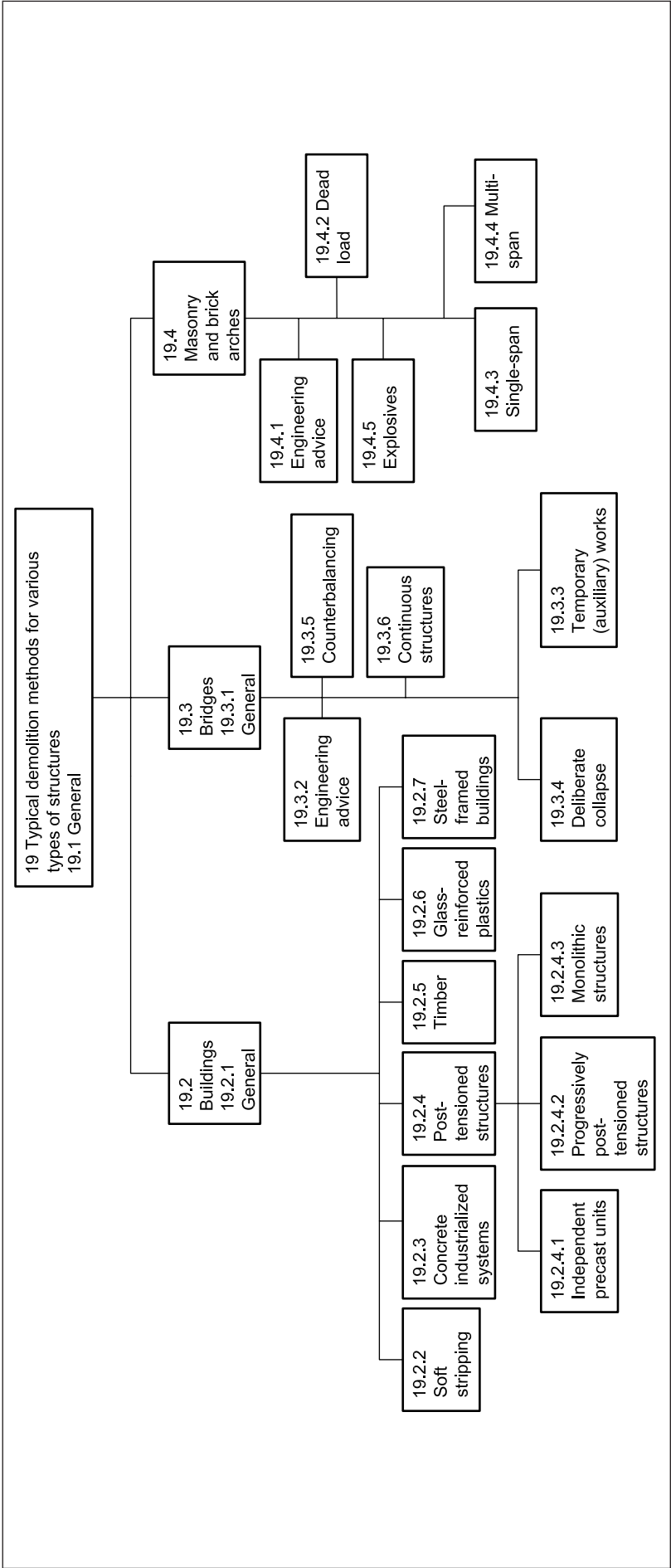
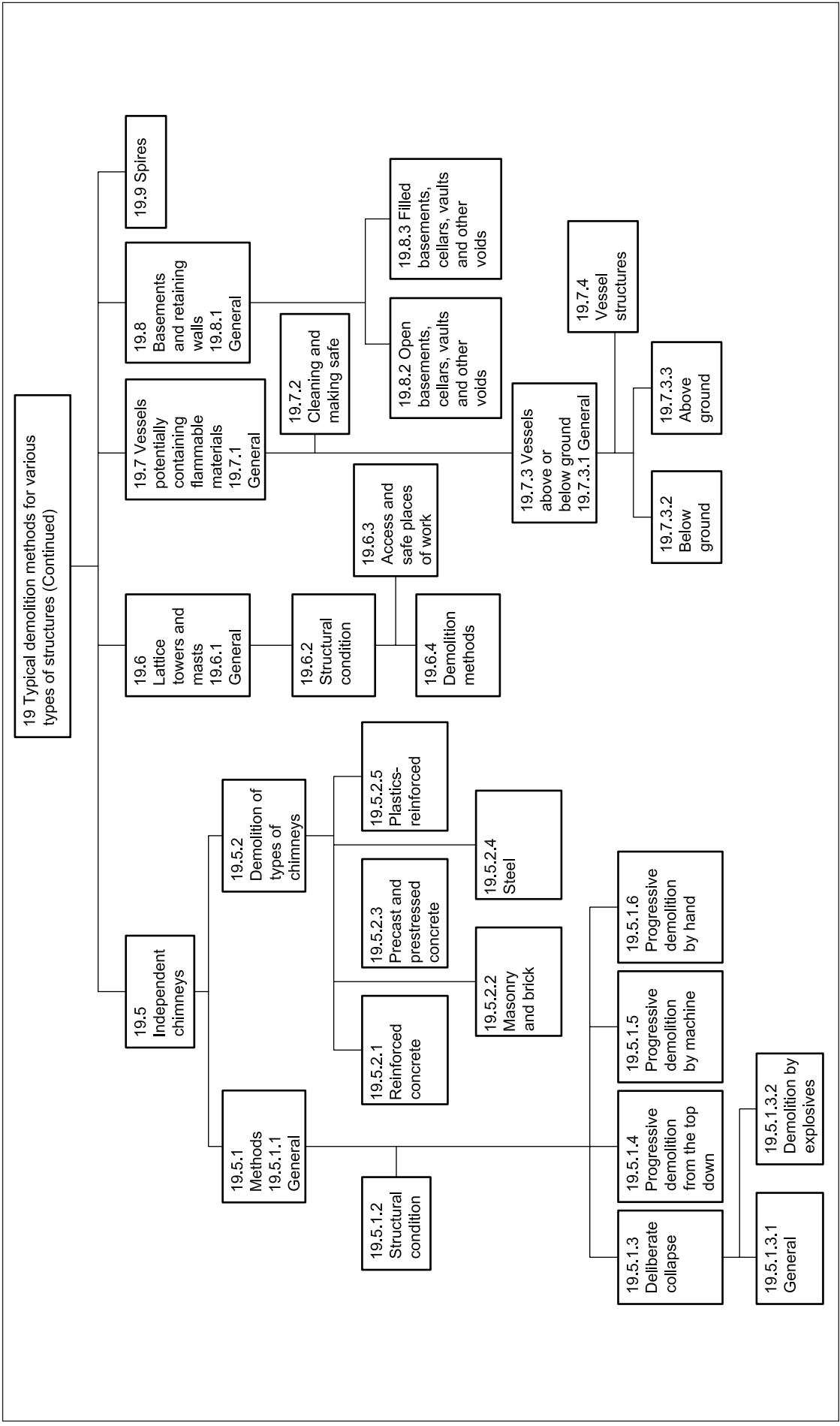


Figure 25 Route map for Clause 19 (continued)



19 Typical demolition methods for various types of structure (see Figure 25)

19.1 General

The demolition processes should commence only when the design and construction principles are known and there is sufficient information about the site, including the relevance of any decommissioning, the state of services and the presence of asbestos. Risk assessments should be carried out, method statements produced and exclusion zones designed and implemented before any demolition works begin (see Clause 5).

Additionally, the sequence of demolition should have been arranged to ensure that any remaining structure is stable. Where necessary, temporary strengthening, such as bracing, should be added.

Where appropriate, demolition materials should generally be segregated and consideration given to the potential for their reuse and recycling (see Clause 12).

19.2 Buildings

19.2.1 General

The full or partial demolition of buildings should commence with the removal of hazardous materials, e.g. asbestos (see 10.3.2.2). This should be followed by the removal of non-structural items (commonly known as soft stripping), e.g. fixtures and fittings, doors, windows, frames, suspended ceilings, studding and partitions, but ensuring that safe accesses and working places are available before work on the structure itself commences.

19.2.2 Soft stripping

The stripping should be carried out using compact machines or hand tools, or by hand, as appropriate. Materials should be separated using machines, where appropriate (see 18.1).

Soft stripping work methods should take account of potential hazards from, for example:

- a) working at height, including the recovery of materials (see Clause 12);
- b) ineffective protection of voids;
- c) falling debris (see 18.5);
- d) "booby traps" maliciously left to injure site personnel, such as used syringes taped under banisters or on top of kitchen units and doors, etc.;
- e) restricted workspace;
- f) manual handling; and
- g) fire, if combustible debris is allowed to accumulate.

19.2.3 Concrete industrialized systems

Where a building has been constructed with an industrialized system, full information on the method of design and construction (including “as-designed”, “as-built” and any retrospective strengthening or other modifications) should be obtained before the planning of the demolition works. Attention should be paid to the principles of the structural design to determine which parts of the structure depend on others to maintain overall stability, e.g. the building could rely on the panel walls for stability. The potential instability of system-built large panel structures should be considered and evaluated as, even though it is known that many similar structures were identified for strengthening following the disproportionate collapse at Ronan Point in 1968, it has been shown that the strengthening recommendations were not always implemented.

