GUIDANCE NOTE	Demolition	Code: C013	Issue: B

This guidance is not exhaustive and reference should be made to the British Standard BS6187 Code of practice for full and partial demolition which provides a useful guide for planning, managing and completing demolition work. The 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. It gives good practice recommendations for the demolition (both full and partial) of facilities, including buildings and structures.

PLANNING AND MANAGING PROJECTS

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

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

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

- Waste management.
- Reuse and recycling.
- Control and minimisation of nuisances to the site’s neighbours, including: dust; noise;vibration;smoke; traffic movements and management.

- Air overpressure.
- Environmental protection, including prevention of pollution.
- Occupational health and safety.
- Planning (including listed buildings and party wall constraints).
- Building regulations.
- Highways and roads.

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:

Affect a public or private road or highway, e.g. works which necessitate:

- the partial or total closure of the road or highway;
- the erection of temporary structures (e.g. scaffolds, fans, screens, hoardings and supports) on or over the road or highway;
- the use of plant or equipment on or over the road or highway; and
- the storage of site vehicles on the road or highway;
- Affect features outside the curtilage of the site (e.g. footway lights, vaults and other voids under a highway)

- Affect access routes, for example, to an adjoining property; or utilities;
- involve scaffolding or a crane jib passing over an adjoining property
- involve the burning of waste in the open on site.

Heritage site activities

The relevant local planning authority (LPA) should be consulted in good time for advice as to whether consent is required for demolition or partial demolition of a building or other structure that is a designated heritage asset or is otherwise considered to have heritage significance meriting consideration in planning decisions; and 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.

Advice should also be sought as to what information will be required in any application and whether the LPA intends to 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 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.

The following other activities should be carried out, where appropriate.

- 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.
- Prior agreement with the local environmental health departments about environmental noise.
- Application to the local authorities for licensing of crusher or screening plant.
- Possible permission from the local authorities and environmental regulator for on-site burning of waste materials.
- Prior consents or other agreements with the relevant regulator for the disposal of ground water or waste water and other fluid discharges.
- Waste management, including waste disposal.
- Allocating site waste management plan responsibilities and requirements.

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 CDP (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.

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 and recorded. This should include selecting methods, materials and equipment to remove or minimize risk from work. 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.

Weather Conditions

Seasonal weather conditions should be considered with a view to carrying out specific types of demolition processes:

- Working at Height
- Use of Scaffolding
- Lifting Operations
- Use of Vibration Tools
- Dust particles

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, programme and safe demolition of the structure.

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, 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.

Method statements

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.

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. 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. 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.

The use of photographic sequences in method statements has been found to be an effective way of communicating the work process.

The chosen methods of work should be determined and and detailed in each method statement. 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. 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 circulated 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.

Avoidance of Unplanned Collapse

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. 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 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.

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 also be established.

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 confirm the assumptions made in any survey of the structure, the risk assessment and the planned method of work.

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.

Information

Information is to be obtained by desk study/on site survey for industry processes and materials and built environment.

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 and should include 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.

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

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

- Radioactive materials;
- Fibres which can be harmful, such as asbestos and man-made mineral fibres;
- Chemicals which can be harmful, such as polychlorinated biphenyls (PCBs).

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

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

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

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

The on-site survey should enhance the knowledge gained during the desk study and enable a more accurate understanding of past features, present features and the existing condition of the site.

The survey should identify health hazards and measures to address these. 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.

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, for example for lone-working.

Information should include historical, archaeological and geological information pertaining to the site to allow for protection of such items and precautions to be taken during any proposed excavation works for unexploded bombs or ordnance (UXB) and (UXO).

HEALTH HAZARDS

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 Site Waste Management Plan (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 which is updated regularly, should be consulted for the workplace exposure limits (WEL) of these substances.

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

Health hazards likely to be encountered in demolition.

Asbestos

Asbestos should be expected in many forms and should be expected to be present, unless established otherwise. As all non-domestic premises are required by the Control of Asbestos Regulations (CAR) to have an asbestos register in place, 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.

A refurbishment and demolition survey should be carried out by trained specialists and all asbestos containing materials removed prior to any demolition work including soft stripping being undertaken.

