John F Hunt

NFDC

National Federation of Demolition Contractors
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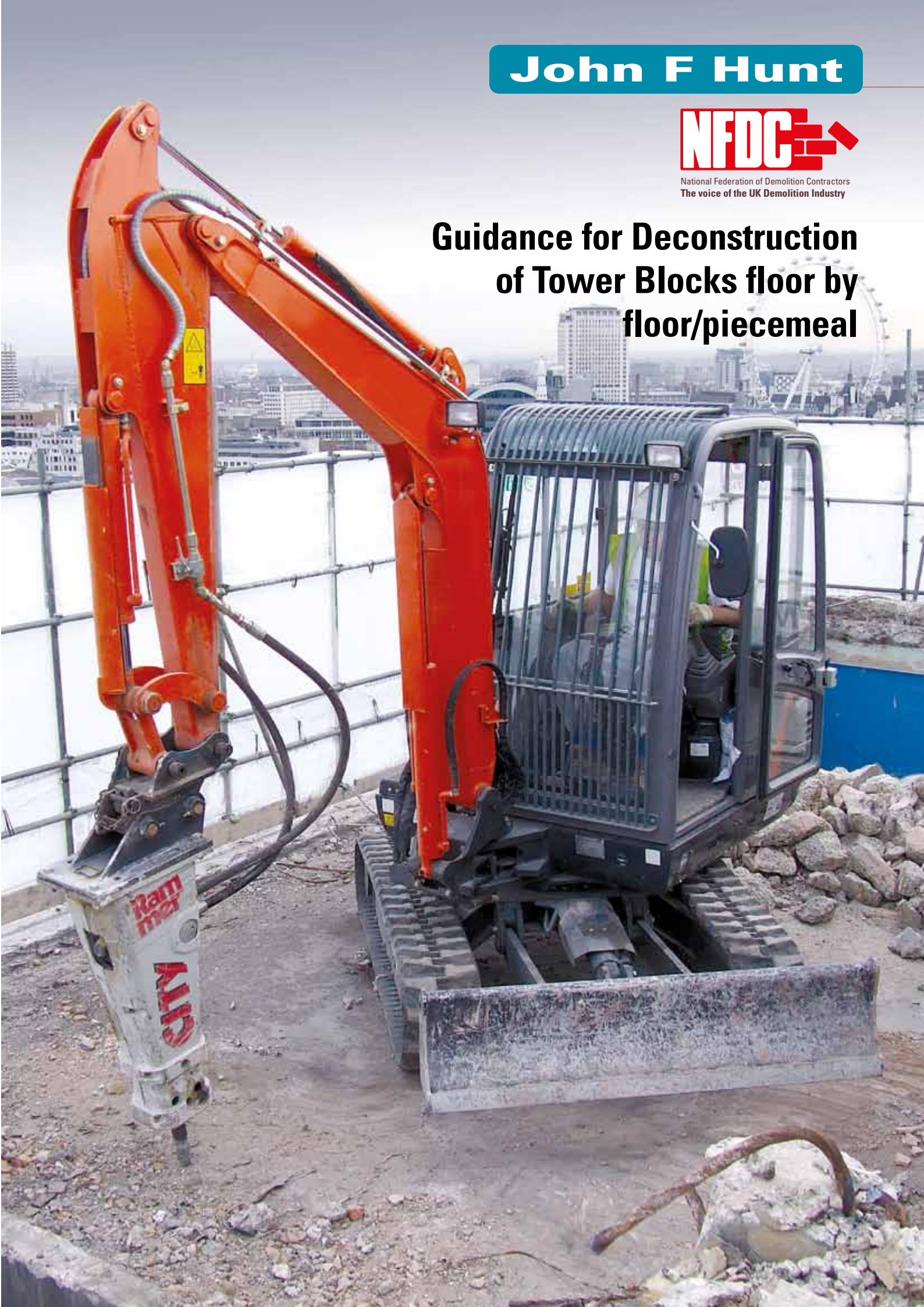
Guidance for Deconstruction of Tower Blocks floor by floor/piecemeal



Foreword

The National Federation of Demolition Contractors (NFDC) is represented on the British Standards Sub-Committee, which prepares the Code of Practice for Demolition [BS6187], and is, along with The Institute of Demolition Engineers, the voice of the UK demolition industry.

Founded in 1941 to help spearhead London's post-Blitz clear-up campaign, the NFDC's corporate members are responsible for more than 90% of all demolition that takes place in the UK.

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Today, the NFDC is committed to establishing safe working practices for its members, and to represent their interests in areas such as training, safety, the environment, waste management, industry guidance, legislative changes and relevant codes of practice.

As a result of growing concern, in respect of demolishing multi storey structures of 18 metres and above, the Federation has established a Sub-Committee to produce appropriate guidance for demolition methodology entailing the demolition and/or dismantling on a floor by floor/piece meal basis.

The Federation have previously published guidance for use of High Reach Demolition Rigs and will consider additional guidance for alternative methods of demolition in the future.

This guidance is aimed principally at Clients, CDM Co-ordinators and Contractors. However, it is considered the guidance will be of benefit to all parties involved in this type of activity.

The principles and procedures in the guidance notes are based on the practices recommended by the Demolition Code of Practice [BS6187] and Guidance Notes prepared by the Health and Safety Executive.

The National Federation of Demolition Contractors is very grateful for the assistance and advice given by the Health and Safety Executive in the preparation of this guidance.

The guidance is advisory, and it is based upon the combined practical experience of Members of the Sub-Committee during the past 30 years.

It is to be remembered that Clients, CDM Co-ordinators and Contractors, must be flexible in their approach in the light of all the circumstances including the many variations that can be encountered as a result of the design, construction and materials used in multi storey buildings. The guidance is not prescriptive and discretion in the application of the Demolition Code of Practice remains with those concerned with each specific project. Accordingly, neither the National Federation of Demolition Contractors nor the Members of the Drafting Sub-Committee, individually or collectively, accept any liability whatsoever for any loss, injury or damage howsoever caused to any property or person as a result of the deconstruction of any tower block, nor for any errors or omissions that the guidance may contain.

Details of further NFDC publications are available at www.demolition-nfdc.com or via:

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1.1 Scope of Guidance

- **Definitions**
- **Nature, applicability and status of guidance**
- **Limitations of good practice guidance**

The scope of this guidance is to define the roles, safe working practices and acceptable levels of control needed to carry out deconstruction/demolition of buildings over 18m.

As such, this document should be used purely as a guide to the works and is not intended to be a specific method statement and risk assessment for any particular works. A contract specific method statement and relevant risk assessment must be produced to take account of all of the issues raised within this document as well as the prevailing site, environmental and regulatory conditions including BS6187 Code of Practice for Demolition.