CAUTION: Additional measures could be required to deal with large panel structures where strengthening recommendations have not been implemented.

19.2.4 Post-tensioned structures

19.2.4.1 Independent precast units

Units should generally be removed from structures before being broken up (see Annex F). Individual units may be demolished *in situ*, although this should be in a predetermined manner and with restraint provided to movement as appropriate (see Annex F).

Separation of units, which can themselves be prestressed together, should be carried out using the most appropriate methods, for example, diamond sawing, water jetting, thermic lancing or mini-blasting techniques, or a combination of hand or machine-mounted breaker and hot cutting. Effects on transverse stability and strength should be taken into account and appropriate lateral support should be provided, if required.

Structures containing separately stressed precast units should be broken up using, for example, impact hammers, hydraulic shears or explosives. The release of stress can be uncertain and sufficient investigation work, such as determining the extent and effectiveness of grouting in ducts for bonded tendons, should be undertaken to ensure that “fly-out” will not occur. However, measures should be taken to ensure that any potential anchorage ejection is properly contained to prevent fly-out.

19.2.4.2 Progressively post-tensioned structures

As the loading and reaction effects on progressively post-tensioned structures are highly specialized, appropriate specialist engineering advice should be obtained and the demolition carried out in strict accordance with that advice.

CAUTION: In some instances the inherent properties of the stressed section can delay failure for some time and the presence of the large prestressing forces can cause sudden and complete collapse with little or no warning.

19.2.4.3 Monolithic structures

Engineering advice should be obtained before any attempt is made to expose the tendons or anchorages of structures in which two or more members have been stressed together.

Exposure of tendons or anchorages and any destressing of tendons should be undertaken in accordance with a strictly controlled procedure.

CAUTION: It might be necessary for temporary supports to be provided before tendons or anchorages are worked on, including for example diaphragm (transverse) beams.

19.2.5 Timber

A timber building should normally be demolished by deliberate collapse methods or by deconstruction. Attention should be paid to the potential for serious decay and/or infestation of timber that might have greatly weakened members.

19.2.6 Glass-reinforced plastics

Glass-reinforced plastics (GRP) sections, which can be mounted on timber support frames, can have asbestos cement/board linings that contain asbestos. In such cases, removal should be in accordance with **10.3.2.2**.

19.2.7 Steel-framed buildings

A steel-framed building should be demolished in a planned sequence so that the residual structural stability is maintained, having regard to the method of stability provided prior to any demolition, whether by deliberate collapsed methods or deconstruction.

19.3 Bridges

19.3.1 General

Bridges should be demolished either by deliberate collapse methods or in the reverse order of construction using, for example, cutting and lifting (or removing the entire deck as one unit) in accordance with Annex F. After removal or deliberate collapse, those parts of the structure should be broken up before removal from site, if required. Precautions should be taken to ensure that the collapsed structure does not present a hazard when being cut into smaller pieces.

Any relevant additional temporary supports should be put in place before work commences to help carry the dead load of the structure and demolition loadings, including plant and equipment, together with any support to aid lateral and longitudinal stability.

Where any part of a bridge is post-tensioned, the recommendations of **19.2.4** should be followed.

19.3.2 Engineering advice

Engineering advice should be obtained for all stages of the demolition of bridges to ensure that the stability of the structure is maintained. The demolition should be closely supervised by persons fully experienced in, and conversant with, the type of work being undertaken.

Work should be programmed in consultation with, and to the satisfaction of, the authorities responsible for the bridge and for the land beneath it.

19.3.3 Temporary (auxiliary) works

Temporary (auxiliary) works should be designed to carry the required loads and temporary bracing should be incorporated into the bridge structure, where necessary, in order to maintain stability under the severest conditions. Before transverse members are removed, temporary supports or guys should be fixed to the main beams or girders, if appropriate.

Where the horizontal thrusts from the abutments are designed to be taken by the deck, these should be dealt with by, for example, inserting temporary struts prior to removal of the deck.

Where temporary support is required as part of the demolition method, e.g. in the case of skew bridges, it should be in place before the stability of the bridge is compromised.

19.3.4 Deliberate collapse

Deliberate collapse methods should be designed such that appropriate initial preparation work is carried out to aid efficient demolition. Explosives or mechanical methods of pre-weakening should be considered as ways of initiating the collapse of the structure.

19.3.5 Counterbalancing

Where the bridge is of a counterbalanced cantilever design, the demolition technique should ensure stability by taking into account such considerations as out-of-balance loadings and lack of fixity at supports by using, for example, temporary supports.

Where counterbalancing is used, the balancing materials should be securely and safely fixed. The bridge or elements of it should be transversely braced, if necessary.

19.3.6 Continuous structures

Where a bridge is continuous over one or more supports, consideration should be given either to cutting the deck above the piers to form a simply supported structure, or to cutting the deck at midspan to form statically determinate cantilevers, taking into account the ability of the structure to maintain stability in these forms.

19.4 Masonry and brick arches

19.4.1 Engineering advice

Engineering advice should be obtained for all stages of the demolition of arches to ensure that the stability of the structure is maintained. The demolition should be closely supervised by persons fully experienced in, and conversant with, the type of work being undertaken (see also 19.3).

19.4.2 Dead load

Dead load may be removed provided that the stability of the main arch rings is not compromised.

NOTE The load-carrying capacity of many old arches relies on the filling between the spandrels.

On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill, the spandrels and the arch rings is removed.

19.4.3 Single-span arches

A single-span arch should be demolished by cutting strips progressively from each springing, parallel to the span of the arch, until the width of each arch has been reduced to a minimum which can then be collapsed.

Where deliberate collapse methods are adopted the crown should be broken out either by remote mechanical methods or by explosives, unless temporary supports are provided before work commences.

CAUTION: Breaking out the crown of the arch will lead to instability and collapse.

19.4.4 Multi-span arches

In multi-span arches, before individual spans are removed, lateral restraint should be provided at the springing level to prevent instability of adjacent spans including any supporting piers. Demolition should then proceed as for a single-span arch, ensuring that the spandrels are demolished as the work proceeds.

19.4.5 Use of explosives

Explosives should be used where it is preferable to ensure the collapse of the whole structure in one operation, so as to avoid the potential for unstable portions remaining.

19.5 Independent chimneys

19.5.1 Methods of demolition

19.5.1.1 General

In general, remote demolition techniques should be used in preference to hand demolition. The construction of the chimney, its condition, the materials from which it is constructed and the available space should be assessed to determine the appropriate demolition method. Chimneys that are to be toppled should be prepared to have a section of their base removed to induce overturning in the required direction. The section of base to the rear of the mouth is referred to as the heel. The chimney will need to stand momentarily on the heel until the out-of-balance forces induce overturning about a line between the mouth and heel, referred to as the hinge line. As part of the planning of the work the direct stress should be checked with the weight of the chimney standing on the heel, to ensure immediate heel failure does not occur.

As a reinforced concrete or masonry chimney falls the hinge will fail. The rate of failure will determine the direction of fall, as will the compressive and bending failure of the heel that follow. For this reason the height of the mouth is critical to ensure the chimney continues to rotate on its collapsed base in the intended direction of fall. In determining exclusion zones the chimney barrel should always be considered to fall at least its length.

For steel chimneys, the entire weight will bear directly on the hinge points to each side of the mouth as the chimney starts to fall and the heel lifts clear of the ground. Slender edges at the hinge line should therefore be avoided to ensure a precise direction of fall.

NOTE For more advice on material types, see 19.5.2.

19.5.1.2 Structural condition

The fabric of the chimney should be examined to determine its condition, taking account of openings in its base, flue entries and soot doors when determining the strength of sections of the structure. The reduction in strength of the construction materials due to deterioration should be considered, particularly at the part of the chimney which might need to be relied upon as the heel.

If the chimney is out of vertical alignment, eccentricity of loading should be considered with regard to pre-weakening and the direction of fall.

19.5.1.3 Deliberate collapse**19.5.1.3.1 General**

Preparation leading to deliberate collapse requires pre-weakening design calculations to determine the stresses in the base of the chimney subject to dead load, eccentric load and wind load. The combined maximum stress should then be compared with the strength of the materials from which the chimney is constructed.

Consideration should be given to the effects of high levels of vibration that can be generated when a chimney barrel impacts on the ground. The potential for ricochet and spread of debris should be taken into account when determining the size of exclusion zone required.

19.5.1.3.2 Demolition by explosives**19.5.1.3.2.1 General**

When explosives are used, the demolition method should be supervised to ensure that the designed method and overall procedures are strictly adhered to (see Clauses 11 and 17).

19.5.1.3.2.2 Reinforced concrete chimneys

Reinforced concrete chimneys are designed as vertical cantilevers and the reinforcing in the wall is subject to tension in high winds. To induce overturning a mouth should be removed by explosives. To avoid the reinforcing bars in the heel providing a restoring moment which resists overturning about the hinge line, the tension capability of the heel reinforcing should be removed at least in part if it is not possible to remove it entirely. This reduces to a minimum the compressive stress at the hinge line during the felling, which increases the accuracy of the direction of fall. Engineering calculations should be carried out before the demolition to reveal whether there is a risk of a "stand-up" or heel failure upon displacement of the mouth supports.

NOTE The speed of rotation of the chimney barrel will determine whether ground vibration is generated by single or multiple impacts.