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.

Only fully trained and experienced personnel shall be permitted to work with these materials, as required by the Control of Asbestos Regulations.

Chemicals and other hazardous non-fibrous materials

If previous uses and/or equipment have left hazardous chemicals such as 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.

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. 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.

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/

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.

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 (radio/electromagnetic waves).

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.

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 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. 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.

Gases

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

- Carbon monoxide (fumes from combustion).
- Carbon dioxide (combustion, decaying organic material).
- Hydrogen sulphide (decaying organic material).
- Methane (public gas supply, landfill sites, coal mines and organic material).
- Petrol fumes.
- Liquefied petroleum gases (from leaky joints in equipment).
- Chemical fumes.
- Ageing fire protection systems containing vaporising liquids, such as halon.

Where such migration is found, its source and extent should be determined. The recommendations of BS 6164 for recognising and dealing with potentially hazardous gases should be followed

Lead

Lead as a toxic dust or fume arises from such demolition jobs as the cutting and burning of steelwork covered with lead based paint and the handling of old petrol tanks from filling stations.

The Control of Lead at Work Regulations requires employers to assess the nature and degree of any possible exposure to lead and to take appropriate measures to control such exposure. Instruction, information and training on the risks from lead must be given to employees and suitable washing and changing facilities must be provided.

The Approved Code of Practice (ACoP) gives guidance on the application of the Regulations, specifies a “lead-in-air” standard to which exposure shall be controlled and indicates when exposure to lead shall be regarded as “significant” (currently 0.l5 mg/m_3 time weighted average concentration over eight hours). Where exposure to lead is significant, the regulations require employers to provide protective clothing and to set up arrangements for environmental monitoring and for the medical surveillance of their employees.

In demolition, it is essential to identify any lead paint or lead containing material before operations begin. If adequate information is not readily available, a sample of the paint or material shall be analysed to determine the lead content.

The cutting of steelwork often has to be carried out within the confines of a building, where the dust and fumes have little chance to disperse and there is risk of a very rapid absorption of lead. Under these circumstances, exposure shall be assessed as significant and liable to exceed the lead-in-air standard. Even if such work is carried out in the open air, high concentrations of the dust or fumes may be inhaled before it has had a chance to disperse if the work is carried out close to the operative's breathing zone.

Where information on "lead-in-air" concentrations from a particular type of work is lacking, air monitoring shall be carried out. Assessment shall be made when exposure is likely to be at a maximum level. Monitoring may not be necessary for work where there is a clear need for the wearing of respiratory protective equipment but, if other persons are working or likely to be in the vicinity, air monitoring may still be needed to ensure that such persons are not exposed to risk. Further guidance on air monitoring is given in HSE Guidance Note EH 28 Control of Lead: sampling techniques and strategies.

Operatives shall be placed under medical surveillance if they are exposed to significant amounts of lead, whether by inhalation, ingestion or skin absorption, for more than a few hours a week, even if only occasionally. This is essential in demolition work, where it is difficult to provide suitable control measures. The frequency of clinical assessment and biological tests shall be determined by the employment medical adviser or appointed doctor on the basis of the information provided by the employer.

Where persons are likely to be exposed to concentrations above the lead-in-air standard, suitable approved respiratory protective equipment must be provided and used. Arrangements shall be made for such equipment to be cleaned and stored at the end of each shift, and to be regularly maintained.

Respiratory protection shall be selected from the list of approved equipment, (Form 2486), according to the highest concentration of airborne lead to which the operator is likely to be exposed. The selection shall also take into account the acceptability of the equipment to the wearer, bearing in mind the nature of the job and the length of time the protection will need to be worn.

Protective clothing shall be provided when exposure is half the "lead-in-air" standard and adequate storage facilities and cleaning arrangements shall be provided. Suitable containers shall be provided for the transportation of contaminated protective clothing, which shall be cleaned at an approved laundry. Changing facilities, away from possible contamination, shall also be provided.

Washing facilities shall be provided as near to the workplace as possible, to enable workers to wash their hands and faces before eating, drinking and smoking. Shower facilities shall be provided for operatives use, should their exposure to high levels of lead be likely.

