HEALTH AND SAFETY IN EMPLOYMENT ACT 1992

Approved Code of Practice for
DEMOLITION

OCCUPATIONAL SAFETY & HEALTH SERVICE

DEPARTMENT OF LABOUR
TE TARI MAHI

ISSUED AND APPROVED BY THE MINISTER OF LABOUR SEPTEMBER 1994

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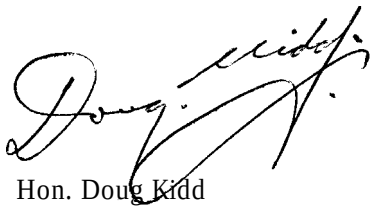
NOTICE OF ISSUE

I have issued this *Approved Code of Practice for Demolition,* being a statement of preferred work practices or arrangements for the purpose of ensuring the health and safety of persons to which this code applies and persons who may be affected by the activities covered by this code.

J. M. Chetwin
Secretary of Labour
September 1994

FOREWORD

I have approved this statement of preferred work practices, which is an *Approved Code of Practice for Demolition,* under section 20 of the Health and Safety in Employment Act 1992. When a code is approved, a Court may have regard to it in relation to compliance with the relevant sections of the Health and Safety in Employment Act. This means that if an employer in an industry or using a process to which an approved code applies can show compliance with that code in all matters it covers, a Court may consider this to be compliance with the provisions of the Act to which the code relates.



Hon. Doug Kidd
Minister of Labour
September 1994

1. INTRODUCTION AND LEGISLATIVE REQUIREMENTS

This code of practice has been prepared to inform employers and employees of precautions and safe practices that should be followed when carrying out demolition work.

It is hoped that the safe practices recommended will be a useful aid to those involved in demolition, to avoid the potential hazards associated with the work.

Additional information about demolition can be found in British Standard BS 6187:1982 *Code of practice for demolition* or in Australian Standard 2601:1983 *SAA Demolition code*, or in other references listed in Appendix C.

Legislation controlling demolition work includes the Building Act 1991, the Health and Safety in Employment Act 1992, the Resource Management Act 1991 and the Historic Places Act 1980.

1.1 THE BUILDING ACT 1991

The Building Act has several purposes (see section 6 of that Act), some of which affect demolition work, including:

(a) The necessary controls relating to building work and the use of buildings.

(b) Safeguarding people from possible injury, illness, or loss of amenity in the use of any building.

(c) Providing for the protection of other property from physical damage resulting from the construction, use and demolition of any building.

All buildings to be demolished require a Building Consent issued by the Territorial Authority. (See sections 32 to 35.) In addition, regulations have been promulgated describing procedures for regulating and controlling construction and demolition of buildings. (Refer sections 48 to 50.)

Before issuing a Building Consent, the Territorial Authority will require a demolition plan and method statement. The application for a Building Consent must contain provisions for the protection of the public, including suppression of dust, disposal of debris, disconnection from public utilities, suppression of noise, and protective structures and fencing.

1.1.2 THE BUILDING REGULATIONS

The Building Code is the First Schedule to the Building Regulations 1992. Clause F5.2 of the Building Code requires that building and demolition work be performed in a manner that avoids the likelihood of:

(a) Objects falling onto people on or off the site;

(b) Objects falling on property off the site;

(c) Other hazards arising on the site affecting people off the site and other property;

(d) Unauthorised entry of children to hazards on the site.

Clause F5.3.1 requires that suitable construction methods be used to avoid the likelihood of tools or materials falling onto places where people may be present. Clause F5.3.2 requires clearly marked barriers of appropriate height and construction, that are difficult to climb and that only have openings as approved by the Territorial Authority, be provided where construction or demolition work presents a hazard in places where the public has access. Clause F5.3.3 requires that where a site contains hazards that might attract children, the hazard be enclosed to restrict access by children. Clause F5.3.4 requires suitable barriers to provide a safe route for public access where lifting equipment creates a risk from objects falling or where a similar risk occurs.

(Note: Users of this code should consult the Building Act, Building Regulations or Building Code for the most current requirements.)

1.1.3 ACCEPTABLE SOLUTIONS

The Territorial Authority may require the demolition contractor to put in place various precautions to ensure compliance with the Building Regulations. The document F5/AS1 (of the Building Code) provides solutions that demolition contractors may adopt, including fencing, gantries, and hoardings, depending on the hazards that may arise during the demolition work. (Note that even though a Territorial Authority may not initially require protection on the work, an Occupational Safety and Health inspector may issue a prohibition notice to stop the work until the inspector is satisfied that the hazard has been eliminated. The inspector may notify the Territorial Authority of hazards arising due to inadequate protection for the public from the demolition works.)

Territorial Authorities may also impose conditions to control other hazards. Such conditions may include traffic management systems, hours of work, lighting, dust and noise control. Such controls may be placed under legislation such as the Resource Management Act.

1.2 A SUMMARY OF THE HEALTH AND SAFETY IN EMPLOYMENT ACT 1992

The principal object of the Health and Safety in Employment Act 1992 (HSE Act) is to prevent harm to employees at work. To do this, it imposes duties on employers, employees, principals and others, and promotes excellent health and safety management by employers. It also provides for the making of regulations and codes of practice.

1.2.1 REGULATIONS

Regulations are promulgated from time to time under the HSE Act. Regulations may, among other things, impose duties on employers, employees, designers, manufacturers, and others relating to health and safety. These regulations may apply with respect to places of work, plant, processes or substances and may deal with particular problems that have arisen. Under the Health and Safety in Employment (Construction) Regulations (yet to be promulgated), it is expected that demolition works will be notifiable to the Occupational Safety and Health Service of the Department of Labour.

1.2.2 APPROVED CODES OF PRACTICE

"Approved Codes of Practice" are provided for in the HSE Act. They are statements of preferred work practice or arrangements, and may include procedures which could be taken into account when deciding on the practicable steps to be taken. Compliance with codes of practice is not mandatory. However, they may be used as evidence of good practice in court.

1.2.3 EMPLOYERS' DUTIES

Employers have the most duties to ensure the health and safety of employees.

Employers have a general duty to take all practicable steps to ensure the safety of employees while at work. In particular, they are required to take all practicable steps to:

(a) Provide and maintain a safe working environment;

(b) Provide and maintain facilities for the safety and health of employees at work;

(c) Ensure that machinery and equipment is safe for employees;

(d) Ensure that working arrangements are not hazardous to employees; and

(e) Provide procedures to deal with emergencies that may arise while employees are at work.

Taking "all practicable steps" means doing what is reasonably able to be done in the circumstances, taking into account:

(a) The severity of any injury or harm to health that may occur;

(b) The degree of risk or probability of that injury or harm occurring;

(c) How much is known about the hazard and the ways of eliminating, reducing or controlling it; and

(d) The availability, effectiveness and cost of the possible safeguards.

1.2.4 HAZARD MANAGEMENT

Employers must identify and regularly review hazards in the place of work (existing, new and potential), to determine whether they are significant hazards and require further action. If an accident or harm occurs that requires particulars to be recorded, employers are required to investigate it to determine if it was caused by or arose from a significant hazard.

"Significant hazard" means a hazard that is an actual or potential cause or source of:

(a) Serious harm; or

(b) Harm (being more than trivial) where the severity of effects on any person depend (entirely or among other things) on the extent or frequency of the person's exposure to the hazard; or

(c) Harm that does not usually occur, or usually is not easily detectable, until a significant time after exposure to the hazard.