19.5.1.3.2.3 Masonry and brick chimneys

Masonry and brick chimneys are designed as gravity structures, their self weight maintaining their structural stability in high winds. More often than not these chimneys have internal refractory linings separated from their windshields by a cavity. If this is the case, consideration should be given as to whether explosives placed in the mouth support will be effective in displacing the internal lining.

NOTE It is important that the explosive displacement of the mouth support is conclusive to ensure continuing rotation about the intended hinge line; if not, a second hinge will form within the displaced mouth which could prevent the chimney from falling or cause it to fall in another direction. Another consequence of the mouth closing is compressive force being induced up the front of the collapsing chimney barrel, which will hold it together and cause a single full-length impact with an increased risk of ricochet spread of debris.

19.5.1.4 Progressive demolition from the top down

Reducing the height of the chimney from the top down, either by machine or by hand, should be planned so as to avoid build-up of demolition arisings inside the barrel.

Account should be taken of the additional wind load moment at the base of the chimney as a result of projecting scaffolding or suspended demolition rigs mounted on the top of the chimney. An opening may, if necessary, be formed or enlarged at the base of the chimney for the removal of arisings from within. Because this will weaken the chimney, it should only be carried out if structural calculations have proven that stresses will remain within safe limits.

19.5.1.5 Progressive demolition by machine

A high-reach machine to be used for the demolition of a chimney should be capable of reaching over the top of the chimney. As far as possible arisings should be displaced outwards to prevent them building up within the base on the chimney, thereby avoiding the need to weaken the base for the removal of arisings.

Any mechanical rig placed on the chimney should be designed to remain stable at all times and should be CE-marked as suitable for the purpose for which it is to be used.

19.5.1.6 Progressive demolition by hand

Demolition by hand should be carried out from safe working platforms, either suspended or supported from the ground. If debris is to fall within the chimney an opening may, if necessary, be formed or enlarged at the base of the chimney for removal of arisings from within. Because this will weaken the chimney, it should only be carried out if structural calculations have proven that stresses will remain within safe limits.

NOTE This may be provided either internally or externally.

A careful inspection and survey should be made to determine whether existing ladders, climbing irons and bands are safe if it is proposed to use them for access. No reliance should be placed on existing features without a full assessment.

Work methods should ensure that any cornice or similar projecting feature is adequately supported or taken down before the weight of the structure above it is removed.

19.5.2 Demolition of types of chimney

19.5.2.1 Reinforced concrete chimneys

When a chimney is to be progressively reduced in height from its top, the windshield should be cut into panels; the panels should be formed by breaking out locally around the edges to expose the reinforcement. Each section should be supported, if required, prior to the reinforcement being cut to release panels to drop down to ground level inside the chimney. The panels should be limited to a size that cannot form a blockage in the chimney barrel or cause unacceptable impact at its base. Debris should be cleared at regular intervals and not be allowed to build up inside the base of the chimney.

Remaining panels at the top of the chimney should not be left in an unstable condition at the end of working periods.

19.5.2.2 Masonry and brick chimneys

Where progressive demolition by hand is employed, the chimney should be demolished course by course. The debris may be allowed to fall to the ground internally but should be cleared in a planned way as the work proceeds. Where the masonry, brickwork or mortar is of poor quality and structural stability indeterminate, independent access may be provided if necessary. Where adequate access cannot be provided, debris should be lowered in suitable containers outside the chimney rather than dropped internally.

19.5.2.3 Precast and prestressed concrete chimneys

Precast concrete sections chimneys usually have vertical threaded steel reinforcing bars which bolt the sections together. These tensioned fixings provide prestressing and can induce out-of-balance forces. This can influence the direction of fall when demolition is carried out by deliberate toppling. Detail of construction drawings should be studied and, in the absence of this information, exploratory work should be carried out to establish the positions and extent of the heavy large-diameter vertical bars that link the reinforced concrete sections together. Reliance should not be made on these bars being uniformly tensioned.

Openings in the chimney base, flue entries and soot doors might have been made as modifications to the original construction and will have caused localized increase in stress in the concrete. These locations might reveal the positions of the tensioned bars. Deterioration of refractory linings throughout the height of the chimney might have allowed the bars to be heated unevenly, which will affect the tension in the bars.

19.5.2.4 Steel chimneys

When steel chimneys are being lifted down they should be slung and lowered to the ground in sections. Chimneys which are internally lined with spray-applied concrete are usually reinforced with fishtail studs welded to the inside of the windshield. A strip of external steel windshield plate may be removed, if necessary, to enable the internal lining to be accessed and broken out. Bearing stress at the slinging points on thin steel plate determines the maximum weights of sections, including lining that can be lifted.

Pulling to topple steel chimneys should preferably be designed to occur about a pair of bolts at their bolted base assemblies. This may involve forming a mouth which ensures an adequate restoring moment maintains structural stability until the overturning pulling force is applied. The pulling force required to overcome the restoring moment should be calculated to ensure that it is within the pulling capacity of the machine and pulling rope to be used for this purpose.

19.5.2.5 Plastics-reinforced chimneys

Plastics-reinforced chimneys are normally constructed inside a structural steel framework and should be demolished in a similar manner to that employed for masts or towers (see 19.6).

19.6 Lattice towers and masts

19.6.1 General

A lattice tower or mast should be out of service and appropriately decommissioned, but the structure should be adequately earthed during the demolition process. As stability is often provided by tensioned guy ropes, the amount of tension, and thus the overall balance of forces in the guys, which is critical to the stability of the mast, should be identified by the survey and taken into account. Independent (tubular) structures that are secured only at the base should be considered to act as cantilevers.

No work should be undertaken at height in poor weather conditions, e.g. during strong or gusty winds, in icy conditions or if lightning is seen or predicted.

19.6.2 Structural condition

Although all prime members of the structure should be visible for inspection, a check for corrosion should be undertaken, particularly at plated joints and especially if the joints are potential moisture traps.

Assessments of wire ropes should also be made, taking account of the difficulty of inspection because corroded or broken strands can be hidden inside or covered by grease.

19.6.3 Access and safe places of work

Work on parts of the structure away from ladders and working platforms, which should be checked for safety before any use, should be carried out by specialist riggers who are trained to work on masts and towers. All personnel should be attached at all times to a suitable fall arrest device.

19.6.4 Demolition methods

The selected methods of demolition should minimize the need for work at heights, e.g. felling should be considered if sufficient space is available.

For progressive dismantling, the operations should be carried out in a predetermined order, based on a structural analysis of all stages to determine the degree of residual stability.

Where demolition is to be by explosive cutting charges, the structure should first be pre-weakened. Explosive cutting charges may be used to cut members for progressive dismantling.

CAUTION: Removal of bolts by hand can be difficult because of, for example, the loads on them from the structure.

For the demolition of lattice towers or pylons, progressive demolition techniques should be employed so that assemblies of manageable size can be safely lowered to the ground by crane or attached derrick.

For guyed structures, the removal of guys should be carried out in a controlled sequence to ensure continued stability during demolition.

19.7 Vessels potentially containing flammable materials

19.7.1 General

CAUTION: The preparation and cleaning of plant that has contained flammable or combustible materials for internal inspection, hot work and demolition is a specialized activity. There is always the possibility that vessels can contain hazardous atmospheres (see 11.10). Unsafe work practices can result in fires or explosions, not only from such obvious sources as hot work, but also from friction sparks, increased temperature or build-up of electrostatic charge.

During the demolition of vessels potentially containing flammable materials, the external environment of the tank(s) should be checked to ensure that it is similarly free from potential hazards (see also 17.12 and, as an alternative to hot cutting, 17.5).

Those engaged for such work should be able to demonstrate their competence, including the earlier planning of the work, making adequate provision for health and safety (see Clause 11, in particular 11.7).

The requirement to inform and/or consult the local authority petroleum officer, fire officer or other responsible person should be considered at the planning stage (see Clause 5).

The decommissioning report (see 8.1.3) should be consulted for confirmation of the nature of the contaminants present (if any), specification of appropriate decontamination procedures and precautions for the safe disposal of waste (including any vent and/or purge gases), standards to be adopted, and named responsibilities for the work, etc. Any specific structural features of tanks or vessels where gases, liquids or residues can be trapped, e.g. between the lining and the shell, tubular roof supports or floating roof crevices, identified in the decommissioning report should be taken into account when defining decontamination procedures.

Prior to commencing any work the operator/contractor should confirm the procedures to be carried out and be issued with the appropriate authority to work by the competent person controlling the activities (see Clause 8 and 11.7).

19.7.2 Cleaning and making safe vessels

Where a vessel is to be prepared for removal and/or demolition, in order to eliminate the risk of fire and explosion it should be emptied and thoroughly cleaned (see 19.7.1) by such procedures as:

- a) steaming;
- b) water or solvent washing/jetting;
- c) other manual means; and
- d) "gas-freed" by forced ventilation or another suitable method, with a "gas-free" certificate issued as appropriate.

CAUTION 1: If vessels have contained even a small amount of flammable or combustible gas, liquid, sludge or solid, including dust or powder, and have not been cleaned effectively, an explosion can occur on application of the flame cutting blow torch.

Alternatively, in cases where gas-freeing and cleaning cannot be readily carried out, e.g. if the vessel is underground, the equipment can be rendered temporarily safer after removal of as much of the contents as possible, by "inerting". Depending on the type of work planned, however, consideration should be given to thorough cleaning later.

NOTE 1 "Inerting" is the process of completely filling vessels with materials such as one of the following to replace previous gaseous contents.