The guidance has sought to avoid being over prescriptive as this might limit the scope for innovation and the development of cost-effective solutions. Furthermore, this guide is an enabling document and does not form a code of practice. The guidance does not in any way limit the responsibilities and statutory duties of those parties involved in the design, specification and deconstruction/demolition processes.

This guide cannot deal with every eventuality and site condition. A formulation of good practice can only be of value where it is applied with careful planning, competent supervision, control and monitoring of the works under appropriate contractual arrangements. All stakeholders should exercise their own knowledge, experience and judgement in all matters.

Other methods that should be considered when choosing the appropriate demolition methodology include the use of high reach mechanical demolition techniques and the controlled use of explosives. These methods are covered in separate guidance and therefore will not be included in this document.

This guidance note has no specific recommendations on the type of structures that can or cannot be demolished using the methods described within this document.

1.2 Objectives of Guidance

- **Principal objective is to promote safety**
- **Secondary objectives include understanding of the risks and responsibilities in development of appropriate methodology.**

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The primary objective of this guide is to promote the health and safety of all involved during the deconstruction/demolition of buildings over 18m.

Compliance with all relevant legislation is essential with the appointment of experienced consultants, CDM Co-ordinators and contractors to carry out the works in accordance with the Construction (Design and Management) Regulations 2007 (CDM 2007).

High rise buildings vary in size, shape and construction. Together with the additional difficulty of location (e.g. remote or in high density areas) means each building must be individually assessed and the deconstruction/demolition methodology will therefore vary accordingly. These types of building present a high risk to health and safety and require a high level of competence to assess and understand the appropriate safe deconstruction/demolition method. Previous experience of dealing with these types of structures should be provided by appointed parties and advisors from the outset of a project.

It is recommended that only specialist demolition contractors who are able to demonstrate suitable technical competence and experience be involved with this type of work. The factors to be considered are;

- Previous proven experience in the type of work (size and type of structure)
- Experienced management (engineering and site teams)
- Sufficient resources (financial/management/operatives/plant and equipment)
- Companies training procedures
- Accident record statistics and enforcement history
- Appropriate demolition insurances

This guidance has been prepared to assist all parties in understanding safe working methods and the many variables faced when carrying out deconstruction/demolition of buildings over 18m.

1.3 Responsibilities

- **Parties involved in the selection of the deconstruction/demolition method of a multi storey structure**
- **Responsibilities to be defined**
- **Use of appropriately trained, qualified, competent personnel**

The Client (usually the building owner) has a duty to appoint a team of consultants one of which will be the CDM Co-ordinator. Demolition contractors can be appointed directly by the client or via a main contractor. The demolition contractor or the main contractor can also be the Principal Contractor.

It is important that contractual arrangements and the respective roles of the various parties should be clearly understood with the responsibilities and liabilities of all parties clearly defined and recorded in the relevant contract conditions. This guide does not extend or affect such responsibilities and liabilities.

Construction (Design & Management) Regulations 2007 (CDM2007)

These regulations provide a framework within which the management and co-ordination of health, safety and welfare is planned for all stages of a construction project, including design, construction, in service maintenance, alteration and demolition.

The Regulations apply to all demolition work and it is anticipated that the "Construction Phase Health and Safety Plan," developed by the Principal Contractor, will become the main tool in the planning and management of any demolition project.

The principle duties of each of the main parties named in these Regulations are summarised below:

- The client: should ensure that only competent people are appointed as CDM Co-ordinator and principal contractor. This also applies when making arrangements for the appointment of designers and other contractors. They should also ensure that sufficient resources, including time, will be allocated to enable the project to be carried out safely.

  Duties on clients do not apply to domestic householders when they have construction work carried out.
- The designer: should ensure that structures are designed to avoid, or where that is not possible to minimise, risks to health and safety while they are being built, maintained, used and eventually demolished Where risks cannot be avoided, adequate information should be provided to enable other designers, the CDM coordinator and contractors to be aware of those risks and to take account of them. Design will also include the preparation of specifications – it is not limited to drawings.
- The CDM co-ordinator: has overall responsibility for co-ordinating the health and safety aspects of the design and planning phase. They should identify and collect pre-construction information, advise the client on the suitability of the principal contactors construction phase health and safety plan and produce or update the health and safety file at the end of a project.
- The principal contractor: should take account of health and safety issues when preparing and presenting tenders, method statements, risk assessments or similar documents. The principal contractor also has to develop the construction phase health and safety plan and co-ordinate the activities of all contractors to ensure they comply with health and safety legislation and site rules. Principal contractors have duties to check on the provision of information and training for employees and for consulting with employees and the self-employed on health and safety issues relevant to the project.

1.3 Responsibilities (continued)

- Contractors and the self-employed: should co-operate with the principal contractor and provide relevant information on the health and safety risks created by their work or others and how they will be controlled. Contractors and the self employed also have duties to plan, manage and monitor their own work to make sure that workers under their control are safe from the start of their work on site. They should satisfy themselves that they and anyone they employ or engage are competent and adequately resourced.

1.4 Health & Safety Legislation

The deconstruction/demolition works must be carried out in accordance with all relevant and current legislation. As legislation is subject to change this guidance refers to current legislation at the time of printing. A summary of which can be found in Appendix "A".

Health and Safety Regulations, including the Health and Safety at Work etc Act 1974, Construction Design and Management Regulations 2007, Control of Asbestos Regulations 2006 and BS6187: in particular, apply to all aspects of demolition work and are recognised in the applied methodology within this guidance note.

2.1 Pre-Tender Planning

It is recommended that the following minimum level of information is included in any pre-tender stage health and safety information which the CDM Co-ordinator should ensure is prepared.

- Description of the works.
- Programme restraints and requirements.
- Contractual requirements.
- Contractor Pre-Qualification and Competence
- Details of Structure to be demolished
- Details of existing Services and Utilities
- Details of Previous Uses of the Building and Site
- Details of Asbestos and Other Hazardous Materials
- Details of Site Environment

2.1.1 Contractors Pre-Qualification and Competence

It is essential that works of this kind be undertaken by only competent and suitably experienced contractors and personnel.

Competent contractors must be able to demonstrate sufficient knowledge, skill, practical experience and training.

A competent person may be defined as:

'A person who can demonstrate sufficient knowledge, skill and practical experience and has received adequate and relative training.'

It is recommended that only specialist demolition contractors who are able to demonstrate suitable technical competence and experience be invited to tender for high rise deconstruction works.