Polychlorinated Biphenyls (PCBs)

PCBs are toxic substances used in transformers and capacitors and are still found in some heating and refrigeration equipment.

It is important to identify equipment that contains PCBs, either from the labels or from enquiries to the manufacturers or previous owners. Where equipment is to be moved or transported, leakage of PCBs is a hazard and checks of the joints and welds of the equipment shall be made for leakage. The fluid shall be removed from equipment that is to be broken up or dismantled.

Drainage of PCBs shall be carried out in the open air and full protective clothing, including respirators and chemical eye protection shall be worn. Waste PCBs shall only be disposed of through the relevant waste authority.

Confined Spaces

Tanks and other vessels may contain a toxic residue, gases or vapours. The atmosphere of any tanks or confined space shall be tested, prior to entry, and entry shall only be carried out under a “permit to work” system. A rescue procedure shall be drawn up, relevant to the particular task. (Reference “Confined Spaces” guidance notes).

Noise

Demolition plant and equipment frequently creates noise levels in excess of the “Action Levels”, as laid down under the Control of Noise at Work Regulations. (Reference “Noise at Work” guidance note).

Dust

Dust generated from demolition activities if breathed can cuase acute or chronic breathing problems, brick, block and cement dusts contains Silica which can cause silicosis an irreversible lung disease.

Vibration (HAVS & WBV)

Pneumatic drills and breakers are among the many hand tools likely to give rise to vibration white finger, particularly in cold weather. Use of plant and equipment such as excavators, dumpers, loading shovels and ride on rollers can cause whole body vibration and lead to injuries if not adequately controlled. Plant and equipment shall be selected, wherever reasonably practicable, to minimise the risk of vibration. (Reference “Compressors & Pneumatic Tools” & ‘’Vibration’’ guidance notes).

Construction Occupational Health Management Essentials (COHME)

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

- Back pain;
- Skin problems;
- Breathing problems;
- Problems caused by noise or vibration;
- Stress.

Roles in managing occupational health risks for demolition activities

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

- Principal Desingers 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.
- Clients can remove or reduce risks to health.
- Designers can identify and eliminate hazards, and reduce remaining risks.
- Principal contractors can plan and implement a strategy to manage occupational health risks.
- Contractors can manage any occupational health risks that their workers might be exposed to.

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

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.

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

Consideration should also be given to contacting other organisations, as appropriate, such as the police, Fire and Rescue Service, Environment Agency and the Health and Safety Executive.

The demolition contractor should address public concerns over the proposed demolition works to allay any fears by the local residents regarding forthcoming demolition activities by attending public meetings to explain how issues such as noise, dust and damage etc. can be addressed and reduced to the lowest possible expectations through careful and deliberate planning prior to execution. Letter drops to the local community providing information of forthcoming works can also assist in this matter.

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 sites of demolition activities should be segregated from the public by an effective barrier selected following risk assessments, e.g. fencing, timber 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.

- Fence excavations.
- Immobilise vehicles and plant.
- Isolate electricity and gas supplies, or enclose them in locked compounds.
- Outside working hours, remove ladders which provide access from the ground to the first landing place and store them in a secure area.
- 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.

Protection of the Public (working 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

The provision of facade debris netting or reinforced plastic sheeting enclosing the demolition area and debris fans to scaffolding shall be considered and installed, where necessary, to prevent persons being struck by projected or falling debris or materials. Any fans provided shall not be used for access or be permitted to become loaded with debris. Pavement areas below scaffolding gantries should be adequately protected from falling demolished material passing through scaffold boards onto pedestrians.

Scaffold screens incorporating debris netting or plastic sheeting should be erected to elevations of the structure adjacent to neighbouring buildings to act as a protection screen from dust, noise and any projected material from the demolition process. Scaffolding should be struck in sequence with the demolition by a competent person and any alterations that need to be made to the scaffolding should be carried out by the competent person.

NOTE: Wind load factors to scaffolding if netting or sheeting is installed need to be calculated and the system designed by a competent person prior to installation.

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.

Falling and Projected 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.