Where the hazard is significant, the HSE Act sets out the steps employers must take:

(a) Where practicable, the hazard must be eliminated.

(b) If elimination is not practicable, the hazard must be isolated.

(c) If it is impracticable to eliminate or isolate the hazard completely, then employers must minimise the likelihood that employees will be harmed by the hazard.

Where the hazard has not been eliminated or isolated, employers must, where appropriate:

(a) Ensure that protective clothing and equipment is provided, accessible and used;

(b) Monitor employees' exposure to the hazard;

(c) Seek the consent of employees to monitor their health; and

(d) With informed consent, monitor employees' health.

1.2.5 INFORMATION FOR EMPLOYEES

Before employees begin work, they must be informed by their employer of:

(a) Hazards employees may be exposed to while at work;

(b) Hazards employees may create which could harm other people;

(c) How to minimise the likelihood of these hazards becoming a source of harm to themselves and others;

(d) The location of safety equipment; and

(e) Emergency procedures.

Employers are also required to inform employees of the results of any health and safety monitoring. In doing so, the privacy of individual employees must be protected.

1.2.6 EMPLOYERS TO INVOLVE EMPLOYEES IN THE DEVELOPMENT OF HEALTH AND SAFETY PROCEDURES

Employers need to ensure that all employees have the opportunity to be fully involved in the development of procedures for the purpose of identifying hazards and dealing with significant hazards, or dealing with or reacting to emergencies and imminent dangers.

1.2.7 TRAINING OF EMPLOYEES

Employers must ensure employees are either sufficiently experienced to do their work safely or are supervised by an experienced person. In addition, employees must be adequately trained in the safe use of equipment in the place of work, including protective clothing and equipment.

1.2.8 SAFETY OF PEOPLE WHO ARE NOT EMPLOYEES

Employers are also responsible for the health and safety of people who are not employees. Employers must take all practicable steps to ensure that employees do not harm any other person while at work, including members of the public or visitors to the place of work.

1.2.9 EMPLOYEES' AND SELF-EMPLOYED PERSONS' DUTIES

Employees and self-employed persons are responsible for their own safety and health while at work. They must also ensure that their own actions do not harm anyone else. However, these responsibilities do not detract from the employers' or principals' responsibilities.

1.2.10 ACCIDENTS AND SERIOUS HARM (RECORDS AND NOTIFICATION)

The HSE Act requires employers to keep a register of work-related accidents and serious harm. This includes every accident that harmed (or might have harmed):

(a) Any employee at work;

(b) Any person in a place of work under the employer's control.

Employers are also required to investigate all accidents, harm and near-misses to determine whether they were caused by a significant hazard.

Employers are required to notify serious harm that occurs to employees while at work to the Secretary (in practice, the nearest OSH office), as soon as possible. In addition, the accident must also be reported on the prescribed form within 7 days. (Forms are included in the *Workplace Accident Register* available from OSH offices and selected stationers.)

If a person suffers serious harm, the scene of the accident must not be disturbed unless to:

(a) Save life or prevent suffering;

(b) Maintain public access for essential services, e.g. electricity, gas;

(c) Prevent serious damage or loss of property.

The OSH office will advise whether it wishes to investigate the accident and what action may be taken in the meantime.

2. DEFINITIONS

All practicable steps: This takes into account:

(a) The possible nature and severity of harm;

(b) The current state of knowledge about the likelihood of harm, the nature of the hazard and the methods available for minimising the hazard;

(c) The availability and cost of methods for minimising hazards.

Balling: Mechanical demolition by the controlled swinging or dropping of a demolition ball suspended from a suitable lifting device.

Blast mat: An absorbent and protective covering of sufficient strength and weight and of fine enough mesh to contain flyrock during blasting operations.

Brittle roofing: Roofing material that may not safely withstand the weight of a person and includes corrugated flat or troughed asbestos, perspex, plastic material, pinex, woodtex, corroded galvanised iron or corroded aluminium roofing.

Catch screen: A protective structure made of suitable materials such as scaffold tubes and planking, and fixed to the face of the building or to the perimeter fencing, to contain falling debris during demolition.

Chute: A trough of tube used to transfer debris from one level to another, set at an angle to prevent free-falling debris.

Demolition: The dismantling, wrecking, pulling down or knocking down of any building or structure or part thereof; but does not include such work of a minor nature which does not involve structural alterations. (Note that demolition comes within the definition of "building work" in the Building Act.)

Demolition ball: A cast steel weight with eyes and fixings, suspended from a lifting appliance and used to demolish a structure.

Demolition contractor: A person, company or organisation carrying out demolition; an employer within the meaning of section 2 of the Health and Safety in Employment Act 1992.

Gantry: A structure covering a public way providing protection from both side and overhead.

Guardrail: A rail erected to prevent persons or materials or other things falling from a working platform or other working place.

Hoarding: A structure alongside a public way providing side protection but no overhead protection.

Machine-lifted platform: A working platform which is moved into any working position by a power-operated machine to which it is attached.

Propping: A system of temporary supports to prevent movement or unintended collapse.

Pulling rope: A wire rope used in conjunction with an anchored winch or attached to a tracked or heavy vehicle, to pull down a selected part of the building.

Pusher arm: A steel attachment fixed to an extended boom on mechanically operated mobile equipment.

Scaffolding: Any structure, framework, swinging stage, suspended scaffolding, or boatswain's chair, of a temporary nature, used or intended to be used for the support or protection of persons engaged in or in connection with construction work for the purpose of carrying out that work or for the support of materials used in connection with any such work; and includes any scaffolding constructed as such and not dismantled, whether or not it is being used as scaffolding; and also includes any plank, coupling, fastening, fitting, or device used in connection with the construction, erection or use of scaffolding.

Significant hazard: A hazard that is an actual or potential cause or source of:

(a) Serious harm; or

(b) Harm (being harm that is more than trivial) the severity of whose effects on any person depend (entirely or among other things) on the extent of frequency of the persons exposure to the hazard; or

(c) Harm that does not usually occur, or usually detectable, until a significant time after exposure to the hazard.

Toe board: A board placed on edge round a working platform, to prevent tools or materials from falling.

3. GENERAL REQUIREMENTS

3.1 GENERAL

Demolition must be carried out in accordance with the Health and Safety in Employment Act 1992 (HSE Act) and the proposed Health and Safety in Employment Regulations (HSE Regulations).

3.1.1 DUTIES OF OWNERS AND PRINCIPALS

Section 16 and section 18 of the HSE Act require principals and owners to take all practicable steps to ensure that no employee of a contractor or subcontractor and no other person is harmed while any work is being carried out for the owner or principal.

Examples of all practicable steps are:

(a) Provide all available descriptions of the building to be demolished, including drawings; site survey; plan of services; extent. nature and location of hazardous materials; and relationship to surrounding properties.

(b) Obtain the necessary approvals from Territorial Authorities and notify the relevant authorities controlling essential utility services prior to commencement of the work.

(c) Define the extent of the work.

(d) Notify adjoining owners before demolition commences and, if necessary, request permission for the use of adjoining air space.

(e) Where appropriate, ensure the inspection of buildings and record existing defects.

(f) Locate all services.

(g) Locate and notify the contractor of all known hazardous materials and hazardous conditions pertaining to the site.

(h) Maintain a degree of supervision and co-ordination such that significant hazards identified do not cause harm to the contractors or the public.