Factors to be considered for pre-qualification include:

- Track record in successful planning and execution of work on the size and type of structure being considered.
- Experience and competence of contractors' design/management/site team.
- Accident record statistics and enforcement history.
- Commitment to and extent of management and operative training and maintenance.
- That full specific demolition, public and employers liability insurance cover is in place at all times.
- Policy should be free of restrictions such as work at height, as some insurance policies restrict the height a company can operate at
- Health and Safety Policy, it's monitoring and reviewing of procedures.

2.1.2 Details of Structure to be Demolished

Sufficient information should be provided to allow a contractor to develop a suitable demolition method. This should include:

- Original construction drawings that identify the structural form of the building, detailing the nature of the building frame, including any special forms of construction – e.g. cantilevered elements/pre-stressed/pre/post tensioned elements, type of roof and cladding systems.
- How overall structural stability is maintained [e.g. shear walls, braced bays and shear cores].
- Evidence of any gross structural defects in the building or known major alterations since construction.

2.1.3 Details of Existing Services and Utilities

All existing services should be clearly identified including building operation and maintenance manuals (O&M's) and;

- Electricity; underground cables, overhead lines, building supply, meters, ancillary equipment and transformer rooms.
- Gas mains and meters
- Oil and other fuel lines
- Hydraulic pressure mains and district heating systems
- Foul and storm water services including drainage
- Telecommunications equipment and fibre optic cables
- Radio and TV cables.

2.1.4 Details of Previous Uses of the buildings and site

- Identify any previous use of the building/site, that may indicate any existing hazards e.g. contamination, underground cellars or voids, tunnels or underpasses.
- Identify any previous use of the site, which may give rise to a physical or health hazard, influence selection of the demolition method or plant e.g. contamination of land, underground cellars or voids, tunnels or under passes.
- Identify the extent to which the facility has been decommissioned and request a copy of any decommissioning plan, which should itself be checked against the current state of the facility.
- Ordnance

Where potential ordnance hazards have been identified, sufficient investigations should be undertaken so that tenderer's can be suitably informed of the risks.

2.1.5 Details of Asbestos and other Hazardous Material

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Surveys should be carried out to identify hazardous materials, these may include, but are not limited to, the following;

Asbestos

- Lagging to pipes and boilers
- Fire insulation
- Wall boards and partitions
- Insulation under window sills
- Linings to ducts and airing cupboards.
- In room heaters
- Floor and ceiling tiles
- 'Dry riser' water pipes
- Insulation within curtain wall cladding

Hazardous Materials

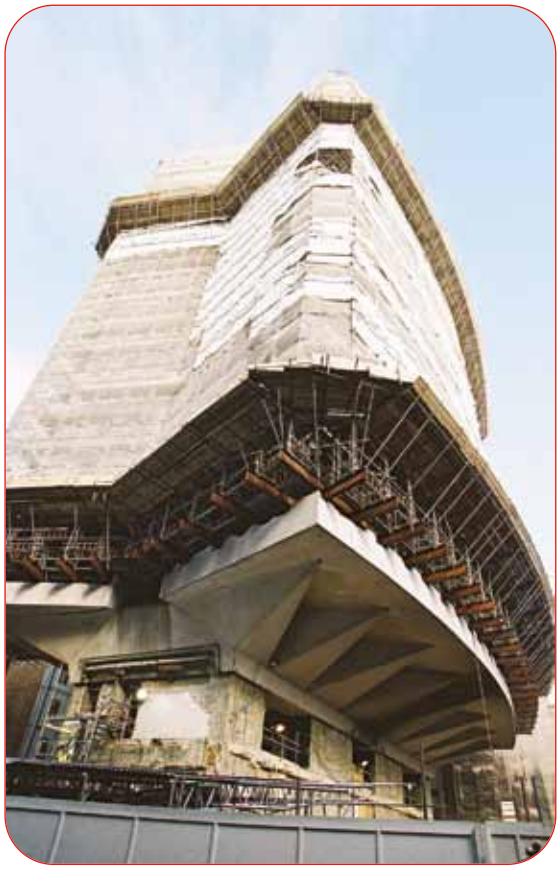
- Chlorofluorocarbon (CFC)
- Pentachlorophenol (PCP)
- Polychlorinated Biphenyls (PCB)
- Man made Mineral Fibre (MMMF)
- Fluorescent tubes & bulbs
- Lead paint

Others:

- Used syringes and hypodermic needles
- Pigeon droppings
- Rodent infestation
- Human excrement
- Contamination of air conditioning tanks – Legionnaires disease.
- Ozone depleting substances
- Emergency lighting systems (acid battery's) and smoke detectors (radioactive)

Any such hazards should be identified by survey. Only suitably trained and competent personnel should undertake this survey work which should be completed prior to any other investigations in order to minimise the risk of accidental exposure.

The removal of such materials should, where appropriate, be undertaken in advance of and in isolation from, any deconstruction operations, with adequate time allowed for removal.



2.1.6 Details of Site Environment

Sufficient information is to be provided to assist in the development of demolition methods which could include the following;

- Environmental Management Plan (EMP) to include details of adjoining/adjacent buildings, environmental requirements, working hours, noisy work restrictions, waste disposal requirements.
- Existence of flora, fauna and ecology and any requirements for their protection.
- Highways, transportation systems, watercourses and service runs.
- Crime and vandalism rates in the area, with instructions on minimum levels of security (hoardings, watchmen, etc) to be provided to ensure site security.
- Archaeological requirements.

2.2.1 Construction Safety Plan

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Under the CDM Regulations 2007 the principal contractor will be responsible for the development of the Construction Phase Plan.

The Plan will include comprehensive risk assessments together with detailed method statements and programme of works.

Prior to commencement on site adequate welfare facilities must be provided.

Dependant on the size and complexity of the project it is recommended that the contractor receive a minimum of six weeks lead in time.

2.2.2 Notification of the project

The HSE are required to be notified of the project works, via form F10, signed by the client. A copy of the F10 is required to be clearly displayed on site.

Other notifications will/may include;

Local Authority – Section 80(2) Notice and Section 81(2) response from the local authority Building/Demolition Warrant for Scotland.

Any adjoining/adjacent buildings will require notification under the Party Wall Etc Act legislation.

Other interested stakeholders may include;

- Utilities
- Police/Fire
- Underground/Rail Networks
- Environment Agency/Scottish Environment Protection Agency
- British Waterways
- Holders of Wayleaves
- Emergency Services
- Natural England and English Heritage

Further guidance may be obtained from the NFDC web site ‘clients guide’

2.2.3 Method Statements

Method statements should be prepared for all works following completion of an initial risk assessment and should form part of the Construction Phase Plan.

Method statements and risk assessments should be communicated to all site personnel as part of a structured induction process. Photographs, pictorials and drawings can also be an effective way of communicating the safe method of work to the site personnel.