- a) *Water.*
- b) *Inert gas (nitrogen or possibly "combustion" gas).*
- c) *Carbon dioxide (from dry ice).*
- d) *Nitrogen foam (there are limitations to the use of air foam).*
- e) *Hydrophobic foam.*

CAUTION 2: If a vessel has contained water, the atmosphere inside the vessel can be depleted of oxygen and contain flammable hydrogen due to corrosion.

Similar preparation/decontamination procedures should be applied to associated pipework and equipment prior to its dismantling and/or entry, though by nature of its construction it can invariably be dismantled by "cold cutting" methods.

The cleaning/inerting techniques are employed to realize a specific purpose. Unless specified, it should not be assumed that the vessel is either suitable for entry and/or hot work.

When using gas inerting and purging techniques, it should be ensured that efficient dispersion/mixing of the inerting/purging gas occurs throughout the entire vessel and that there are no dead spaces. This should be confirmed by frequent atmosphere checks, as appropriate, and, where possible, in different parts of the vessel (using remote sampling).

Methods of cleaning and/or inerting should be chosen to be compatible with vessel characteristics and the nature of contaminants, etc., and potential hazards identified, taking into account the fact that some flammable materials float.

In all these operations the process should be managed to ensure that no flammable liquid, vapour or gas is allowed to enter any drainage or water course and that flammable vapours purged to atmosphere do not create an explosion or health hazard.

Certificates confirming that a vessel is, for example, "Gas-free", "Safe for entry" or "Safe for hot work", should only be issued by a competent person, who should state for how long the certificate is valid and the nature of work permitted.

If the vessel is to be subsequently dismantled on site it should be ensured that the vessel remains in a safe state in the interim period, and will be safe at the time of dismantling. Those making safe the tank and/or certifying this should be consulted before work proceeds.

HSE guidance note CS15 [71] should be consulted for further guidance.

NOTE 2 Further information can be obtained from the Energy Institute (see Annex C).

19.7.3 Vessels above or below ground

19.7.3.1 General

Vessels below ground should be removed, where practicable, by remote methods. Consideration should be given to cold cutting techniques, such as utilizing mechanical plant fitted with shear attachments. Such techniques are particularly effective where the vessels are not to be recovered for reuse, but are to be recycled for their scrap value. Mechanical plant use is also most effective in sensitive, noxious or hazardous environments where flame cutting or heat applications are inappropriate. Diesel fuel powered machinery can be fitted with an acceptable spark arrestor for work in flammable/explosive atmospheres or, alternatively, robotic-controlled electrically-powered machines should be considered.

19.7.3.2 Vessels below ground

Prior to excavation, any vessel should be cleaned or made safe using the methods recommended in **19.7.2**. If a method involving water filling is used, water should be emptied from the vessel prior to it being lifted out of the excavation and the vessel refilled if necessary.

Where a vessel surround is being excavated there should be an assessment to determine whether material in the surrounding area has been contaminated, either by leakage from the vessel or by spillage. If contamination has occurred, precautions including the following should be taken.

- a) Appropriate barriers should be placed around the work and hazard notices displayed.
- b) No smoking, naked lights or other potential ignition sources should be permitted in the vicinity, and equipment used should either be suitable for use in a potentially flammable area (e.g. flame-proof and non-sparking hand tools) or be located in a safe area (e.g. plant such as compressors).
- c) A plentiful supply of water should be used to lessen the risk from sparking.

The sides of excavations formed to enable removal of underground vessels should be made stable, e.g. by sloping back to a safe angle or by providing adequate support.

After excavation and prior to removing the vessel(s), consideration should be given to printing the words "FLAMMABLE HAZARD" in clear, conspicuous letters at each end or on opposite sides of the vessel.

Where further cleaning (see 19.7.2) is appropriate for subsequent activities, this should be carried out when the vessel has been removed from the ground to a more suitable and safe location.

19.7.3.3 Vessels above ground

Before commencing removal and/or demolition the vessel should be prepared using an appropriate method recommended in 19.7.2, and certification provided as appropriate.

Only cold cutting techniques should be used, unless the vessel has been cleaned and "gas-freed" or the risk of fire and explosion has been otherwise eliminated (see 17.12).

19.7.4 Vessel structures

19.7.4.1 Roofs

Cold cutting by remote means should generally be the preferred method of demolition.

Depending on the size, weight and type of construction of the vessel, consideration should be given to cutting and then removing the roof in one piece by crane. If this is not appropriate, temporary roof supports should be provided to ensure the stability of the roof during the demolition.

CAUTION: The need to install any temporary supports should be determined prior to cutting.

When the roof or roof plating is being removed an edge ring beam should be left, sufficient to retain the rigidity of the tank walls. Occasionally, a ring beam can be provided to provide temporary stability during the demolition.

On vessels where fixed roofs are supported by steelwork rafters or trusses, the removal of roof plating should be consistent with retaining residual structural stability in and by the steelwork supports. Centre plates can be left in place to enhance structural stability.

The structure should generally be demolished in a sequence that removes diametrically opposite pieces. Floating roofs should not be dismantled until they have been fully stabilized by, for example, being landed on the floor of the vessel. The demolition of roofs should not be commenced while they are still supported on maintenance legs.

19.7.4.2 Walls: single shells

On a vessel with a fixed roof, removal of the shell of the vessel should not be commenced, apart from access manholes, before the roof has been removed. On a vessel with a floating roof, the roof should be fully supported before the shell is removed.

Remote machine-based cutting techniques should be employed, together with suitably-designed exclusion zones based on the assessed behaviour of the structure. Alternatively, where there are site constraints the shell of the vessel should generally be dismantled course by course horizontally around its perimeter, with each piece supported and removed by a suitable crane. Methods using single, long vertical cuts in the walls can produce unstable walls with results that are difficult to predict. Explosives should be considered as a further alternative.

CAUTION: Temporary support should be considered to maintain structural stability as partially demolished tanks are susceptible to collapse, e.g. due to wind loading.

19.7.4.3 Floors

The underside of the floor of a vessel should be investigated for leakage and/or trapped vapour in any voids beneath the base plates which can give rise to a risk of fire and explosion. Where possible, they should be lifted prior to cold cutting into manageable sized pieces.

Where prior removal of the floor is not adopted, and where decontamination or preparation suitable for hot work is necessary (but see 17.12), measures such as cold cutting and/or drilling into the base, followed by inert gas purging or water flooding, or other suitable techniques, can be employed.

19.8 Basements and retaining walls

19.8.1 General

Before commencing the demolition of a structure with basements or retaining walls, the contractor should establish whether any intermediate walls or floors are supporting the retaining or perimeter wall, so that suitable support can be provided if necessary. Any previous structural assessments should be referred to for additional information.

The local highways or roads authority should be consulted before any wall supporting a road or highway is to be removed (see 5.1.3.2). Consideration should be given to leaving perimeter walls in place, whether or not the void is to be filled.

Water should either be allowed to drain from or, conversely, be allowed into the structure, to counter upward pressure, depending on the water table in the area concerned. Methods to be considered should include holes broken through the floors of basements, voids, etc., provided that structural stability is not compromised.

Appropriate precautions should be taken to prevent water penetration to adjoining buildings, including the provision of appropriate damp proofing systems. Precautions should also be taken to prevent accidental access to basements that are filled with water.

19.8.2 Open basements, cellars, vaults and other voids

Where basements, cellars, vaults or voids need to be left open, adequate buttressing walls should be left to support the retaining walls to ground level. Where there are insufficient buttressing walls, shoring or ramping should be provided. In all cases where such features are to be left open they should be securely fenced.

19.8.3 Filled basements, cellars, vaults and other voids

Where basements, cellars, vaults or voids need to be backfilled, all organic matter should first be removed.

Where the basements, cellars, vaults or voids adjoin any other property, any party or adjoining cellar walls should be inspected as these might not be of adequate strength to withstand the resulting ground pressure imposed on them by the fill. If the party or adjoining walls are inadequate, specialist engineering advice should be taken to determine the method of strengthening such walls prior to back-filling. Provision should be made for adequate damp-proofing.

Wherever basements, cellars, vaults or voids extend beneath footpaths or roads, and they are not opened up, they should be filled to the approval and satisfaction of the local highway or roads authority (see 5.1.3.2). The type of fill, degree of compaction and level required should be specified (in the design).

19.9 Spires

The fabric of the spire should be examined to determine its condition and whether there has been any deterioration in the strength of the materials. The surveying of spires should include structural materials that are obscured by cladding. Measurements should be taken to determine whether the spire has deviated from the perpendicular. Examination of the structure should be carried out to ensure that vibration caused by pre-weakening and drilling does not cause any of the structure, such as masonry or brickwork, to be dislodged. If necessary specialist engineering advice should be obtained about any pre-weakening. Reference should be made to any relevant information.

The same demolition principles should be applied to spires as for chimneys, so both deliberate collapse and progressive demolition should be considered, particularly using remote machine techniques. Demolition by deliberate collapse should be used only on sites that are detached and reasonably level, where the whole structure is being demolished and where there is sufficient space all around the spire for an adequate exclusion zone to be provided (see Clause 13).

When progressive demolition is being used, the heavy solid stonework at the peak of a masonry spire, which can normally be removed only after releasing the central tie rod, should be reduced to a suitable size if manually handled before being lowered to the ground.