3.1.2 DUTIES OF EMPLOYERS (DEMOLITION CONTRACTORS)

Section 6 of the HSE Act requires employers (demolition contractors) to take all practicable steps to ensure the safety of all persons affected by the works.

All practicable steps could include but not be limited to the following:

(a) Plan for demolition work and select the method or methods of demolition.

(b) Inform the owner or principal and other relevant parties of the method or methods of demolition selected and equipment to be used.

(c) Obtain the necessary work permits, confirm that the building to be demolished has the necessary building consent, and notify OSH if the works are notifiable.

(d) Nominate an experienced person to control the works at all times.

(e) Inspect adjoining properties where necessary, and record the conditions of adjacent buildings.

(f) Erect all appropriate hoardings, fences and gantries for the protection of the public and other people affected by the work.

(g) Maintain the security of the site.

(h) Maintain safe access and egress at all times.

(a) Control the works to ensure that safe work methods are being used at all times.

Note that clauses 3.1.1 and 3.1.2 do not relieve any person of their responsibilities under the HSE Act.

3.2 HEALTH AND SAFETY INSPECTORS.

These inspectors are officers of the Occupational Safety and Health Service (OSH) of the Department of Labour. Their principal functions are:

(a) To help employers, employees, and other persons, improve safety at places of work, by providing information and education;

(b) To ascertain whether or not the Act is being and will be complied with;

(c) To take all reasonable steps to ensure that this Act is being complied with; and

(d) Other functions conferred on inspectors by this Act or any other enactment.

3.3 CONSTRUCTION WORK

Construction work includes the demolition or construction of any building or civil engineering structure, and includes walls, fences, or chimneys; roads, harbour works, railways, cableways or aerodromes; drainage, irrigation or river control works; electricity, water, gas or telegraph reticulation; and bridges, dams, viaducts, pipelines, culverts or tunnels.

3.3.1 NOTIFIABLE CONSTRUCTION WORK

Under the proposed Health and Safety in Employment Regulations, certain construction works will be notifiable to OSH, for example, where employees risk a fall of 5 metres or more, where buildings contain asbestos, or where it is intended to use explosives. Any notifiable work must be notified to the appropriate OSH office 24 hours before the work commences.

3.3.2 GENERAL SAFETY PROVISIONS

It is important that demolition is carried out under the supervision of a suitably experienced person. All reasonable precautions must be taken for the safety of employees, and equipment must be operated by competent persons. Particular care must be taken when employees demolish brittle roofing (see 4.4.2).

Where there is a danger to the public, warning signs, barricades or warning devices must be provided and used.

3.3.3 SAFETY OF MECHANICAL PLANT, TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

The HSE Regulations will set out general rules relating to the design, manufacture and supply of mechanical plant, tools, and gear on demolition work. Employers must ensure that such plant and equipment is used, adjusted and maintained in accordance with the relevant information and instructions.

3.3.4 SAFE USE OF EXPLOSIVES

The HSE Regulations require that only certified construction blasters be allowed to use explosives on demolition work.

3.3.5 NOISE CONTROL

Employers have an obligation to protect their employees from harmful noise during demolition. Territorial Authorities may require compliance with the requirements of NZS 6803 *Measurement and assessment of noise from construction work*.

3.3.6 FIRE PROTECTION

See section 5.10.5 of this code.

4. PRE-DEMOLITION CHECKS

4.1 INTRODUCTION

The potential risk of a fatal or serious injury accident is high during any demolition project, both to employees and to the public. The identification of hazards and the promotion of safe methods of work are essential and these should also reflect responsibilities to third parties.

The public is primarily concerned with materials falling, or dust billowing from the site onto public roadways or onto adjacent properties. Two other main concerns are the potential instability of partially demolished structures, and noise emanating from demolition sites.

Every demolition job, no matter how small, must be planned. The planning period is the time to identify the hazards and consider the precautions to be taken. Safety planned at the start of the demolition process will always be more cost-effective than safety introduced midway during the project.

Managers (including principals, agents of principals, and employers) of demolition projects must lay a solid foundation for safety by adopting safe systems of work, and employees must co-operate to ensure that their actions do not compromise safety. This may mean rejecting some long-established trade practices.

4.2 SITE INSPECTION

4.2.1 GENERAL

Check the site, building or structure, and its contents, for likely hazards. These may include asbestos, electric power lines or cables, gas reticulation, telecommunications, and unsafe structural members. Pedestrian and vehicle movements passing the site must be determined and traffic control facilities protected. (See also 5.15.)

4.2.2 ADJOINING BUILDINGS

Check the relationship and the condition of adjoining buildings. They could be affected by the demolition. For instance, they might rely for

support on the building to be demolished, be very susceptible to damage by ground shock, or have shallow foundations or contain poorly stacked or fragile materials. Find out if there are any restrictions concerning right of support to adjacent buildings.

4.2.3 USE OF THE BUILDING

Find out what the building was used for in the past. There may be dangers from explosive or flammable substances, toxic substances, lead, asbestos and radioactive substances. Asbestos must be removed prior to demolition. Check with the Territorial Authority to determine if a dangerous goods licence has ever been issued for underground tanks.

4.2.4 PUBLIC SERVICES

All services, either under ground or above ground, such as gas, water, electricity, drains, telephone cables, etc., must be located. Arrangements must be made to have them either cut off or diverted at the site boundary, or suitably protected to the approval of the appropriate authority. In some cases, more than one source of supply may be found. Particular care needs to be taken when constructing boundary fences or gantries, to ensure their foundations do not strike public utilities that are still in use. Provision must be made for the safety of pedestrians and vehicles passing the site. Footpaths must be maintained in a safe condition.

4.3 DANGEROUS STRUCTURES

If a structure seems dangerous, check with the Territorial Authority. They may know about the type of construction and the cause of damage or weakness. Find out if the Territorial Authority has a site file with notes on special features.

4.4 STRUCTURAL INSPECTION

4.4.1 BUILDING PLANS

Examine all available plans of the building or buildings where necessary, but be aware that the original drawings may not be a true record of what was actually built. Where the nature of the construction is uncertain, a special investigation must be carried out. Seek the advice of a registered engineer. Where it is intended to use heavy plant and machinery on roofs and floors, or where it is intended to load debris on roofs or floors, the allowable loadings must be determined. Propping or strengthening may be necessary. “No go”

areas for plant and machinery should be fenced off to avoid confusion as to what is safe and what is not.

4.4.2 ROOF

Examine the roof structure. Check the condition of roof trusses and identify and mark any bracing that is essential for its stability. Check the nature and condition of roof cladding. If it is brittle, special precautions must be taken to prevent employees from falling through it. In particular, care must be taken with corrugated “plastic” and asbestos cement roofing.

4.4.3 WALLS

Examine the walls. Identify and mark load-bearing walls and check whether party or cross walls are properly bonded into front and rear walls. Check the thickness and condition of walls and gables which are to remain after the demolition has been completed. Note particularly any reduction in wall thickness. Any effect on remaining buildings due to the removal of buttressing walls must also be considered. If in doubt, consult a registered engineer.

4.4.4 CANTILEVERED STRUCTURES

Check cantilevered structures such as staircases, balconies, cornices, etc. which are fixed to a building. Their stability is likely to be affected when adjoining structural members in the building are removed. For instance, if a cantilever is the continuation of the building’s roof or floor beams, it may collapse when the beams inside the building are cut.