It is imperative that all persons receiving an induction to safe working should acknowledge understanding of the whole process and that this communication is recorded and retained on site. No deviation from the method statement should occur unless such a change has been amended and agreed by the author or other authorised person.

Method statements should take into consideration all aspects described in section 2.2 of this guidance.

Effective means of communication with foreign workers must be implemented.

2.2.4 Training

The National Federation of Demolition Contractors strongly recommends that all demolition operatives engaged in work covered by these guidance notes should have, or be under training to obtain as appropriate.

i. CSCS/NDTG/CCDO Certificate of Competence - Demolition Operatives/Supervisors;

ii. CSCS/CPCS Certificate of Training Achievement – Plant Operatives;

iii. NDTG Cerificate of Training Achievement – Plant Operatives

iiii. NVQ Level 2/3 – Demolition

Induction training specific to that project must be given to all personnel before the commencement of work on site.

All demolition plant opertives should be trained and experienced, particularly with regard to the application of skid steer loaders and mini breakers working at height.

It is recommended that only trained and experienced operatives undertake demolition/deconstruction of high rise buildings.

2.2.5 Structural Survey/Temporary Propping and Shoring

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Structural survey and design works should be undertaken by a suitably qualified and experienced temporary works engineer and or an experienced structural engineer.

The survey will supplement, confirm and extend the information given at Pre-Tender stage and based on direct observation, testing and examination of existing drawings, it will be required to:

- Confirm the form of construction.
- Confirm the existing condition of the structure, including identification of vandalism, damage, corrosion, condition of special elements such as pre-stressed/post tensioned elements and changes to the structure during its lifetime
- Provide information on the floor loading, to include debris, plant and other, which may be safely carried by the existing structure so that any propping arrangements may be designed
- Confirm the size of all elements to determine craneage requirements.
- Provide sufficient information to ensure that the structural integrity of the building is maintained in order to prevent an unplanned collapse during the sequence of demolition.
- Provide information on the structural integrity of party walls to determine if structural support is required to those walls during the demolition.
- Core tests may be required by the structural engineer to provide information of the quality of concrete on the floors and walls as well as reinforcing arrangement.

Where assessment is required by a structural engineer for the design of a temporary propping and shoring system to the building floors and or walls it will be necessary to take account of the following;

- Plant and equipment loads on floors
- Debris loads on floors or against any wall, including perimeter.
- Arrangement of the structure and its safe load capacity.
- Changing structural form, i.e. from original load path design to one of temporary support, could affect the safe loading capacity of floors.
- The structure should be subject to continuous monitoring during the demolition process to ascertain that load transfer is occurring as designed and that vibration from the works is having no significant effect upon floors below the working floor or on neighbouring or adjacent properties.
- Where lift shafts are used for rubble removal, determination of the need to provide external support to the shear walls against bulging or fracture should be made by the structural engineer

The design programme should take into consideration:

- The form and condition of the structure.
- That due care is taken to ensure that no components are unsupported during or in advance of demolition/dismantling or deconstruction.
- The presence of post-tensioned concrete and the possible structural effects of cutting the stressing tendons e.g. ejection of tension bolts or anchor blocks

All design details should be passed to site in easily understood and clear form (e.g. annotated drawings) and a feed-back system must be established to ensure that any deviations found to any designs, plans and calculations are passed to the Structural Engineer so a reassessment can be undertaken.

2.2.6 Environmental Considerations

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The pre-tender information must be taken into consideration when assessing the environmental impact of deconstruction/demolition operations and in determining appropriate methodology.

It is recommended that effective public liaison is carried out with all those likely to be affected by the project prior to and throughout the works. Specific procedure may be outlined by the relevant Local Authority, Client or Main Contractor.

The Principal Contractor will develop the Site Environmental Management Plan (SEMP) which will normally include any specific environmental requirements of the local authority.

As well as the SEMP the Principal Contractor will produce a Site Waste Management Plan (SWMP) in accordance with current legislation.

The production of waste arisings should be controlled to separate at source the individual waste streams, with the intent of maximising recycling and reclamation opportunities

Due consideration should be given to traffic management (vehicle and pedestrian) and protection of the public for the project duration.

- Dust Control

  Provision should be made for an adequate supply of water and/or other appropriate measures for the suppression of dust arising from the works, particularly where local water pressure is low.

  Consideration should be given to the monitoring of dust emissions throughout the works.

- Noise Control

  Control measures should be put in place to reduce noise pollution which may affect the public and neighbours. These may include appropriate methodology and time limits on the use of plant and equipment.

  Consideration should be given to the monitoring of noise emissions throughout the works.

  Following noise assessments the correct personal ear protection must be provided to all site personnel who are affected by the works. Appropriate signage must be in place to alert personnel to the affected areas.

- Vibration Control

  Demolition methodology should consider vibration caused by the works and monitoring may be required.

  Risk assessment and personal monitoring is required for any persons exposed to vibration, on or above that recommended within the Control of Vibration at Work Regulations 2005, which could cause Hand Arm Vibration Syndrome or Whole Body Vibration Syndrome.

2.2.7 Asbestos and other Hazardous Materials

Prior to demolition a 'refurbishment and demolition' survey must be undertaken to identify all asbestos materials within the building. Asbestos materials will either be notifiable (requiring a licensed contractor) or non-notifiable (not requiring a licensed contractor). In all cases a method statement and plan of work is required by law and this must be specific and current. Where the asbestos is notifiable form ASB(5) must be completed by the licensed contractor and submitted to the HSE 14 days prior to commencement of any works.

Other hazardous materials may include chemicals, pigeon guano, PCB's, PCP's, gases in refrigeration and air conditioning systems (cfc's), lead and 2 pack paint and galvanised steel. Although these are not notifiable to the HSE appropriate safe systems of work and disposal must be prepared to deal with their removal.

This may also include health monitoring for persons directly involved in the operation e.g blood lead testing for operative hot cutting steel covered in lead based paints.

2.2.8 Services and Utilities

A survey should be undertaken where practical to:

- Verify the information given at Pre-Tender Stage.
- Physically check and locate the routes of all notified incoming services to the site.
- Physically, check that no unidentified services remain in the building or cross the site.
- Understand the sequences and time scales required to safely plan and programme the works (these may include notification and payment to the utility companies).

Any live services that are to remain should be accurately located, marked and protected or diverted as necessary.

Provision should also be made for temporary power supply to the site for the duration of the works.