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.

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 maximised, and the adverse impacts minimised. 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, maximises the opportunities for reuse and recycling of components and materials from demolition operations.

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 demolition is considered to be a waste generating activity, those involved should plan to take account of waste requirements, as well as other pollution control, considerations that could result from demolition operations. e.g.: spillage of chemicals, run off of water, noise and dust generation.

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

Ecological surveys may be required for sites that have lain idle for some time and may have been inhabited by wildlife and any protected species such as bats, badgers, newts and birds.

Further to any ecological survey carried out provisions need to be made to ensure that any requirements for protected or endangered species are adhered to.

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.

Waste minimisation and reuse, recovery and recycling of materials

The application of the waste management and material recovery hierarchy in practice should seek to minimise contaminated waste and maximise 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.

DEMOLITION TECHNIQUES

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. Safe working spaces and exclusion zones should be established and maintained in accordance with BS 6187. 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. Irrespective of which demolition method is adopted, its choice should be based on

minimising 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. The outcome of risk assessments should indicate the extent to which such assistance should be utilised.

Demolition by Hand

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.

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. 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

Demolition by machine

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. 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.

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.

Hydraulic Attachments

The following attachments may be used during demolition work.

- Impact hammer.
- Hydraulic shears.
- Pulveriser.
- Demolition pole.
- Grapple.
- Multi-purpose hydraulic attachments, e.g. interchangeable jaws.
- Demolition ball.
- Magnet.

Any attachments should be properly fitted to machines of adequate power and stability for the intended use.

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.

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 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. 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 BS 6187:2011.

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.

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. The extra loading caused by any temporary access ramps should also be taken into consideration.

Tower and other high-reach cranes

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. Tower cranes are designed for lifting freely-suspended loads and should not be used for balling operations.

Demolition by Wire Rope Pulling

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.

If the attempt to pull the structure over is unsuccessful the structure may be rendered unsafe. The process should then be re assessed and an alternative method of work developed and then used.

Cutting by drilling and sawing

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.

Bursting

Gas expansion bursters, hydraulic bursting and expanding demolition agents are technique’s to be used for the demolition of concrete, masonry or rock as an expanding device to force apart a mass fracturing the material and should be considered where environmental constraints such as the reduction of noise, dust and/or noise need to be taken into consideration. However, the noise and vibration created by drilling holes for inserting the grout or paste should also be considered.

Demolition by explosives

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.

Hot cutting

Hot cutting techniques include any methods that can potentially generate sufficient heat, e.g. in the form of incendive 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. 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 . 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.

Thermic lancing

Thermic lancing is used to cut through materials including concrete. The tip of the lance is preheated to start an oxygen/ion 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.

Metal powder cutting

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.

High-pressure water jetting

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 specialised and should be carried out by suitably competent people.in accordance with the Water Jetting Association’s Code of Practice.

STRUCTURAL DEMOLITION: PRINCIPLES, MECHANISMS AND HAZARDS

Progressive Demolition

Progressive demolition is 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 structure. The key structural members and their sequence of removal should be clearly identified in the method statement and on site. This method of demolition should be considered for most sites especially in confined or restricted areas.

Deliberate Collapse Mechanisms

Deliberate collapse is carried out by removing key structural members to cause the collapse of all, or part, of the structure. The key structural members and their sequence of removal should be clearly identified in the method statement and on site. This method should only be used on detached isolated and reasonably level sites where the whole structure is to be demolished. There should be sufficient space to enable all equipment and personnel to be removed to a safe distance.

Deliberate Removal of Elements

The deliberate removal of elements involves 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.

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.

Typical demolition methods for various types of structure

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 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

Buildings

The full or partial demolition of buildings should commence with the removal of hazardous materials, e.g. asbestos 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.

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.

Soft stripping work methods should take account of potential hazards from:

- Working at height, including the recovery of materials;
- Ineffective protection of voids; falling debris;
- “Booby traps” maliciously left to injure site personnel, such as used syringes taped under banisters or on top of kitchen units and doors, etc.;
- Restricted workspace; manual handling; and fire, if combustible debris is allowed to accumulate.