4.4.5 BASEMENTS, CELLARS, AND VAULTS

Check basements, cellars, vaults and other voids for their effect on the remainder of the structure and adjoining properties. Points to consider are:

(a) Will they be a hazard to people or machines?

(b) Will removing the walls threaten adjacent foundations?

(c) Will adjacent ground cave in?

4.5 WELLS AND UNDERGROUND STORAGE TANKS

Wells and underground storage tanks should be tested for flammable vapours or any other hazardous gases if there is any suspicion that such vapours or gases are present. The position, depth, size, construction, type of well and contents of tanks should be determined and procedures developed to manage the hazards.

4.6 CONCRETE STRUCTURES

These should be examined for signs of damage due to the corrosion of reinforcement or damage to concrete. Additions and alterations may require special consideration.

4.7 SPECIAL BUILDINGS

Special buildings include, but are not limited to, precast concrete tilt slab structures, framed structures of precast concrete, column-beam-slab construction and prestressed concrete structures. Because of the lack of practical experience in the demolition of these types of buildings, it is essential to proceed with caution. Carry out a full investigation to determine the type of structural framework before any demolition begins. Where necessary, advice should be sought from a suitably experienced registered engineer.

4.8 DEMOLITION PLAN (METHOD STATEMENT)

To undertake a demolition job without creating risks, and to execute it in a safe and orderly manner, requires careful planning of each stage of the demolition. Usually a written plan should be prepared. A demolition plan (sometimes known as a method statement) should describe the extent of the work, the type of plant to be used and the proposed method of removing each part of the structure, e.g. roof, walls, floors, and foundations. It should include a hazard identification, assessment and control method. It must also outline the precautions for the safety of employees on site and persons in the vicinity including the emergency procedures. It should also cover dust and noise controls and safety for the public.

When called for, a demolition plan or method statement must be submitted to the health and safety inspector.

5. SAFETY PRECAUTIONS DURING DEMOLITION

5.1 GENERAL

Accidents have been caused during demolition by:

(a) Persons falling from high, unprotected workplaces and through openings;

(b) Persons being struck by falling objects;

(c) The building collapsing suddenly and unexpectedly;

(d) Insecure materials in or on the structure;

(e) Plant being used on elevated slabs without proper precautions being considered.

Safety precautions must be taken to safeguard persons working on the site and members of the public who are in the vicinity, as well as to protect property likely to be affected by the demolition.

5.2 EARTHQUAKES, WIND AND VIBRATION

Structures must not be left in a condition in which they could be brought down by a moderate earthquake, moderate wind storm or vibration from traffic or plant.

5.3 SUPERVISION

The contractor must ensure that a competent person is in constant charge of the demolition while it is being carried out.

5.4 PLANT, TOOLS AND EQUIPMENT

(See also Part 7 of this code.) Make sure that plant, tools, and equipment, including ropes, strops, and hand winches are in good working order. (See also Appendix A.)

Mobile construction plant (except for hired in cranes used solely for lifting) used on demolition sites must always be fitted with a falling-object protective structure (FOPS).

Because of the danger of exhaust fumes, check that there is sufficient ventilation when using mechanical plant in confined or enclosed areas.

Precautions must be taken when cranes and mechanical plant are working near overhead electric wires. All lines should be treated as live. A minimum clear distance of 4 metres must be maintained from the lines unless otherwise permitted in writing by the local electrical supply authority. All practicable steps for lifting equipment could include the 6-monthly checking and certifying of lifting equipment (such as chains, strops, etc.) as well as the daily visual check of lifting equipment.

5.5 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Safety equipment protects only if it is being used and only if it is being used in accordance with the supplier's instructions. A number of hazards in demolition work require the use of personal protective equipment. These hazards range from the sharp edges on debris to exposure to hazardous chemicals.

Employers must ensure that employees are provided with, and use, protective clothing and equipment. Goggles, face shields, hearing protection devices, safety belts, gloves and appropriate respirators for dust or chemicals must be provided as necessary.

5.5.1 SAFETY HELMETS AND SAFETY FOOTWEAR

Safety helmets and safety footwear must be worn at all times on demolition sites, except that operators may remove their helmets while inside a FOPs-protected cab. (Also see Appendix A.)

5.6 PROTECTION OF PUBLIC

People walking or driving past any demolition work must be protected from falling objects, projections, dust, noise, welding and cutting, and mechanical plant, including trucks and vehicles entering and leaving the site, at all times while work is in progress.

Where people in the vicinity could be endangered by falling debris, a gantry or a protective screen of sufficient strength, must be provided over the footpath adjacent to the building. For gantries, the roof should be weatherproof and decked with a minimum of 50 mm timber planking or equivalent, depending on the span and loading. For some demolition projects, properly "engineered" structures may be required. Design loadings for the gantries are given in NZS 4203 *General structural design and design loadings for buildings.*

Where there is no danger of falling debris, but there are dust, water, sparks or other demolition hazards, a hoarding or fence erected on the boundaries of the site may be sufficient to protect the public. Such a fence or hoarding may also prevent unauthorised public access onto the site. Particular attention should be given to prevent children from entering the site. Hazards that could attract children may need to be fenced off.

Fences and hoardings should be difficult to climb. In general, they should be at least 2.0 metres in height from the ground level on the side accessible to the public. Fences could be constructed using galvanised chain link netting (50 by 50mm) with posts at 2.5 metre centres and hoardings could be constructed using continuous sturdy cladding.

Signs should be placed at several points around the site to inform the public that demolition is in progress and that danger exists. Flag bearers must be stationed at truck entrances and exit points when trucks are operating. During the hours of darkness, warning lights must be used to warn of barricades or debris heaps. Holes which present a hazard must be covered.

All footpaths or thoroughfares adjacent to the work site and open to the public must be kept clear and clean at all times. Road kerbs and stormwater drains must also be kept clear of material to prevent flooding.

In busy inner city areas, the more hazardous stages of demolition could be carried out during non-working hours, i.e. evenings or weekends, when there is a minimum of traffic, or during off-peak working hours when traffic and pedestrians can be more easily controlled.

5.7 UNAUTHORISED ACCESS TO SITE

The contractor must ensure that no unauthorised persons are allowed on to the site during demolition. Where persons are permitted to remove or purchase materials from the demolition site, safe access and egress must be ensured.

5.8 NOISE CONTROL

Contractors must ensure that necessary precautions are taken to protect their employees, the general public and occupiers of adjoining property from harmful noise. The best practicable means should be adopted to ensure that noise emission does not exceed reasonable levels. (See also 3.3.5.)

5.9 DUST CONTROL

Demolition work often creates large volumes of dust which, in windy, busy or densely populated areas, can be dangerous to vehicular traffic, or can be a nuisance and health hazard to the general public. Watering down of debris, including loaded vehicles, chutes, floors, stairways, and other places, must therefore be carried out frequently.

5.10 DEMOLITION PROCEDURES

5.10.1 GENERAL

All temporary works and protective structures, including hoardings, gantries, screens, scaffolds and propping, should be erected before demolition begins, and be maintained in good order throughout the duration of the work. Demolition must be carried out in a planned sequence. Ensure that everybody is kept at a safe distance, and that no one enters the building once demolition by pulling, balling or deliberate collapse has begun.

5.10.2 SCAFFOLDING

Where "special" scaffolding (refer to the OSH *Approved Code of Practice for the Safe Erection and Use of Scaffolding*) is used for demolition work, it must be designed by a competent person to carry the loads placed upon it during demolition. Scaffolding 8 metres or more in height can only be erected by a certificated scaffolder.