Any hand demolition should be carried out from a safe working platform, such as by scaffolding encircling the spire (see 11.17).

Flame cutting tools should not be used to remove metal fittings or clamps from timber components in a spire, because of the risk of fire (see 17.12).

An assessment should be carried out to establish whether the stonework above the spider needs to be supported temporarily in position before the tie rod is released, particularly where the structure is in poor condition.

The following should also be considered.

- a) Any overhanging or corbelled stonework when the weight of the structure above is removed.
- b) The need for temporary bracing.

20 Completion of the works

20.1 Safety and health

On completion of the demolition works the site should be left in a safe and secure condition.

All pits, trenches, sumps or voids should be left filled, securely covered and marked, or guarded in a safe condition.

The site drainage system should be thoroughly cleaned and tested to ensure that it continues to operate.

Any walls that are to remain, in particular to act as the boundary to the site, should be checked to ensure that they remain stable under anticipated loadings.

All contaminants should be removed or left in a condition such that they present no hazard to health or to the environment. All contaminants, whether they remain on site or have been removed, should be identified in the health and safety file (see 20.2). Where they remain, all details should be notified to those who will have the responsibility for the site so that they can, for instance, control entry to these areas.

The CDM coordinator should ensure that the health and safety file has been prepared and handed to the client on completion of the works.

20.2 Health and safety file

The health and safety file should include the following information, as appropriate.

- a) Description of the works undertaken and site location details.
- b) Description of the site as is, including topographical details as necessary.
- c) Any known underground residual risks remaining, i.e ground conditions, buried objects, voids and chambers.
- d) Known service runs/locations and/or termination points in and around the site.
- e) Details of the structural principles and safe working loads for floors and roofs.
- f) Remaining proximity hazards for oncoming contractors or users of the site.
- g) Water courses, drainage or soakaways remaining.
- h) Safe access and egress points, boundaries and security concerns.
- i) Any other information deemed relevant.

In addition, all service disconnections, drainage terminations, etc., should be recorded in the health and safety file that is compiled as the work progresses and is usually coordinated on behalf of the client by the CDM coordinator.

Annex A
(informative)

Training and competencies

A.1 Demolition

A.1.1 Background

The National Demolition Training Group (NDTG) in conjunction with ConstructionSkills and the National Federation of Demolition Contractors (NFDC) are the focus for training in the demolition industry. The NDTG was established under the Construction Industry Training Board (CITB) Group Training Association Scheme and membership is available to all demolition firms registered with CITB ConstructionSkills. Full details of the training courses available can be obtained from the ConstructionSkills Training Adviser at the CITB or the NFDC. The NDTG can provide National Vocational/ Qualifications Credits Framework (NVQ-QCF) qualifications for the demolition contracting industry. (See Annex C.)

NOTE Professional institutions and other organizations (see Annex C) also provide means of improving competencies by, for example, running conferences, symposia and courses.

A.1.2 Training schemes and courses

A.1.2.1 The National Demolition Training Group (NDTG)

The NDTG manages and administers the following scheme and courses for demolition operatives, supervisors and managers.

- a) *The Scheme for the Certification of Competence* provides a certificate to operatives who have achieved a satisfactory level of competence at work, in accordance with the competencies laid down by the NDTG Guidance Notes to the Certificate of Competence of Demolition Operatives (CCDO) Scheme.

The scheme applies to all operatives employed within the demolition industry, and is the recognized standard among the demolition workforce and wider industry.

Within the CCDO Scheme there is recognition of formal training and assessment for the whole of the workforce. Training and qualifications are available for basic operatives, skilled operatives, supervisors and managers.

- b) In order to obtain the relevant CCDO Card, candidates have to hold the relevant Health and Safety Touch Screen Test and an approved Asbestos and Demolition Awareness training certificate (1 Day Course). Furthermore, candidates need to have undergone a form of verbal, one-to-one assessment with an industry experienced assessor externally appointed through the NDTG. The CCDO Scheme is cross-mapped to the relevant QCF units. All higher level cards, including those for skilled workers, supervisors and managers, require proof of competence through the appropriate QCF (NVQ) Qualification. Furthermore, in conjunction with the QCF (NVQ) Achievement, supervisors and managers have to undergo the relevant training programme from the following and undertake an external assessment arranged through the NDTG to obtain the CCDO Card.

- Demolition Supervisor 12 Week Course.
- Demolition Managers 5 Day Course.

Both courses place a strong emphasis on trade-specific issues, inter-trade relationships and behavioural leadership.

QCFs (NVQ/SNVQ) are a measure of an operative's capabilities to carry out a range of work to the performance criteria set out by industry. Demolition NVQs currently available are: NVQ Level 2 – Demolition, NVQ Level 3 – Demolition and QCF (NVQ) Level 4 – Demolition. Further information is available from the NDTG (see Annex C).

A.1.2.2 The Drilling and Sawing Association

The Drilling and Sawing Association (DSA) runs a ConstructionSkills approved scheme for the training and certification of drilling and sawing operatives. The objective of the scheme is to ensure that all operatives certificated under the scheme have attained acceptable standards of basic skill and safety awareness. Further details are available from the DSA (see Annex C).

A.1.2.3 The Institute of Demolition Engineers

The Institute of Demolition Engineers (IDE) organizes a preparation day course for those wishing to take the professional admittance examinations.

The IDE also authenticates applications for the professional membership of those pursuing the route to the Construction Skills Certification Scheme/Professionally Qualified Persons (CSCS/PQP) Card. It is necessary for all candidates to be proficient in the National Occupational Standards (NOS) for the NVQ 4 in Construction Site Management (Demolition).

NOTE Candidates do not have to attain the NVQ 4, but they do need to comply with all the requirements.

A.1.3 The Institute of Explosives Engineers

The Institute of Explosives Engineers (IExpE) runs or endorses training courses that meet the General and/or Specialist Paper standards of its membership criteria. These papers and/or endorsed training equate to the training requirements of BS 5607. IExpE-endorsed training is mapped to National Occupational Standards. The IExpE Development Office for Explosives Skills (DOES) works with the explosives sector to identify and develop vocational training for explosives disciplines (including demolition applications) up to QCF/NVQ Level 4 and the IExpE provides routes for professional registration, including EngTech, IEng and CEng, for explosives engineers.

A.2 Human performance training

Human performance is recognized as being fundamental in facilitating safe operations. Training is available with the objective of developing skills and awareness of techniques in this area of human behaviour.

Annex B (informative)

Legislation, statutory regulations, codes of practice and guidance relevant to demolition

Attention is drawn to the following acts and regulations, and Health and Safety Executive (HSE) approved codes of practice (ACoPs) and guidance, though this is not an exhaustive list of relevant legislation and guidance.

- The Health and Safety at Work etc. Act 1974 [72] and associated guidance [73].
- The Management of Health and Safety at Work Regulations 1999 [74] and *Management of health and safety at work ACoP* (HSE L21) [75].
- The Construction (Design and Management) (CDM) Regulations 2007 [2], *Managing health and safety in construction* (HSE L144) [76] and *Health and safety in construction* (HS(G) 150) [77].

- The Work at Height Regulations 2005, as amended [78], and *Work at Height Regulations 2005 (as amended). A brief guide* (INDG401) [79].
- The Lifting Operations and Lifting Equipment Regulations 1998 [61] and *Safe use of lifting equipment* ACoP (HSE L113) [80].
- The Personal Protective Equipment at Work Regulations 1992, as amended [32], and *Personal Protective Equipment at Work – Guidance* (HSE L25) [33];
- The Provision and Use of Work Equipment Regulations 1998 [81] and *Safe Use of Work Equipment* ACoP (HSE L22) [82].
- The Electricity at Work Regulations 1989 [83].
- The Control of Asbestos Regulations 2006 [29] (see also [84, 85, 86, 87]).
- The Control of Noise at Work Regulations 2005 [88].
- The Confined Spaces Regulations 1997 [44].
- The Control of Lead at Work Regulations 2002 [67].
- The Building Act (England and Wales) 1984 [89].
- The Building (Scotland) Act 2003 [90].

Attention is also drawn to legislation relating to:

- the protection of the environment, such as the Environmental Protection Act 1990 [5];
- landfill and waste management (including special and hazardous waste), such as the Landfill Regulations [15] and the Site Waste Management Plan Regulations 2008 [4]; and
- roads and highways, such as the New Roads and Street Works Act 1991 [40], the Highways Act 1980 [91], the Road Traffic (Temporary Restrictions) Act 1991 [92], the Road Traffic (Temporary Restrictions) Regulations 1992 [93] and the Road Traffic (Temporary Restrictions) Procedure Amendment (Scotland) Regulations 2005 [94].

Annex C
(informative)

Useful contacts for demolition work

Table C.1 lists useful contacts for those undertaking demolition work.