2.2.9 Scaffolding and Protection

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Scaffolding and protection is a critical part of the deconstruction of high rise buildings. Careful consideration must be given to the following:

- Intended method of deconstruction. (Elevations requiring scaffold and the width of those scaffolds).
- Whether or not external access is required at each working level (e.g. to demolish external brick wall panels).
- The risk presented by falling debris to site personnel and the general public. should be controlled by ensuring the lifts are close boarded to prevent any debris falling down the face of the building. In addition, the installation of scaffold fans or protection gantries should be considered.
- Measures, which can be put in place to control dust and noise such as appropriate sheeting to the scaffold with acoustic treatments to reduce noise.
- Scaffolds may include emergency escape provision such as external ladder access to all levels.
- Provision of protection to exposed leading edges during partial demolition of sections to the building/structure.
- Provision of boarding up external openings in order to contain dust and debris.
- The design of exclusion zones to areas where large plant are operating is sufficient to allow the safe operation of that plant.
- Edge protection around openings created during demolition such as drop zones, well holes, lift shafts, stairwells and the like.
- All scaffolds should be designed by competent/qualified scaffold designers who will provide scaffold drawings and calculations. The design will incorporate suitable and sufficient ties back to the main structure in accordance with the current British and European Standards and legislation. It is recommended that demolition scaffolds should contain additional scaffold ties to ensure that the scaffold is always tied to the remaining structure during deconstruction/demolition process. This will require liaison, planning and co-ordination with the scaffold designer and installer. Should banners be required on the scaffold the scaffold designer is to confirm that the wind loading is acceptable.
- Where scaffold protection fans are used all boards should be securely fixed down and any materials on the fans should be cleared progressively.

The erection and dismantling of all scaffolds (including ladder access) should be carried out by a competent scaffolding contractor and will be subject to continuous inspection throughout the works. Scaffold tagging systems should be used.

In virtually all cases the Health and Safety risks, will dictate the use of scaffolding with sheeting prior to and during deconstruction/demolition. If a total enclosure of the scaffold is not to be employed, careful planning and execution of the works will be required to ensecure safe edge protection is fitted and effective at all times. Neither, personnel, tools, or materials should be at risk of falling.

In addition to guidance given by British Standards, the HSE, Professional Bodies and applicable Trade Associations for general scaffolding, the following points should be taken into consideration in the planning and design of demolition scaffolds on multi storey structures.

- Risks assessments should establish the necessity of Reinforced Plastic Sheeting or otherwise. It is considered best practice not to utilise debris netting at high levels on demolition projects, RPS that is airflow will alleviate some problems associated with high wind pressures. Standard RPS may be used at lower levels to lessen the spread of dust and debris. In all cases the RPS must be overlapped to ensure debris containment. All aspects of design must be supported by drawings and calculations, which are clearly understood by site personnel.
- If reinforced plastic sheeting RPS or tarpaulins etc. are used at higher levels it will subject the scaffold to wind loading. Therefore the scaffold design must take account of this factor.
- Provision should be made on scaffold platforms to prevent small sized debris from falling to lower levels.
- Flame retardant RPS is available, and should be used where hot cutting is employed.
- Protection of personnel and the public at ground level and of personnel at heights must be a priority. External, independent tied, tube and fitting scaffolding is preferred and will provide safe access for breaking out joints between pre-cast wall units, external brick wall panels and a safe means of supporting protective screens.
- A systematic and safe programme for dismantling the scaffold should be arranged to coincide with removal of the structure being dismantled. A maximum of 2 lifts should remain above the floor being removed.
- Guardrails and toe boards should protect all openings and edges, including those which are created at stairs, floors and lift shafts.
- Where it is not possible for all or any of the requirements for guardrails or toe boards, other forms of protection will be needed.
- Where lift shafts are used for tipping materials, further substantial protection should be provided when using mechanical methods. The bottom of the lift shaft should be regularly cleared to prevent lateral pressure against the shaft walls.

  An exclusion zone should be maintained during tipping activities and clearly indicated in the method statement. A safe working system must be implemented for personnel undertaking the clearance of debris at the bottom of the lift shaft.

2.2.10 Selection and Use of Cranes

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Crane types can vary from telescopic, crawler and tower and a project may require the use of more than one type of crane. All craneage works are subject to LOLER Regulations and as such all lifts have to be planned and the lift plan produced by a suitably qualified Appointed Person. All slinging must be carried out by trained, competent and authorised slingers experienced in the type of lifting operation required. Emergency procedures must be in place prior to any lift taking place.

Crane selection will take account of the location, lifting radii, size and centre of gravity of the load, adjacent buildings, proximity hazards and others. It is recommended that crane specialists are consulted during this process.

Where tower cranes are used the base of the crane should be designed by a structural engineer and constructed to the engineer's specifications to ensure stability of the crane at all times. On no account should old tower crane bases be used unless they have been checked and approved by a structural engineer.

Where telescopic and crawler cranes are used the ground conditions must be suitable to remain stable during the works. This may include designed extra strengthening to distribute the load which must be checked by a structural engineer. Particular consideration must be given to underground services, voids, basements and the like.

Consideration must be given to the lifting capacity of the crane to prevent potential overturn and collapse. Account must be given to the lifting hook and chain etc as this must be included in the weight to be lifted.

The height of the crane must allow for the safe clearance of loads over the structure and scaffolding above the working floor level and the clearance for slings/chains etc beneath the hook.

Restrictions should be placed on jib lengths to prevent loads being moved over public highways or adjacent properties. Effective communication between crane driver and the slinger/signaller is imperative and it is recommended that a dedicated crane co-ordinator is employed. Handset radio communication is recommended in preference to hand signals.

Where more than one crane is employed it is essential that co-ordination is established and monitored to avoid crane collision.

All cranes and associated equipment are subject to regular inspection and testing in accordance with the manufacturers recommendations and UK workplace regulations.

When cranes are not in use suitable measures must be taken to prevent any unauthorised access.

When cutting and lifting during demolition the centre of gravity must be correctly ascertained and the weight of the item to be lifted must be within the lifting capacity of the crane. To prevent overturn and collapse of the crane it is considered reasonably practicable to allow spare capacity when lifting to allow for errors in underestimating weights. An estimated weight and the actual weight could be some way apart.

Therefore it must be recognised that if there is an element of doubt a factor of safety of twice the estimated load should be allowed for all lifts. Account must also be made for the lifting hook and chain weight etc.

It is important to establish the position of cranes to ensure safe working loads are not exceeded. Frequently, tower cranes are preferred for work on high rise buildings particularly in urban and confined city areas.

2.2.11 Schedule of Conditions/Dilapidation Survey

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It is recommended that pre-contract and post-contract conditions/dilapidation surveys are commissioned on the immediate adjacent properties, roads, pavements and haul routes. These may be distributed to the Local Authority Highways Officers, party wall surveyors or other relevant parties.