Where there is a danger of materials falling onto employees or the public below, the entire face of the scaffold must be covered with small mesh netting unless other precautions are taken. Where public access ways pass alongside these scaffolds, catch screens covered with suitable protective material must be provided. These scaffolds must be lit during the hours of darkness and be provided with large notices warning the public to keep out of the demolition site because danger exists.

Precautions should be taken to prevent the collapse of scaffolds at demolition sites. Accidents have occurred due to the removal of the parts of the building to which the scaffold was tied, making the scaffold unstable. In general, scaffolding can only remain free-standing after the removal of supporting ties, if its base equals one-third or more of its height.

5.10.3 HEALTH

The main hazards to health during demolition work are:

(a) Asbestos dust, chiefly from insulation materials, and frequently found in fire-protective cladding around structural steel members, partition walls, sprayed ceilings and lagging to steam and chemical plant. All asbestos must be removed from a building or structure prior to demolition commencing. Such asbestos could include asbestos cement siding and roofing, asbestos cement piping, some ceiling materials, acoustic sprays, fireproofing materials for steel or concrete, insulation of ducts, pipes and cavities, and so on. All work involving the removal of asbestos is to be in accordance with the Asbestos Regulations 1983.

(b) Lead poisoning, from the inhalation of fumes during the flame cutting (or "burning") of steelwork coated with lead paint. (See Appendix B.)

(c) Gas cutting of galvanised steel also gives off toxic fumes. Contractors must take necessary precautions to safeguard against these hazards. (See Appendix B.)

(d) Toxic substances present on site, either from industrial processes previously carried out in the building or from the disposal of waste. Contractors may have to engage expert assistance to find out the type of toxic substances and residues likely to be encountered and how to deal with them.

(e) Synthetic mineral fibres (SMFs). If SMFs are encountered on a demolition site, safe methods must be followed. The OSH publication *Health and Safety Guidelines for the Selection and Handling of Synthetic Mineral Fibres* contains useful information.

(f) Polychlorinated biphenyls (PCBs). PCBs are a group of over 200 chemicals and have a wide variety of trade names. PCBs were commonly used in transformers and capacitors but because of the hazards PCBs are now being phased out. Disposal of PCBs or equipment containing PCBs is to be in accordance with the Toxic Substances Regulations 1983 amendment 3. The Department of Health Code of Practice *Safe Management of PCBs* also contains useful information.

(g) Silica dust. Where the demolition work creates silica dust, proper precautions must be taken.

5.10.4 DISPOSAL OF DEBRIS AND WASTE MATERIAL

Where practicable, demolished material should be lowered to the ground and the debris sent down in skips or enclosed chutes. Material should only be dropped when adequate precautions have been taken for the safety of employees, public and adjacent property.

Debris must not be burned on the site unless permits have been obtained from either the New Zealand Fire Service or the Territorial Authority, whichever is applicable.

When loading trucks or trailers, care must be taken not to spill debris over the far side of the truck or trailer. Loading shall only be done on the demolition site unless permission is given by the Territorial Authority to load on the street.

5.10.5 FIRE PREVENTION

Welding and cutting operations present a severe fire hazard on a demolition site. When practicable, combustible material in the vicinity of welding or cutting work shall be removed to a safe place. The use of flammable gases and oxygen poses additional fire hazards. Pure oxygen is extremely dangerous: it can set fire to oil or grease by spontaneous combustion, without a flame or spark.

Fire prevention procedures must, therefore, be carried out for the protection of employees and property. Fire extinguishing equipment must be readily available and employees should be trained in its use. In general, water-based fire extinguishers are most suitable for demolition works. Where practicable, standpipes and hoses should be set up prior to cutting and surrounding debris that cannot be removed, must be thoroughly wetted down. In general, cutting should suspended 2 hours before the daily cessation of work operations, if there is a possibility of flammable material catching fire from smouldering.

Oxygen, acetylene or LPG bottles must not be left free-standing.

All welding and cutting should be in accordance with the OSH publication *Welding Safety.* (Also refer to Appendix B.)

5.11 BUILDINGS

To prevent injury from broken glass, all glass must be removed from windows before demolition begins. Window openings on street frontages, or adjacent to access ways, must be blocked off.

Openings in walls, floors, roofs, and stairwells, through which people could fall, must be boarded up or be provided with a guardrail and toeboard, or both. Access to the areas where flooring has been removed must be barricaded off, and notices erected to warn of the danger at each point of entry.

All stairs or installed ladders must be checked before use. Never assume they are sound: it may have been years since they were used. When in good condition, leave them as a means of access or egress for as long as possible.

When dismantling pitched roof trusses, the last frame should be guyed before the second to last truss is removed, because its stability depends on the support from adjacent members. As supports and buttresses are removed, bracing should be provided to stabilise the remaining structure.

Avoid leaving free-standing walls by reducing the building in small lifts. Never leave isolated walls or potentially unstable structures unpropped, unless they are stable against wind and other forces likely to affect them.

When demolishing a reinforced concrete floor, it may be necessary to remove a small section first in order to determine the direction of the main steel. Provide support for beams before cutting them free of columns and walls, if necessary. Columns must be guyed before cutting or weakening the base, so that their fall may be controlled. Clear openings should be made in floors to allow debris to pass through.

5.12 PRESTRESSED CONCRETE STRUCTURES

The demolition of prestressed concrete structures is hazardous and the experience of the industry is still limited. Professional advice must be

obtained from a suitably experienced registered engineer. A demolition plan or method statement is required.

The rapid release of the stored energy in the tendons, by removing the surrounding concrete, and/or burning through the tendons, could cause sudden failure. There is also the possibility of the tendon and its anchorage becoming a missile, especially where the tendons were not grouted during the original construction. A sandbag screen should always be put around anchors when the post-tensioned prestressed members are demolished.

In general, the only safe way to demolish a structure containing prestressed concrete is to dismantle the structure in the reverse order in which it was originally erected. Some buildings will be straightforward, but special care will be needed in the following circumstances:

(a) Continuous structures over more than one support or cantilevered structures;

(b) Suspended structures;

(c) Structures that had been progressively stressed during construction;

(d) Structures made of precast members stressed together once erected;

(e) Shells, ring beams, tension ties, stressed tanks.

Care must be taken in handling prestressed components. For example, long "slender" beams may become unstable if allowed to tip onto their sides. In general, prestressed beams should only be supported near their ends.

Demolition using "conventional" methods such as balling or concrete breakers may be unsatisfactory due to the possibility of an uncontrolled collapse, or the sudden release of the stressing steel.

Ducts for post-tensioned prestressing tendons have been known to "float" up during concreting, causing additional hazards for demolition contractors. It may be necessary to confirm the location of stressing cables or ducts prior to commencement.

5.13 STORAGE TANKS

Note that the requirements of Dangerous Goods Act 1974 and the Dangerous Goods Regulations may apply. For tanks previously containing class 3 (flammable liquids), an approved procedure is required as well as daily gas-free certificates. For the specific requirements, refer to the OSH document *Code of Practice for the Removal, Repair and Destruction of Underground Storage Tanks (Class 3)*. Useful information can also be found in the Health and Safety Executive (UK) Guidance Note CS 15 *The Cleaning and Gas Freeing of Tanks Containing Flammable Residue*s.