Table C.1 Useful contacts for demolition work (1 of 3)

Type of organizations	Organization	Website
Professional bodies	Institute of Demolition Engineers (IDE)	www.ide.org.uk
	Institute of Explosives Engineers (IExpE)	www.iexpe.org
	Institution of Civil Engineers (ICE)	www.ice.org.uk
	Institution of Structural Engineers (IStructE)	www.istructe.org.uk
	Energy Institute	www.energyinst.org/home
	Royal Institute of British Architects (RIBA)	www.architecture.com
	Chartered Institute of Building (CIOB)	www.ciob.org.uk
	Royal Institution of Chartered Surveyors (RICS)	www.rics.org/uk
	Chartered Institution of Wastes Management (CIWM)	www.ciwm.co.uk
	Institution of Chemical Engineers (ICHEME)	www.icheme.org.uk
	Energy Institute	www.energyinst.org.uk
	Association for Consultancy and Engineering (ACE)	www.acenet.co.uk
	Association of Directors of Environment, Economy, Planning and Transport (ADEPT)	www.cssnet.org.uk
	London District Surveyors Association (LDSA)	www.londonbuildingcontrol.org.uk
	Convention of Scottish Local Authorities	www.cosla.gov.uk
Industry associations	National Federation of Demolition Contractors (NFDC)	www.demolition-nfdc.com
	National Demolition Training Group (NDTG)	www.ndtg.org/
	Asbestos Removal Contractors Association (ARCA)	www.arca.org.uk
	Drilling and Sawing Association (DSA)	www.drillandsaw.org.uk
	Water Jetting Association (WJA)	www.waterjetting.org.uk
	Engineering Construction Industry Association (ECIA)	www.ecia.co.uk
	National Joint Utilities Group (NJUG)	www.njug.org.uk
	Association of Technical Lightning and Access Specialists (ATLAS)	www.atlas.org.uk
	UKLPG	www.uklpg.org
Training bodies ^{A)}	British Metals Recycling Association (BMRA)	www.recyclemetals.org
	Temporary Works Forum (TWf)	www.twforum.org.uk
	ConstructionSkills	www.cskills.org

Table C.1 Useful contacts for demolition work (2 of 3)

Type of organizations	Organization	Website
	National Demolition Training Group (NDTG) Waste Management Industry Training and Advisory Board (WAMITAB) UK Asbestos Trainers Association (UKATA) Independent Asbestos Training Providers (IATP)	www.ndtg.org/ www.wamitab.org.uk www.ukata.org.uk www.iatp.org.uk
Research organizations	Building Research Establishment (BRE) Centre for Waste and Recycling Construction Industry Research and Information Association (CIRIA) BSRIA IMech CIBSE	www.bre.co.uk www.ciria.org http://www.bsria.co.uk/ http://www.imeche.org/home http://www.cibse.org/
Government departments, agencies and authorities	Health and Safety Executive (HSE) HSE Books Health and Safety Executive for Northern Ireland (HSE NI) Environment Agency Northern Ireland Environment Agency Scottish Environment Protection Agency HM Revenue and Customs The Stationery Office	www.hse.gov.uk www.hsebooks.co.uk www.hseni.org.uk www.environment-agency.gov.uk www.ni-environment.gov.uk www.sepa.org.uk www.hmrc.gov.uk www.tso.co.uk
Utilities/services regulators	Office of Gas and Electricity Markets (OFGEM) Northern Ireland Authority for Utility Regulation Office of Water Services (OFWAT) Office of Communications (Ofcom) Nuclear Institute (Decommissioning)	www.ofgem.gov.uk www.uregni.gov.uk www.ofwat.gov.uk www.ofcom.org.uk www.nuclearinst.com/ibis/Nuclear%20Institute/Home
Heritage countryside and nature bodies	Countryside Council for Wales Cadw (WAG historic environment division) Scottish Natural Heritage Council for Nature Conservation and the Countryside (Northern Ireland) Historic Scotland English Heritage Natural England Northern Ireland Environment Agency	www.ccw.gov.uk www.cadw.wales.gov.uk www.snh.org.uk www.cncni.gov.uk/ www.historic-scotland.gov.uk www.english-heritage.org.uk www.naturalengland.org.uk www.doeni.gov.uk/niea/

Table C.1 Useful contacts for demolition work (3 of 3)

Type of organizations	Organization	Website
	National Trust	www.nationaltrust.org.uk
	Royal Society for the Protection of Birds (RSPB)	www.rspb.org.uk
Other industry resources	Association of Local Government Archaeological Officers UK (ALGAO)	www.algao.org.uk
	Planning Portal	www.planningportal.gov.uk
	NetRegs	www.netregs.gov.uk
	CEEQUAL Assessment and Award Scheme Manual for Projects	www.ceequal.com
	BRE	www.smartwaste.co.uk
	CITB (Construction Skills)	http://about.citb.co.uk/ http://www.citbni.org.uk/Home.aspx

^{A)} Other organizations and bodies, including those elsewhere in this table, also provide training and run seminars, etc., in demolition-related subjects.

Annex D
(informative)
D.1

Heritage

General

A “designated heritage asset” is defined in Planning Policy Statement 5 [95] as “a World Heritage Site, Scheduled Monument, Listed Building, Protected Wreck Site, Registered Park and Garden, Registered Battlefield or Conservation Area designated as such under the relevant legislation”. PPS5 also recognizes “heritage assets” (buildings, monuments, sites, places, areas or landscapes) which, though excluded from this definition, could have “a degree of significance meriting consideration in planning decisions”.

Planning permission, Listed Building Consent and/or Conservation Area Consent (as applicable) has to be applied for and obtained from the local planning authority (LPA) before demolition commences. Such permission or consent is not always required, for example if small-scale repair is to be carried out. The LPA might be obliged to refer applications to the national heritage authority for direction, for example in the case of listed buildings in the higher grades (I and II* in England and Wales) and Scheduled Monuments.

Permission and/or consent when granted usually contains Conditions relating to various matters, including heritage matters ²⁾. Four such common Conditions call for:

- a) recording the built fabric;
- b) salvage of fabric;
- c) protection of retained fabric by use of appropriate working methods;
- d) archaeological work.

Not all of these Conditions are imposed in a particular case.

Further work to retained fabric, in the form of repairs and alterations, might require submissions for planning permission, listed building consent and/or conservation area consent, but such work is beyond the scope of this standard.

D.2 Recording

A Condition might require recording of the built fabric in advance of the demolition work, and sometimes (safety considerations permitting) during the work as hidden construction details are exposed. The aim of recording is to retain the information on construction that is to be lost by the demolition or removal (“preservation by record”). In the case of partial demolition, the recording might have to extend to parts of the fabric to be retained, in order to provide a context for the fabric that is to be demolished or removed. Both the exterior and the interior fabric are usually recorded.

²⁾ Guidance to local authorities and applicants on common Conditions relevant to historic buildings is contained in *Analysis and recording for the conservation and control of works to historic buildings*, published by the Association of Local Government Archaeological Officers [96]. This document is currently noted as under revision, following the recent publication of PPS5 [95].

Typically, the Condition will call for a programme of “building recording and analysis” to be agreed with the LPA and carried out in accordance with a written specification (often known as a “written scheme of investigation”) prepared by a specialist acceptable to the LPA (which can usually suggest several such specialists for consideration). The scope of recording can vary widely, but typically includes documentary research, a measured survey, photography and a report bringing these together ³⁾.

D.3 Salvage

A salvage Condition typically requires the identification of sound fabric that can be removed practically, and the preparation of a “salvage schedule” for agreement by the LPA. This schedule then forms the catalogue of material to be recovered during site work, the process of recovery requiring “dismantling” rather than “demolition”.

The salvage schedule could include both notable features of specific interest (such as a plaque) and more typical materials such as sound bricks, stone, slates, setts, ironwork, and timber rafters and joists. The former might be incorporated in new construction for historical continuity, while the salvaged building materials, suitably cleaned and treated as necessary, could be reused elsewhere in the work, or in other projects (thereby contributing to sustainability as well as to the retention of heritage fabric).

D.4 Protection of retained fabric

A Condition could call for the preparation of one or more method statements containing working methods for protecting retained fabric from damage, for agreement by the LPA (see 5.2.3).

Protection of retained fabric requires identification, and avoidance, of the risk of damage from both overall and local actions. In the former category, for example, partial demolition needs to avoid the risk of impact damage to retained fabric as the structure is brought down to ground level, and equally to avoid the risk of undermining retained fabric by excavation and clearance work that removes vertical or lateral support to retained foundations, retaining walls, etc. In regard to local damage, protection can be provided by physical barriers such as hoardings by restrictions on machine use, and by use of low-risk working methods, such as hand removal of bricks in close proximity to retained brickwork.

A further consideration for protection is that elements of construction that were formerly internal, but which will be exposed to the elements by the work, will need to be given suitably durable temporary (and subsequently permanent) protection. Temporary protection may take the form of impermeable sheeting, securely anchored against wind (without intrusive fixings in the retained fabric) and arranged to ensure that rainwater drains away from the retained fabric, with ventilation provided between the sheeting and the retained fabric to prevent a build-up of condensation or water vapour that could lead to dampness and rot.

³⁾ Guidance on the content and conduct of recording work is available in *Understanding historic buildings: a guide to good recording practice*, published by English Heritage [97].

D.5 Archaeological work

Archaeology has traditionally been seen as applying only to historical evidence in the ground. More recently its meaning has broadened, so that for example "industrial archaeology" and "building archaeology" are now terms in common use, although neither necessarily involves any form of ground investigations in search of physical evidence. The assimilation of archaeology into "heritage" alongside buildings and art is confirmed in PPS5 [95], which defines "significance" as "the value of a heritage asset to this and future generations because of its heritage interest. That interest might be archaeological, architectural, artistic or historic". A Condition for archaeology might call for a programme of archaeological work to be agreed with the LPA and to be carried out in accordance with an agreed written scheme of investigation.