Concrete industrialised systems

Where a building has been constructed with an industrialised 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.

Post-tensioned structures

Independent precast units.

Units should generally be removed from structures before being broken up. Individual units may be demolished *in situ*, although this should be in a predetermined manner and with restraint provided to movement as appropriate. Separation of units, which can themselves be pre-stressed 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.

Progressively post-tensioned structures

As the loading and reaction effects on progressively post-tensioned structures are highly specialised, 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 pre-stressing forces can cause sudden and complete collapse with little or no warning.

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 de-stressing 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.

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.

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.

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.

Bridges

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). 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.

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.

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.

NOTE: Information on ‘The management of temporary works in the construction industry’ provided by the HSE should be consulted before any temporary works are considered.

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.

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.

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.

Masonry and brick arches

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

Dead load

Dead load may be removed provided that the stability of the main arch rings is not compromised. 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.

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.

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.

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.

INDEPENDENT CHIMNEYS

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.

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.

Deliberate collapse

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.

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 remove 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.

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. 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.

Lattice towers and masts

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.

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.

Controlled Collapse

This is normally undertaken by the use of explosives, pre-weakening or overturning and is the remit of licensed specialists.

When explosives are being used, very careful planning and control is required by persons experienced in this type of work. Blast protection is necessary in order to minimise damage and exclusion zones must be set up, including a buffer zone. No person may enter the demolition area until the “all clear” is given.

Pre-weakening of the structure may aid demolition or, conversely, the structure may require structural strengthening before demolition begins in order to enhance temporary stability.

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.

Demolition methods

The selected methods of demolition should minimise 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.

Vessels potentially containing flammable materials

The preparation and cleaning of plant that has contained flammable or combustible materials for internal inspection, hot work and demolition is a specialised activity. There is always the possibility that vessels can contain hazardous atmospheres. 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.

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.

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.

The decommissioning report 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**.**

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 by such procedures as:

- Steaming;
- Water or solvent washing/jetting;
- Other manual means; and
- “Gas-freed” by forced ventilation or another suitable method, with a “gas-free” certificate issued as appropriate.

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.

“Inerting” is the process of completely filling vessels with materials such as one of the following to replace previous gaseous contents.

- Water.
- Inert gas (nitrogen or possibly “combustion” gas).
- Carbon dioxide (from dry ice).
- Nitrogen foam (there are limitations to the use of air foam).
- Hydrophobic foam.

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 realise a specific purpose. Unless specified, it should not be assumed that the vessel is either suitable for entry and/or hot work.

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.

Vessels above or below ground

Vessels below ground should be removed, where practicable, by remote methods. Consideration should be given to cold cutting techniques, such as utilising 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.

Prior to excavation, any vessel below ground should be cleaned or made safe using the methods recommended previously. 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.

- Appropriate barriers should be placed around the work and hazard notices displayed.
- 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).
- A plentiful supply of water should be used to lessen the risk from sparking.

Before commencing removal and/or demolition of a vessel above ground the vessel should be prepared using an appropriate method 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.

VESSEL STRUCTURES

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.

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 stabilised 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.

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.

Temporary support should be considered to maintain structural stability as partially demolished tanks are susceptible to collapse, for example due to wind loading.

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, 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.

Basements and retaining walls

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. 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.

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.

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. The type of fill, degree of compaction and level required should be specified (in the design).

Spires

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.

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.

COMPLETION OF THE WORKS

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. 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 Principal Designer should ensure that the health and safety file has been prepared and handed to the client on completion of the works.

The Health and Safety file

The health and safety file should include the following information, as appropriate.

- Description of the works undertaken and site location details.
- Description of the site as is, including topographical details as necessary.
- Any known underground residual risks remaining, i.e ground conditions, buried objects, voids and chambers.
- Known service runs/locations and/or termination points in and around the site.
- Details of the structural principles and safe working loads for floors and roofs.
- Remaining proximity hazards for oncoming contractors or users of the site.
- Water courses, drainage or soakaways remaining.
- Safe access and egress points, boundaries and security concerns.
- 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 Principal Designer.

TRAINING AND COMPETENCIES

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.