The contents of storage tanks must not be just "tipped out" until the contents have been identified and a safe disposal method agreed upon.

The hazards associated with removal of storage tanks include explosions, confined space entry, electrocution, and for underground storage tanks, cave-ins during excavation and while the excavation is unprotected.

After determining the previous use of storage tanks (above or below ground) and ensuring that risks of fire, explosion and toxicity have been minimised, the employer should decide on the technique to be used to render the tank safe to work on, for example:

(a) Flood tank with water and seal ventilating holes; or

(b) Flush out petrol vapour/air mixture by pumping in nitrogen; or

(c) Insert solidified carbon dioxide (dry ice).

Precautions should also be taken with the associated pipework and equipment.

The displacement of vapours from the vents of tanks during purging must also be considered. Before gas cutting any tanks, a daily gas-free certificate must be provided. It should be noted that a tank which has been emptied and gas freed will only remain gas-free for a limited time. Residues in the form of sludge or other solid material may be present which can release gas.

Technical advice can be obtained from the dangerous goods inspector of the Occupational Safety and Health Service, or from the New Zealand Fire Service or other qualified agencies.

A training programme to alert employees about hazards of underground storage tanks could include and emphasise flammable liquids, tank purging and inerting, sources of ignition, overhead electrical hazards, buried cables, cave-ins and trench collapse, toxicity, and the use of monitoring devices.

Precautions should be taken when an underground storage tank has been removed. If the depth of the excavation exceeds 1.5 metres, the same precautions as required for trenches must be adopted. Where the tank has leaked, it may be necessary to remove the surrounding contaminated soil before backfilling.

5.14 UNDERWATER DEMOLITION

The primary danger to divers who are cutting or welding is from electric shocks and from the explosions of trapped gas in the structure being worked on. Divers must be familiar with the precautions necessary when doing this work.

Underwater electrical circuits must have a positive on off switch located where the tender has immediate access. Unless the diver is actually welding, the switch must be in the open or off position.

All welding machine frames shall be earthed before starting operations. An earth wire shall be used to connect the machine directly to the work.

Power supply cables must be kept clear of welding cables.

Insulated gloves shall be used by the diver during underwater electrical welding or welding operations.

Any compartments containing unknown or explosive gases, or residues that could release gases, shall be purged or flooded prior to cutting or welding operations. Compartments of structures which could accumulate welding gas should be vented prior to the start of operations.

5.14.1 UNDERWATER BLASTING

Underwater blasting operations shall not be carried out unless the person who prepares and lays the charge ready for firing is the holder of a certificate of competency as a construction blaster. However, a person in training may prepare and lay charges under the direct personal supervision of a person who is a holder of a certificate of competency as a construction blaster.

Underwater blasting requires the attention of a construction blaster and construction diver, but one person may hold both of these qualifications.

No charge of explosives may be fired while any person is submerged due to the danger from water-borne shockwaves. The exploder key must remain in the control of the underwater diver or the diver's attendant while the person is submerged.

All divers engaged on underwater demolition must be medically fit and hold a diving certificate issued by OSH.

For further information refer to OSH Code of Practice entitled *Diving on Construction Work* or the proposed OSH publication on occupational diving.

5.15 DEMOLITION OF FIRE-DAMAGED BUILDINGS

In general terms, a fire-damaged building will be easier to knock down owing to the damage and weakening of both materials and structure. However, the weakening reduces the structure's ability to act as a load platform for plant, people and materials. Great uncertainty exists on what might happen when various actions are taken. In general, expert advice should be obtained before demolishing all but the simplest fire-affected structures.

Caution is needed, as the strength reduction of the various beams, columns and connections is uncertain. Most common structural materials lose strength when subjected to fire. For example, the expansion of beams and trusses during the fire can cause shear failure of their wall and column connections. Thermal bowing of masonry can occur, and can cause unexpected wall collapses.

5.15.1 INSPECTION PRIOR TO DEMOLITION

Evaluate the fire temperature and locate areas where material strengths appear reduced and deflections larger than normal. Look for shear failures of connections. Evaluate concrete strengths and identify areas

of weakness or collapse. Look for cracked concrete members, even those remote from fire. Check if structural steel requiring compression flange restraint has lost that restraint, i.e. purlins or floor joists. With composite flooring, check for shear failure.

Where loss of strength has occurred in beams, columns, or their connections, precautions must be taken to keep the resulting hazards to a minimum. Additional propping may be necessary to ensure stability.

Before any work starts, ensure that internal areas are well ventilated and be aware that some debris may be toxic. Take particular care if the building had been used to store chemicals.

5.15.2 TEMPERATURE EFFECTS ON THE MATERIALS

Depending on the temperature and duration of the fire, the heat can affect the materials as listed below:

Concrete

0-300 degree C fires	Strength unaffected.
300-600 degree C fires	The concrete may turn pink, it appears sound but strength loss will have occurred.
600-900 degree C fires	The concrete turns whitish grey and becomes weaker and more friable.
Above 900 degree C	The concrete turns buff and is weak and friable.

Reinforcing Steel

Generally OK unless the concrete has spalled off.

For prestressed concrete, the loss of strength can be substantial, extreme caution is necessary.

Steel

Structural steels usually become weak in tension while the compressive strength is affected less. High-strength steel is affected more than mild steel. Take particular care when cutting steel after it has been affected by fire. It may spring unexpectedly.

Timber

The strength is not affected but the loss of section reduces section modulus, thus lowering its load capacity.

Masonry

The compressive strength is probably reduced and tensile strengths substantially reduced.

(Source: Dr J. A. Purkiss, "The Decommissioning of Fire Damaged Building Structures". In *Decommissioning and Demolition.* Proceedings of the Second International Conference 1990, University of Manchester.)

6. METHODS OF DEMOLITION

This part describes the more common ways of bringing down buildings, and includes safety advice. In practice, more than one method is usually used to demolish a building.

6.1 DEMOLITION BY HAND

Hand demolition is not the quickest method; only hand tools are used, but cranes and shear legs may be used to hold or lower beams during cutting. Chutes, or crane and skip are usually used to get debris from the upper stories to the ground.

Safe access and egress must be provided. If work cannot be carried out safely on the building, a scaffold or machine-lifted platform should be used.

Knock down only one storey at a time. It is usually safest to demolish the building in the reverse order to building it, so the roof should go first. Next, part of each floor is taken out so that the debris can fall through. On some jobs, the debris can be dropped down the liftshaft, in which case ensure that guardrails must be provided around openings. Toeboards may also be necessary.

Debris must be removed regularly and not allowed to pile up on floors. An overloaded floor could collapse onto the floor below, which in turn, could collapse on the floor below it. Without the propping from the floors, the walls of the building could then collapse. Walls could also collapse if debris is piled against them.

If people have to work in a place without guardrails, from which they could fall, they must wear a properly anchored safety harness or safety belt.

Hand demolition is usually slow. At the end of each day make sure the building is safe. Guying or propping may be necessary to avoid hazards from wind or vibration. If only part of the building is knocked down, make sure that what is left can stand safely.

6.2 DEMOLITION WITH THE BALL

Most structures can be knocked down by balling, but it is not a method that can be self-taught. Learners must be instructed by trained people and work under close supervision until they are competent. Balling is hard on the machine: not all cranes can swing and control a

demolition ball safely. Converted drag lines are the best machines for this work. They are robust and stable. Cranes with hydraulic rams must not be used.