Annex E (informative)

Demolition waste protocols

E.1 Wastes protocols

An estimated 80 million tonnes of inert construction, demolition and excavation waste is created each year in England and Wales. Of this, around 44 million tonnes are processed into aggregates to be used for a number of applications, e.g. sub-base for roads, piling mats, pipe and gravel.

Opportunities to maximize materials resource efficiency on demolition and regeneration projects are heavily influenced by the way in which tenders and contracts are arranged to give ownership of materials. The demolition industry is an innovative one and already demonstrates high levels of recovery. Demolition contractors, when given this ownership without conditions, effectively seek the best available price in the market place and manage/recover materials accordingly.

Significant cost savings for clients, along with environmental benefits, can be realized by coordinating the movement of material and products to meet potential demand on the same site. Similar savings can be realized by planning ahead to reuse materials at other targeted sites. Environmental benefits are realized through reductions in vehicle movements and the distances that materials are hauled. In addition, the reuse of products leads to lower carbon footprints than disposal, recycling and the use of new products, albeit the latter might have significant recycled content.

Regulators such as the Environment Agency (EA) apply strict controls to all waste materials and, where there is uncertainty regarding waste classification even following full recovery, regulation under the European Waste Framework Directive [3] means that waste management controls might apply to some materials. Through "Waste Protocols", of which only a few are in existence, the EA actively encourages the full recovery of waste products and materials by applying a Quality Management System that meets client specifications and clearly demonstrates recovery from waste.

One such protocol actively in use and of benefit to the demolition sector is the "Quality Protocol for the production of Aggregates from Inert Waste", which sets a uniform standard and control process that provides evidence of the full recovery of the product and its cessation as waste, increased customer confidence in recycled materials, and diversion of materials from landfill.

E.2 ICE Demolition Protocol [17]

The Demolition Protocol [17] has been adopted and implemented across a range of public and private sector programmes and projects through a range of mechanisms, involving planning policy/conditions, tenders/contracts and voluntary agreements.

The 2008 version emphasises the need for waste reduction first, followed by materials reuse and then recycling, with landfill the option of last resort.

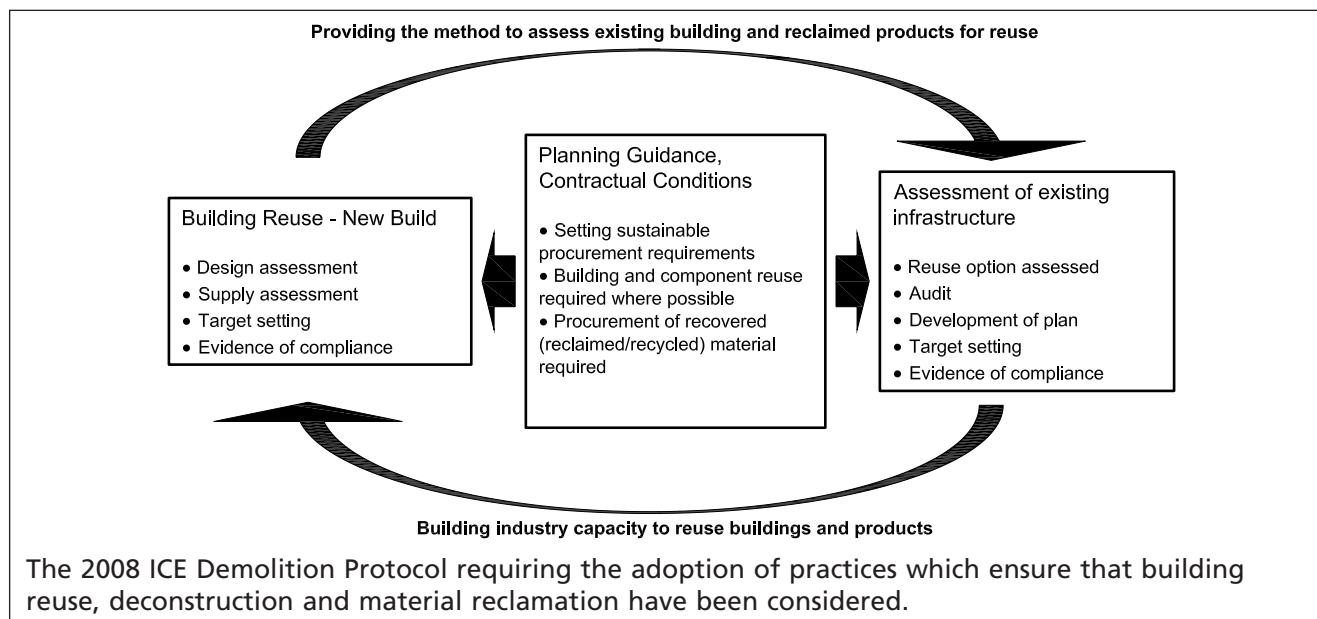
The Protocol is principally aimed at policy-makers and client teams (the principal contractor in a SWMP context). It sets out policy and overall development approaches for sites where building/structure reuse, demolition, stripping out and new build activities are planned. It provides a tool that aids early assessment of potential resources available from buildings and infrastructure.

The 2008 edition provides overarching methodologies that:

- a) explain the role of policy-makers and client teams and cost benefits by adopting the Protocol;
- b) ensure that the principles of the waste hierarchy are adopted in the decision-making process for evaluating buildings, fit-out materials and structures;
- c) offer a process-driven approach to setting targets for deconstruction, reclamation and reuse;
- d) provide a demolition recovery index (DRI): the percentage of material to be recovered for reuse or recycling;
- e) estimate bulk quantities through a pre-demolition audit, summarized in a demolition bill of quantities (D-BOQ);
- f) provides a new build recovery index (NBRI) describing the percentage of material from recovered sources to be used in the new build;
- g) demonstrate compliance with SWMP requirements;
- h) describe the carbon benefits from avoided haulage movements; and
- i) provide data for local authority monitoring of annual construction and demolition waste arisings.

The 2003 edition of the Demolition Protocol referenced a mechanism for driving the supply and demand of recovered materials (reused and recycled). The 2008 edition goes further by describing an approach which entails policy-makers and client teams adopting practices to ensure that building reuse, deconstruction and the use of reclaimed materials are at the heart of decision-making processes. Only once these have been given full consideration are recycling opportunities to be taken forward. These practices are reflected in Figure E.1.

Figure E.1 The 2008 ICE Demolition Protocol [17]



Annex F
(normative)

Hazards associated with prestressed materials

F.1 General

Prestressing is a means by which materials such as brick and concrete are given a built-in compression prior to the application of further loads. The large amount of energy stored in structural elements constructed from prestressed materials requires that special care be taken when they are demolished. It is important to identify the size, type and number of tendons used in a member, since the force contained can vary from a few tonnes in smaller wires up to 1 000 tonnes in some multi-strand cables.

Prestressing can also be present in some steel structures, e.g. steel beams with a concreted flange.

F.2 Investigatory examination

The investigatory examination should, where possible, identify the type of construction, the method of prestressing, the manufacturer of the prestressing system and likely tendon forces, and the probable tendon layout. In addition, the condition of the materials and tendons should be determined. These factors are likely to affect the choice of demolition technique and the method of working. Any sequential stressing during construction should be identified and taken into account.

All available records should be thoroughly inspected to establish whether the construction conforms to these records. If none are available, a careful examination of the structure can often reveal any prestressed elements. F.4 lists the major features to be considered in ascertaining whether an element is prestressed or not.

Unless it can be established beyond doubt that the structure is prestressed or otherwise, expert engineering advice should be sought.

F.3 Nature of prestressing

Prestressing is applied to concrete elements by means of highly stressed individual, or groups of, wires, strands or bars anchored into the concrete. The type of anchorage depends on the prestressing system used. In pretensioned members, the tendons are anchored through direct bond with the concrete. Post-tensioning tendons can be anchored by cones, wedges or screw threads with locking nuts. Wires, strands or bars can be anchored separately or in groups. In long spans, continuous members of segmental structures, anchors and/or couplers may occur at intermediate positions. Intermediate anchors can be placed in recesses or external to the main body of the structure.

Prestressing concrete enables it to work more effectively and permits the required area of plain reinforcement to be considerably reduced. However, by reducing the quantity of plain reinforcement, the element will behave in a more brittle fashion when individual tendons are cut during the demolition process.

After post-tensioning tendons have been anchored, it is common practice to fill internal ducts with grout. The grout performs two functions: it protects the prestressing steel from corrosion and bonds the tendon to the concrete along the length of the duct. However, even when specified, it is not always the case that full grouting of ducts occurs, leaving the tendons unbonded or only partially bonded. It is the presence of bonds which restricts the violent release of tension during the demolition process. Therefore, it should be determined whether an element contains fully bonded, partially bonded or unbonded tendons.

F.4 Recognition of prestressed members

F.4.1 General

Exposure of non-tensioned reinforcement is not conclusive evidence as to whether a member is prestressed or not. The following criteria should be used when determining whether a structure is prestressed or not (some prestressed members might not meet any of the criteria and further investigation might be necessary).

- a) *Age of construction.* Prestressing did not become a popular form of construction until after 1945.
- b) *Span/depth ratio.* The pre-compression induced in the member allows it to carry greater loads with a shallower depth of section than for comparable reinforced concrete sections.
- c) *Uneven soffit.* Creep deflection is usually seen in the form of hogging at midspan of beams and slabs.

NOTE 1 The deflected shape can vary between adjacent floor slab panels or beams and the difference in camber might be visible once finishes are removed.