2.2.12 Protection of the Public from Nuisance

Attention should be paid to adjacent/adjoining buildings and their uses, as it is necessary to provide protection against nuisance and damage to these buildings during demolition and dismantling. Due consideration must be given to pedestrians beneath scaffolding in city centre locations and allowance must be made for temporary hoardings, diversion routes, ramps, lighting etc.

2.2.13 Site Security

Site security must be considered on an individual basis and is subject to risk assessment. The following aspects are recommended to be considered:

- Site Boundary. Unless the site is secured by existing structures e.g. boundary walls. Secure fencing/hoarding not less than 2 metres high is generally required. The fencing/hoarding should enclose all demolition/dismantling operations with appropriate secure entrances to prevent unauthorised entry to the site. Suitable statutory safety signs and notices must be prominently displayed. In addition, it is prudent to consider the following;
- Security of building/structure out of working hours.
- Provision of security personnel included out of hours.
- Entrance gate(s) security.
- Reporting arrangements for visitors.
- Immobilising plant when not in use.
- Provision of CCTV.
- Prevention of unauthorised access to tower cranes hoists and other plant.
- Scaffold alarm systems.
- Site lighting.

2.2.14 Exclusion Zone

Exclusion zones should be established on site to ensure the public and personnel are protected from falling debris. There may be several changes to the exclusion zones as work progresses which will form part of the detailed method statement for the works.

An exclusion zone should be established around the structure: this is the space encompassing the demolition/dismantling activity from which all persons, except essential persons directly involved in the demolition, are to be excluded. The size of the area will depend on the method selected, the risk of collapse and the risk posed by falling debris in relation to the predicted debris area. This last point may be of particular importance where a sheeted scaffold enclosure is not to be used.

2.2.15 Access and Egress

Safe access/egress should always be maintained, using the existing facilities whenever possible. Materials should not impede safe access and egress to all floor levels, including the floor being dismantled. An alternative safe means of access and egress must be maintained at all times for emergency use. A traffic management plan must be created to ensure that pedestrians and moving plant and vehicles are segregated throughout the works. Means of emergency escape from working areas to a safe point should be kept clear of materials progressively.

2.2.16 Fire Plan

Precautions should be taken to prevent the risk of fire and explosion caused by gas, combustible dust or vapour. The following items should be considered by the contractor and appropriate emergency procedures established and included in the Health and Safety Plan:

- Establish fire assembly points and escape routes.
- Provision of fire fighting equipment at critical locations (appropriate number and type of fire extinguishers inc' maintenance regime)
- Adequately trained personnel.
- Means of raising alarm.
- Evacuation plan.
- Establish correct hot work procedures including a permit to work system
- Provision of a dedicated mains water supply where possible.
- Maintenance of the high rise water supply during any prolonged period of cutting with gas/oxygen cutting equipment.
- Provision for early removal of flammable material.
- Falling sparks, from hot cutting, to floors below and onto debris sheeting
- Floors with little or no natural light may require emergency lighting.
- Materials likely to release toxic fumes in a fire should not be overlooked.

These plans would be brought to the attention of all persons on site via site induction and or toolbox talks and must be clearly displayed on site. Directions to the nearest Hospital A&E Department should be displayed on the site notice board.

2.2.17 Weather

It may be necessary to consider the possible effects of seasonal weather when planning the works. Risk Assessment should take this into consideration.

For example

- Wind speed and direction for lifting operations
- Inclement weather for personnel working outside and/or at height
- Wind loading on scaffolding when fixed with protective sheeting
- Fog for visibility
- Dust and small particles picked up by high winds and deposited onto adjacent occupied site areas.

3.1 Large Panel System

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Buildings over 18m are generally deconstructed on a floor by floor process down to a height where conventional demolition plant can safely reach and demolish the lower floors.

The deconstruction procedures given have been divided into two sections, approximating to the two broad categories of structure encountered. These are:

a) Large Panel System precast concrete structures.

b) Framed System (steelwork or reinforced concrete) with infill panels of brickwork, blockwork or 'no fines' concrete, precast concrete cladding.

It is essential that the chosen method of deconstruction is appropriate to the type of construction and location of the structure and suitable exclusion zones designed and maintained in all cases.

3.1.1 General

The use of large precast concrete wall and floor units were employed in the construction of high rise buildings during the 1960's and 1970's. The system was particularly prevalent in high rise blocks designed for domestic dwelling developments. This type of construction used the reinforcement in the connections and cross walls for framing support. The structures were built on a floor by floor basis and assembled using appropriate craneage. Shear loadings were applied via the reinforced in-situ concrete stairs and lift cores. Structural integrity depended upon the panels being joined and secured by bolted and concrete grout infill connections which, over the years, have been found to be inconsistent in terms of quality and must not be relied upon during deconstruction/demolition.

The process of floor by floor erection entailed lifting each unit by the in-built lifting eyes and bolts. Propping of wall panels was necessary to stabilise them in position before bolting and infilling with concrete was completed.

The simple multi-box structure was brought under official and professional engineering scrutiny by the collapse of a high rise block at Ronan Point, London. A local gas explosion, within one of the flats, blew out the walls of the flat thus removing support for the upper storeys causing a progressive collapse. As a result of the ensuing enquiry, many similar buildings were structurally reinforced but some have remained unaltered. Information regarding any such reinforcing on subsequent projects of this nature will need to be ascertained before work commences.

Numerous serious accidents occurred during the erection of the structures of which three causes in particular have been identified. The prime cause of injuries was as a result of persons falling from edges where guard rails and toe board protection were non existant. The second largest cause was a failure of the propping systems either through insufficient props or the inadequacy of their fixings. The third largest cause was a failure of the various components of lifting equipment, including the lifting eyes which were built into the panels.

When, floor by floor dismantling procedures are adopted, the afore mentioned factors will clearly need to be addressed within the safety method statement to describe the process needed to prevent accidents occurring.

In general, the original lifting eyes and bolts are likely to be damaged or corroded and should be considered unsuitable for re-use. In addition, it is unlikely that any of the original drawings detailing these lifting points will be available for examination. Therefore, design and positioning of new lifting points will be necessary for panel removal.

It is important that an accurate assessment of the weight of all component panels and of the design of their reinforcement is necessary to ensure that the design of any lifting equipment and crane capacity is adequate for the task.

3.1.2 Temporary Works/ Propping

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The arrangement and design of propping for lateral support must take into account the floor panels. The latter require support during pneumatic breaking out from their wall supports. Similarly, each wall panel should have a minimum of two points of propping to prevent sudden collapse by twisting or buckling. The props and fixings for wall units must be capable of resisting push/pull forces, which occur during breaking out. Diagonal props to wall panels are particularly advantageous.