Cranes used for balling should be fitted with a FOPS cab and should be enclosed, strong and debris-proof. Cranes used solely for lifting on a demolition project need not be fitted with a FOPS cab, however operations that could cause flying debris should not be carried out close to the crane.

The boom angle when balling should not be more than 60 degrees to the horizontal. The top of the boom should not be less than 3 metres above the wall being knocked down.

The safe working load for the machine must be at least 3 times the weight of the ball.

When not being dropped, the ball should be used with a tag line to keep it under control. Swinging the ball by slewing is particularly hard on the machine. This can only be done safely on very robust machines driven by very skilled operators.

The ball should be positively fixed in such a manner to prevent it becoming disconnected by slack in the load line or other causes. These connections should be checked hourly.

Some warnings are:

(a) Beware of a trapped ball: getting it free may overload the crane.

(b) Always operate from outside the building.

(c) Any other building nearer than a distance equal to half the height of the building being demolished is in danger.

(d) Keep the public well away from balling operations.

(e) Keep employees clear of the demolition area and make sure that the area is clear each time demolition resumes after a break.

(f) Remember that the shocks from a building being knocked down can be felt in any attached building. Avoid damage to attached buildings by detaching them: hand demolition is necessary for this.

(g) When balling a building, the crane and ball should be sufficient to pass through all floors of the building.

(h) Avoid build-up of debris on floors and against walls.

(i) A heavy-duty swivel joint must be provided between the ball and the end of the crane rope.

(j) Check the ball, swivel, rope and the rigging hourly.

(k) Note the location of all overhead power wires and be aware of these when turning the crane from the normal work face.

6.3 DEMOLITION BY PUSHER ARM

In recent years, hydraulically operated excavators and loaders have been fitted with various attachments for demolition work. Excavator buckets, boom-mounted hydraulic percussion breakers and the pusher arm equipment have been successfully used with these machines.

The main advantages of such machines are that they are extremely mobile, have a high output, and are able to work on vertical faces and floors above standing level. The disadvantages are that the machines need adequate access, a firm and relatively flat base to work from, and can only work within the reach of their booms. To operate these machines efficiently, the length of boom when fully extended should be at least 1.5 metres above the height of the building being demolished.

The pusher arm method is not suitable for large buildings on confined sites but it is good for masonry infill structures. The building is pushed over in stages by a horizontal force from the machine. An arm is fitted instead of a bucket, and the crowd ram, or the excavator's tracks, provides the push.

If using this method, always:

(a) Work from outside the building and never let anyone enter the building while plant is wrecking the building.

(b) Be sure the operator has been trained in the work or is being instructed by a trained person.

(c) Get the local body's authority if working off roads or footpaths is required.

(d) Put up barriers to keep the public clear and safe.

(e) Use hand demolition to get the building to a level where pushing can start.

(f) Separate the building from any attached buildings, using hand methods.

(g) Make sure the debris does not build up too high against the walls: this may push the wall onto the machine.

(h) If terraces of debris are used to enable the machine and its pusher arm to gain height, ensure the terraces are well-consolidated and the machine can be maintained level during operation.

6.4 DEMOLITION BY DELIBERATE COLLAPSE

This will require engineering expertise to decide which key structural members should be cut or removed to cause a collapse. Once this method is begun, it is likely the building will be unstable until it is down. The method is best suited to bridges and structures on isolated sites.

When using this method, always:

(a) Ensure that the site is level enough to allow employees to get clear safely.

(b) Consider the safety of the remaining parts of the building at each stage.

(c) Use it only where there is plenty of space for the building to fall safely.

(d) Instruct workers of their role, tell them where they are to work and to where to withdraw to before collapse.

(e) Know where every person is.

(f) Keep the public a distance from the building of at least one and a half times its height. If flying debris is expected, the public will need to be kept further back than this.

6.5 DEMOLITION BY WIRE ROPE PULLING

This is really a form of deliberate collapse. Cables and wire ropes are fixed to key structural members, then pulled down by tractors or winches. It is suited to detached buildings where there is plenty of room. The method can be used for timber-framed buildings; for bridges; for brick, masonry or steel chimneys; and for spires and masts.

If this method is used:

(a) Use wire ropes at least 16 mm in diameter, and check them regularly. Wire ropes must have a factor of safety of 6.

(b) Anchor the machine securely, and set it so that the rope is flatter than 1 in 2.

(c) Do not let anyone stand between the tractor and the building, or on the side of the rope.

(d) Have a full FOPS canopy on the tractor to protect the operator from broken ropes and falling objects.

(e) Never let anyone enter the building while pulling is in progress.

(f) Set all ropes before pulling starts.

(g) Ensure that the pulling ropes are kept clear of overhead power wires, especially when taking up the rope slack.

(h) Remember that pylons and masts can twist as they are pulled. If the legs are of different lengths, the pylon could fall at right angles to the pull.

6.6 DEMOLITION BY EXPLOSION OR IMPLOSION

This is a job for the expert. Most structures, except timber-framed and brick structures, can be demolished this way.

Safe methods of using explosives are discussed in the OSH publication *Blasting Code* [currently out of print].

The usual method is to cut or disintegrate key structural members by loading drilled holes with explosives or fixing plaster charges to the outside of these members.

The main safety rules are:

(a) Have an experienced certified construction blaster in charge of the work.

(b) Consult with a registered engineer to ensure the method planned is feasible.

(c) Give the health and safety inspector a plan of the demolition at least 4 days before starting.

(d) Beware of strong columns that may make the building "sit down" rather than topple.

(e) Use mats and small charges to stop flying debris.

(f) Advise the local authority and police of the proposals; notify the local fire brigade.

(g) Have safe escape routes open.

(h) Keep the public at a safe distance.

(i) Plan and inform all employees of evacuation proposals.

(j) Preplan procedures for misfires, remembering that the building may be grossly unsafe due to being partly demolished.

(k) Use electric shot firing.

(l) Beware of shock damage from large amounts of detonating fuse.

Note problems with either undercharging or overcharging. Undercharging can leave the structure standing, but in a much weakened condition. Overcharging leads to excessive and possibly dangerous flying debris.

6.7 DEMOLITION USING POWER GRAPPLES AND SHEARS

Power shears may be used to crop and cut through concrete and metal such as reinforcing steel or beams, particularly where there might be a risk of fire or where the more precise cutting of a torch is not required. Care should be taken to ensure that any member to be severed is either effectively supported or, if to be allowed to fall, will not endanger personal or remaining structures.

Power grapples may be used to handle waste material, either to move it about a site or to load other vehicles when disposing of the waste. As some debris resulting from demolition has a high density, care should be taken to avoid overloading the equipment or to avoid damage to the equipment itself or to avoid the risk of the machine overturning as a result of instability induced by a heavy load.

6.8 OTHER METHODS

Other methods including thermic lances, drilling and sawing, and bursting are discussed in documents such as the BS 6187 *Code of Practice for Demolition.*

7. SAFETY USING MECHANICAL PLANT

7.1 GENERAL PLANT SAFETY

This section covers the safe use and operation of excavators, loaders, backhoes, trucks and other plant. This equipment can be a hazard on demolition sites unless site rules are established to promote safe use and operation. It is important that employees are properly trained in the safe use, inspection and operation of the equipment to be used.

7.1.2 INSPECTION

An essential factor of any equipment safety programme is the enforcement of the daily, weekly, monthly, or regular, inspection and maintenance of plant and equipment. The regular inspections are those that are set out in the equipment manuals, and these should be consulted. Records should be kept of all inspection and maintenance activities. Inspections should be carried out by competent employees who have a thorough knowledge of the equipment.