NOTE 2 Precambering of precast prestressed concrete beams is particularly common in bridge decks.

- d) *Shape of section.* Pretensioned units often come in "standard" shapes other than rectangular, e.g. "T", "U" and "I" sections and hollow boxes. Post-tensioned sections can come in a variety of shapes and are usually harder to identify, although "I" and box sections are common.
- e) *Joints.* In segmental construction, individual sections are post-tensioned together to form a unit.

NOTE 3 The joints between the sections can vary in thickness and are formed of cement mortar, concrete or a thin resin layer.
- f) *Concrete strength.* To avoid crushing of the concrete under the applied pre-compression, the strength of the concrete should be fairly high.

NOTE 4 Strengths in excess of 50 N/mm² are usual and could be higher. Thus, testing for compressive strength can provide an indication of prestressed concrete. Concrete strengths can be estimated by non-destructive means. However, if cores are removed, particular care needs to be exercised to avoid cutting tendons.

- g) *Ends of members.* With pretensioned members it is common for the ends of the tendons to be cropped flush with the ends of the concrete. Signs of burning might be evident or the ends might have been coated with bitumen or a similar protective layer. In some instances the tendons might be easily visible due to the draw-in of the steel that occurs at transfer of compression to the member.

NOTE 5 In post-tensioned members the tendons are normally cut off flush with the anchor, which is then encased in a protective layer of concrete. The end of the concreted recess is often visible and confirms the presence of post-tensioned cables. It is sometimes possible to identify the prestressing system from the shape of the covered area. However, it needs to be recognized that the ends of prestressed members are very rarely open to immediate inspection and are often built into the rest of the structure (see F.5 for inspection hazards).

- h) *Resilience.* If, during the demolition process, a member exhibits a high degree of resilience to normal demolition techniques, there is a likelihood that the element might be prestressed.

NOTE 6 Further investigations ought to be made before the demolition process is allowed to proceed.

F.4.2 Tanks

It is common practice to prestress circular tanks, resulting in thinner walls than for ordinary reinforced concrete construction. The wires might consist of a series of individually stressed hoops or a continuous spiral, tightly wound onto the concrete shell and covered with a layer of concrete or mortar. On large tanks there may be two or more layers of wires. Portions of the covering may be chipped away to reveal the presence of prestressing steel. Where the wires are stressed as a series of hoops, anchoring buttresses are likely to be present at intervals around the tank. Further confirmation may be given by the presence of anchorages along the top edge of the tank, but the absence of these does not imply that no prestressing is present.

F.4.3 Columns

It is not common practice to prestress columns, although portal frames and some raking columns on bridges may be prestressed.

F.4.4 Retaining walls

Deep retaining walls are sometimes stressed vertically, with the anchorages located at the top of the wall, usually within the thickness of the ground slab. Where a deep wall is considered to be of slender section, with no apparent form of horizontal support, then the possibility of the presence of prestressing should be considered.

Masonry retaining walls, either of brick or concrete blockwork, might be prestressed vertically usually with bars rather than strands. This type of wall is difficult to identify as there might be no anchorages apparent. Masonry retaining walls, which have no other apparent means of structural support, should be viewed with caution. However, the levels of prestress in this type of structure tend to be lower than in prestressed concrete elements.

F.4.5 Ground anchors

Many structures, such as retaining walls, dry docks, cofferdams, tall buildings, suspension or arch bridges, tension roofs and transmission towers, are constructed using anchors prestressed into a load-bearing stratum to provide a counterbalance for the structural forces. If structures of these types have no apparent method of structural support, prestressed ground anchors might be present. The termination of these anchors might not always be visible.

F.4.6 Types of prestressed members

There are five main categories of prestressed member. The form of the members in a structure should be identified before attempting demolition, bearing in mind that any prestressed structure can contain elements of more than one category.

Category 1. Members prestressed before the application of the superimposed loads and having all the cables or tendons fully bonded to the concrete or grouted within ducts.

Category 2. As category 1, but the tendons are left deliberately ungrouted. This type of construction can sometimes be recognized from the access points provided for inspection of the cables and anchors. More recently, unbonded tendons have been used in the construction of beams, slabs and other members; these are protected by grease and surrounded by plastic sheathing, instead of the usual metal duct.

Category 3. As category 2, but with the tendons placed external to the structure. This type of construction is easily identifiable as the protective plastic sheath or concrete layer covering the cables can be seen during inspection. The use of external unbonded cable has become more common in the construction of bridges as it has the advantage that the tendon can be replaced.

Category 4. Members that are post-tensioned progressively as the building construction proceeds and the dead load increases, using bonded tendons as category 1.

Category 5. As category 4, but using unbonded tendons as in category 2, which could present an even greater hazard if it is not possible to reduce the prestress gradually.

Examples of progressively prestressed members may be found in the podia of tall buildings or some types of bridge, particularly segmental. The greatest care should be exercised in demolishing such members to avoid upward or hogging failure, which could have catastrophic results. Such failure might occur when part of the dead load has been removed. Therefore, it is essential that cables or tendons are cut in succession as the load is removed, in order for a reasonable state of equilibrium to be maintained.

F.5 Hazards

F.5.1 Stored energy

Post-tensioned tendons contain a large amount of stored energy, which makes demolishing structures that contain them a problem. This is particularly the case when the tendons are unbonded or partly bonded, since there is nothing to contain the energy and prevent the anchorages being projected from the end of the member like a missile. Therefore, the following safety precautions should be taken when demolishing prestressed concrete structures.

- a) No personnel should pass behind the end anchorages during the demolition process.

NOTE 1 If anchorages remain unprotected, no cutting of cables ought to be allowed and alternative methods ought to be found.

- b) End anchorages should be covered and shielded by timber, concrete or steel plates and the demolition method approved by the engineer in advance of the works.
- c) The minimum number of people necessary to carry out the work should be in the area of the cutting operation.
- d) All cutting operations should be supervised and monitored.
- e) Propping or counterbalancing should be provided where necessary.

NOTE 2 The capacity and positioning of props has to be such as to allow for a sudden, uncontrolled release of prestress.

It should be remembered that locking nuts are used as anchorages at the ends of prestressed bars and these are as potentially dangerous as other forms of anchorage. Any inadvertent release of prestress due to the unscrewing of these locking nuts should be avoided.

F.5.2 Handling

Prestressed members are usually designed to resist applied loads in one direction only and should be handled with this in mind. Sudden failure of the element can occur if handled incorrectly. Elements with multiple tendons are normally prestressed symmetrically, so asymmetric release of stress should be avoided where possible to minimize any uncontrollable sideways buckling. However, damaged members might fail even though handled correctly.

Segmental structures should be handled with particular care since any reverse or transverse bending can cause the section to become unstable, particularly when no steel crosses the joints. Where the member contains corroded and partially bonded cables, mishandling might lead to a sudden loss of prestress that could cause the section to fail at a joint.

F.5.3 Continuous members

Members continuous over more than one support may have tendons which run over more than one span or along the full length. Demolition of one section may release and collapse the adjoining spans. Progressive collapse is a real possibility, particularly in the case of category 2 partly grouted tendons and structures.

F.5.4 Progressively prestressed members

Category 4 and 5 structures provide additional hazards, as the construction process cannot easily be reversed during demolition. It should be ensured that the removal of dead weight does not impair the stability of the structure and cause premature collapse. Possible secondary effects of this failure should be considered, such as the collapse of wall cladding panels as a result of the removal of dead load. Rupture might be preceded by upward deflection, with excessive deformations causing collapse.

F.5.5 Signs of damage or deterioration

Where the concrete in a prestressed concrete element exhibits signs of damage or deterioration, or if the tendons or anchorages show signs of damage or corrosion, extreme care should be exercised when lifting the member. In some cases, such as in the deterioration of high alumina cement concrete or in structures affected by alkali-silica reaction, it might be advisable to add temporary bracing before the element is removed.

F.5.6 Inadvertent collapse

In some cases, sudden collapse can occur where incorrect demolition procedures have inadvertently been followed. Failures of this type occur with little or no warning and, as such, are of particular danger to site personnel. Care should therefore be taken to follow the correct demolition procedures

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Further reading

BS 638, *Arc welding power sources, equipment and accessories*

BS 5744, *Code of practice for safe use of cranes (overhead/underhang travelling and goliath cranes, high pedestal and portal jib dockside cranes, manually operated and light cranes, container handling cranes and rail-mounted low carriage cranes)*

BS 5974, *Code of practice for the planning, design, setting up and use of temporary suspended access equipment*

BS EN 1089-3, *Transportable gas cylinders – Gas cylinder identification (excluding LPG) – Part 3: Colour coding*

BS EN 1263, *Safety nets – Safety requirements*

BS EN 1990, *Eurocode – Basis of structural design*

BS EN 1991-1-1, *Eurocode 1 – Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings*

BS EN 1991-1-2, *Eurocode 1 – Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire*

BS EN 1991-1-3, *Eurocode 1 – Actions on structures – Part 1-3: General actions – Snow loads*

BS EN 1991-1-5, *Eurocode 1 – Actions on structures – Part 1-5: General actions – Thermal actions*

BS EN ISO 14121-1, *Safety of machinery – Risk assessment – Part 1: Principles*

BS EN 60774, *Helical-scan video tape cassette system using 12,65 mm (0,5 in) magnetic tape on type VHS*

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