The proposed floor loading calculations by a structural engineer should take into account the loading likely to be imposed by plant equipment and demolition debris and it is recommended that back propping be provided as appropriate.

Where there is uncertainty regarding the structural integrity of the floor and walls immediately below the operational level, it is recommended that at least two or more floor levels should be propped (structural engineer to advise). During the breaking back of the upper floor level, edge protection for the prevention of falls will need to be considered. The work should be planned in such a manner that no “free” walls are left standing. Where this is not practical or possible, additional propping should be provided to ensure stability for prolonged periods or overnight.

3.1.3 Sequence

One complete storey should be removed at a time if and where possible. However, there may be occasions when the floor removal will need to be staggered to aid demolition. All work at that level should be completed before moving on to the next. This will certainly apply to all precast elements. Where cast in-situ areas are established, such as stair and lift cores, the order of work must be arranged to ensure that edge barriers are maintained around the areas at floor levels under demolition. Typically, works to ready the panels for lifting using mini demolition plant will involve the following;

- Remove roof
- Chase panels to free holding bolts
- Forming holes for lifting

The practice of lifting concrete walls and floor panels by slings and the positioning of lifting points should be carefully considered in relation to the original design of the lifting points. The old lifting points should not be used as their integrity cannot be guaranteed. The exact positioning of the new lifting points in the panels and the method of slinging should be clearly shown in the safety method statement. Particular attention should be paid to panels, which have door or window openings.

- Installation of push/pull ropes or diagonal braces to vertical panels prior to chasing of joints
- Removal of panels in sequence working towards the stair/lift core (edge protection must be provided in these areas)

It is recommended that all structural demolition, so far as is reasonably practicable, should be carried out by demolition machines working adjacent to the floor being demolished and with a demarcation line clearly marked.

- Removal of complete floor and repeat the process down to the required level.

Areas of floor remote from the cores, at the next level below, may commence whilst work on the ‘in situ’ elements above is being carried out to completion.

3.2 Framed Systems

3.2.1 General

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Framed systems can be constructed of steel or reinforced concrete. These may have infill panels of brickwork, blockwork, no fines concrete or pre-cast concrete cladding.

Stability depends upon individual elements consisting of steel or concrete beams and columns with fixed end connections. Concrete beam and columns may be pre-tensioned, connected either by pre-stressing steel or structurally bolted/welded connections.

Alternatively, the design may depend upon a concrete or steel core in the centre of the building. Structural beams extend from the core to the external columns. The core incorporates lift shafts, staircases and service risers. Floor construction and external cladding will vary in their design.

Floors can be of in situ reinforced concrete, infill clinker, hollow pot, composite units or precast concrete units with concrete infill at joints.

External walls usually consist of infill curtain walling systems. Less frequently, they consist of concrete panels with window openings incorporated. Occasionally, some may be of low-density (no fines) concrete or infill brickwork.

3.2.2 Sequence

- Remove the roof
- Removal of cladding
- Divide the structure into panels/sections dependant on the lift capacity of the crane(s) and the supporting structural design of the building. If the survey reveals a need for propping, the system should be designated to support and secure the perimeter floor beams. In the case of flat slab construction a strip of slab should be left in place to maintain the stability of the perimeter wall panels below.

  Where external masonry panels have been used these should be removed ahead of the floor removal. Operatives working from the safety of the scaffold should demolish them from top down, course by course depositing the debris on the adjacent floor.
- Cut the floor in panels, working towards the core, in a pre-determined cut sequence away from the floor area being broken out. Where the crane is to be employed to lift these sections clear, each panel should be suspended from a crane before exposing and cutting the reinforcement. After cutting the reinforcement, the panel can be lifted and removed to a designated drop area for breaking. Rubble arisings on the floor below should be cleared progressively to keep the areas clear and avoid a build up.
- Rollover (dropping to next level down) propping of floors must be competed before any heavy plant is transferred to the next level. Loose debris arising from demolition should be removed via the drop zones or by skips lowered by crane.
- Operatives working from access scaffolds will generally demolish perimeter brickwork panels by hand. All debris should be directed inwards onto the floor for subsequent removal.
- Columns and beams should be removed in a predetermined sequence.
- Beams should be suspended from a crane, preferably at two third points along their length, before breaking away the ends from column node points and cutting the reinforcement. After cutting the reinforcement, the beam can be lifted and lowered to a designated drop area for breaking.
- Columns should be removed in predetermined sequence together with the beam removal. It is important to note that before exposing any column reinforcement, the columns must be attached to the crane to prevent collapse. After cutting the reinforcement the column can be lifted and lowered to a designated drop area for breaking.
- All debris should be cleared progressively to prevent a build up of excessive loads on floors and lateral pressure on walls. Where risers or lift shafts are used to deposit rubble down, containment in lower floors must be provided and exclusion zones determined and set up at each floor level (lift shaft doors openings should be sealed where possible).
- Remove core and repeat process down to the required level.

3.3 Demolition of Lower Storeys

Demolition of the lower storeys of the structure will usually be carried out by mechanical means. The level at which the change to mechanical demolition takes place will be based on an assessment of:

- The reach, capacity and operating limitations of the plant proposed. (See NFDC guidance on use of high reach demolition rigs).
- The exclusion zone required for safe containment of debris.
- The proximity of any live or occupied areas around the site previously protected by the scaffold system. The contractor must also demonstrate an ability to adequately control dust emissions.

3.4 Plant and Equipment

The following are indicative of the common items of plant and equipment used for demolition/dismantling of high rise structures;

- Mini demolition machines (including remote controlled)
- Large demolition machines
- Skid steer loaders
- Cranes (tower, luffing, crawler and mobile)
- Compressors (breakers, drills etc)
- Generators (lighting, small tools power etc)

This equipment should only be operated in accordance with the manufacturers recommendations, by trained and competent operators experienced in demolition operations.

It is essential that plant and equipment is carefully selected, of suitable size when working on the floors and is suitable for the nature of work to be carried out. The appropriate PPE and RPE should be worn by all operatives. Careful consideration should be given to live loads placed on the structure during the deconstruction process, particularly where floor integrity may be affected by the induced weight and movement of plant and machinery. An appropriate risk assessment must be undertaken before work commences. Control measures put into place as a result of any risk assessment process must be monitored regularly for their continued effectiveness.

3.4.1 Cranes Generally

The choice of cranes available to dismantle any high structure is wide. The shape, height and design of the structure, site constraints and economics ultimately drive the decision on the use of a particular type. All crane operations used in the deconstruction should be controlled by a crane coordinator working with an experienced banksmen and slinger. The transfer of plant from floor to floor should be undertaken by crane or prefabricated ramps, that a competent engineer has approved the design of. The use of ramps constructed by debris is not considered best practice.

3.4.2 Tower Cranes

Stationary and rail mounted tower cranes offer the greatest control when dismantling. The operator can usually see the load being lifted and can react to hand signals as well as radio directions. The choice of jib type, either luffing, swan neck or conventional saddle may be decided by site constraints or contractor preference. Wherever possible, it is recommended that the lowering/set down area be in clear view of the crane operator at all times. The estimated maximum loads and radii to be encountered should be calculated and considered when specifying the suitability of any crane.

One of the most important factors to be considered in the selection of tower cranes is the construction of the building and whether it is capable of offering any support to the mast of the tower crane. It is generally recommended that cranes should not be tied into a structure but it is accepted that in some cases there may be no alternative.

A structural engineer should be employed to produce a suitable foundation design for the tower crane. Old tower crane bases, used to construct the building, should not be used to support further cranes for the demolition element.

The tower crane will usually be powered by 3 phase electricity and sufficient time should be allowed to obtain this supply from the electricity suppliers or a suitably sized generator will be required.

3.4.3 Crawler/Mobile Cranes

Conventional or tower rigged crawler cranes are extremely flexible where site conditions permit. However, it is considered that they may be less appropriate for deconstruction of tower blocks. Any crane working at the base of any structure should have a Falling Object Protection System (FOPS) Cab.

3.4.4 360° Mini Demolition Machines

Mini demolition machines equipped with hydraulic breakers or shears are generally the most widely accepted item of plant utilised when dismantling any high-rise structure employing the floor-by-floor method. Pulverizing attachments mounted on mini machines can be useful where noise restrictions apply, but can be relatively slower in operation than the mini/hydraulic breaker combination. The weight and use of any such equipment will be determined by the calculated floor loadings of the structure.

Remote controlled demolition machines, equipped with breakers or shears, are used extensively in work of this type as they generally have a greater break out force than a comparable mini excavator of the same weight. They also have an ability to remove the operator from the immediate vicinity of the machine and work face, thus reducing the risk to the operator.

Adequate and usually extensive back propping of floors immediately below the working level will enable the use of larger equipment, but such methods must be supported by the necessary calculations (See Propping).

3.4.5 Skid Steer Loaders

The permissible size of such equipment is again dependent upon the structure to be demolished and the necessary back propping. Skid steers are used to clear broken debris from floors, either into skips, purpose made discharge chutes or existing discharge chutes, e.g. lift shafts etc. The means to prevent machines falling over a leading edge or into discharge chutes must be addressed. Baulk timbers on the floor together with hand rails or purpose made steel frames with handrail are two such systems.

3.4.6 Pneumatic Breakers

These types of hand held tool are generally used when working from external scaffolds and at particularly difficult locations. Consideration should be given to ensure the appropriate weight of breaker is employed for the task being undertaken. Breaker types should be assessed for their ability to reduce exposure to Hand Arm and Whole Body Vibration to the user.

3.4.7 360° Demolition Machines

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Excavators equipped with specialised attachments and buckets are generally used to process and load away the resultant materials. They work at the base of tower blocks outside of and within the working radius of the crane. They should be equipped with ROPS (roll over protective structure) and FOPS (falling object protective structure) with FOGS (falling object guard system) cab screen guard. The excavator may also be employed to work alongside a crushing unit to process the aggregate arisings into a recyclable and re-usable secondary material.

4.1 Acts of Parliament

This Section lists the principle legislation, British and European standards applicable to demolition operations as this document went to press. It is recommended that contractors ensure they are aware of any updates that may have followed publication on this document. More detailed information on key issues regarding health and safety legislation for persons planning demolition work can be found in the Health & Safety Executive's (HSG150) Health and Safety in Construction guidance.

Health and Safety at Work etc Act 1974

Environmental Protection Act 1990

4.2 Regulations

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Control of Asbestos Regulations 2006

Control of Lead at Work Regulations 2002

Control of Noise at Work Regulations 2005

Control of Substances Hazardous to Health Regulations 2002

Control of Vibration at Work Regulations 2005

Construction (Design & Management) Regulations 2007 and Approved Code of Practice

Construction (Head protection) Regulations 1989

Electricity at Work Regulations 1989

Environmental Permitting (England & Wales) Regulations 2010

Environmental Protection (Duty of Care) Regulations 1991

Hazardous Waste Regulations 2005

Health and Safety (Consultation with Employees) Regulations 1996

Health and Safety (First Aid) Regulations 1981

Lifting Operations and Lifting Equipment Regulations 1998

Management of Health & Safety at Work (Amendment) Regulations 2006

Manual Handling Operations Regulations 1992

Notification of Conventional Tower Cranes Regulations SI 2010 No. 333 & 811

Personal Protective Equipment at Work Regulations 1992

Provision & Use of Work Equipment Regulations 1998

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

Special Waste Amendement (Scotland) Regulations 2004

Waste Management Licensing Regulations 1994

Work at Height Regulations 2005

Workplace (Health, Safety and Welfare) Regulations 1992

4.2 British and European Standards

BS EN 12811 – Temporary Works Equipment

Part 1 –Scaffolds, Performance requirements and general design (2003)

Part 2 – Information on materials (2004)

Part 3 – Load testing (2002)

TG20:08 Technical Scaffolding Guidance

BS6187 Code of Practice for Demolition (2011)

BS5974 Code of Practice for temporarily installed scaffold and access equipment (2010)

BS7121 Code of Practice for safe use of cranes: Part 1 – General (1989);

Part 2 Inspection, testing and examination (2007)

BS7212 Code of Practice for safe use of construction hoists (2006)

BS7375 Code of Practice for Distribution of Electricity on Construction sites (2010)

BS8411 Code of Practice for the use of safety nets etc. (2007)

BS5975 Code of Practice for Temporary Work Procedures and the Permissable Stress Design of Falsework (2008)

BS5228 Control of Noise and Vibration on Construction and Open Sites (2009)

These lists are not exhaustive.

Construction Phase Health and Safety Plan Check List

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- Scope of works
- Description of existing structures with existing drawings
- Site welfare arrangements
- Sequence of works
- Setting up sites and site security
- External scaffolding and calculations
- Details of cranes, plant and equipment
- Asbestos and other hazardous material survey and removal
- Storage of gases for hot work
- Safety requirements, including Risk and COSHH assessments and resultant Safety Method Statement to cover:-
- Removal of non-load bearing elements and fixtures and fittings
- Removal of roof structures
- Removal of existing lift cars
- Removal of partition walls
- Temporary propping of walls panels and columns
- Removal of external walls
- Removal of floors and propping requirements for plant and debris loads

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