The daily inspections should include a thorough walk-around before climbing aboard the machine. All fluid levels should be checked. Missing bolts, pins, loose fittings and couplings, frayed cables and hoses, loose tracks and so on should be identified and corrected. Cracked paint can be evidence of underlying structural failure. Equipment surfaces and the ground under the machine should be checked for evidence of leaking fluids.

Windscreens should be kept clean. All warning alarms should be in good working condition.

When the machine is under any form of maintenance, a tag must be placed on the ignition to prevent the machine being started. Only the person placing the tag may remove it.

The pre-ignition check should include removal of all personal items which might obstruct the operator's movement. Before ignition all controls should be in neutral, and the controls checked to ensure there is no "tag-out" on the ignition. Such a tag-out might indicate that maintenance employees are under the machine. After start-up, the equipment should be checked for proper readings and all controls should be tested.

Any faults found during any of the checks should be reported to the employer (person in charge) and corrected before work starts. No

matter how important the job is, it cannot be done safely with defective equipment.

Operators must be familiar with parking and shut-down procedures which should follow the operator's manual. Clutches should be disengaged and brakes left on. Adequate precautions should be taken to prevent unauthorised start-up. Ignition and cabs should be locked if possible.

7.1.3 MAINTENANCE

Maintenance can be hazardous unless carried out carefully and in accordance with safe work practices. It should only be carried out in a safe location. Before anyone crawls under any machine, the wheels should be blocked and the ignition tagged out. All controls should be in neutral and the brakes applied.

Adequate ventilation must be provided to ensure employees are not poisoned by fumes.

Even common items such as batteries and tyres can be hazardous, and safe practices must always be followed.

7.2 FRONT-END LOADERS, BACKHOES, EXCAVATORS AND BULLDOZERS

When operating loaders, always use the seat belt.

On demolition work, this equipment must always have a FOPS (falling object protection structure). A FOPS canopy protects operators in situations where debris falls.

Operators should remain alert to the safety of other people in the vicinity.

Never demolish anything higher than the bucket. When demolishing walls, ensure that there is no one on the other side of the wall.

All other personnel must stay well away from the machine. If other employees need to talk to the operator, they should make eye contact from a safe distance and wait until the machine is turned off before approaching the operator.

Be aware of the load to be carried. If it is too large or heavy, the load can cause the machine to tip or roll. When moving with a load, always keep the load as low as possible to the ground. If the machine begins to tip, always lower the load but do not apply the brakes.

The work area should be kept as clean as practicable, bearing in mind the nature of the worksite and the task being carried out.

When dumping the load, the wind direction should be from behind the operator. When stockpiling materials, operators should remain aware of projecting reinforcing steel as this can be hazardous to other employees and can also damage the equipment if it gets caught in the tracks.

7.3 TRUCKS

The driver is primarily responsible for keeping equipment in safe condition. Trailer hook-ups, tyres and safety chains should be inspected before each use.

When trucks are being loaded at the demolition site, the driver should direct the loading from a safe position. The distribution of loads should be as even as possible. Large pieces of debris should be loaded gently onto the truck to prevent damage. Caution must be taken to avoid spilling debris over the other side of the truck. When loading near a public thoroughfare, pedestrians must be kept away. The driver must ensure that debris does not overhang the sides of the truck or extend above the legal height. Dry dust should be moistened down.

When dumping, make sure the ground is level. Avoid soft spots. Tip trucks have been known to fall over during dumping; all people must stay well clear. The driver should always be in the cab with the doors closed during dumping. If the load does not release, the tray must be lowered before the cause is investigated. Avoid dumping in high winds. However, where this is necessary, it is best to dump with the rear of the trailer to the wind.

7.4 USING PLANT INDOORS

When using loaders or other plant inside a building being demolished, additional precautions are also required.

Lighting must be sufficient to allow plant operators to adequately identify hazards. It may be necessary to have a “buddy” on foot working with the operator, but from a safe distance, to help identify hazards. A clear and understood signal system must be used. Operators must not operate machines at such a speed that adjacent employees are endangered.

The work area is to be sufficiently ventilated to ensure fumes from plant does not provide a hazard to operators and other employees in the vicinity.

When working on structural floors, ensure that the floors are sufficient to support the plant and debris that may be deposited. Where “no go” areas have been identified, these should be taped or fenced to avoid any confusion to plant operators.

8. GUIDELINES FOR CLEANUP OF CONTAMINATED SITES

8.1 INTRODUCTION

Demolition work may include the cleaning up of sites that have been chemically contaminated. The hazards of these sites can be environmental or they may present a danger to human health and safety. Contaminated sites can be of variable size and complexity, and for a successful decontamination process, proper evaluation, assessment and management will be required. Further information can be found in the OSH document *Health and Safety Guidelines on the Cleanup of Contaminated Sites*.

In terms of this code, the prevention of exposure to toxic chemicals is the primary concern. Appropriate means to protect demolition employees or the general public must be adopted. In New Zealand, contaminated sites include:

(a) Sites where timber treatment chemicals were used;

(b) Sites where pesticides or agrichemicals were used or stored;

(c) Disused gas works;

(d) Uncontrolled landfill tips;

(e) Sites that contained underground storage tanks.

Occupational hazards associated with the cleanup of contaminated sites may include:

(a) Fire and explosion;

(b) Hazardous substance exposure;

(c) Safety issues;

(d) Heat stress (associated with full body protective suits);

(e) Confined space hazards.

8.2 MANAGEMENT OF CONTAMINATED SITES

Management of the cleanup must be appropriate to the hazards involved. As a minimum, proper management will include adequate planning and organisation, establishing a work plan for each site, establishing health and safety plans, proper assessment of the site, establishing acceptable exposure levels and appropriate personal

protection equipment, monitoring the contaminants and the air, adequate training and supervision, and possible medical surveillance.

8.3 SITE CONTROL

Strict control of the site will be necessary to minimise the potential contamination of employees and to protect the public. Elements of site control include:

(a) Site preparation and defining zones. Defining work zones will assist in managing areas where appropriate protective clothing must be worn.

(b) Decontamination procedures. It may be necessary to fully enclose some areas and provide air locks, shower areas, waste recovery.

(c) Site security to prevent unauthorised entry to certain areas.

(d) Communications.

(e) Safe work policies and procedures.

Strict personal hygiene practices cannot be overstressed. Where heat is a problem, provisions need to be made to allow the employees to drink adequate fluids. Emergency procedures need to be planned in advance and contingencies made.

9. HOUSE LIFTING FOR REMOVAL OR EXCAVATION UNDER

9.1 INTRODUCTION

House lifting or the lifting of buildings, as a prelude to either excavation under the house or for relocation of the house, is extremely hazardous unless properly planned and carried out taking the appropriate precautions.

9.2 GENERAL REQUIREMENTS

(a) All necessary building consents must be obtained and all services disconnected prior to work starting on the site.

(b) A temporary works plan showing the proposed support system, the position of all supports, the alterations necessary and the sequence of operations must be prepared before work commences. This plan should be available on the site for inspection. Where the building has to be cut into sections to allow transportation, it is recommended that a structural engineer review the plans to ensure stability of each section before work starts.

(c) Where there is a possibility of children playing in the vicinity, the site should be securely fenced to prevent public access.

(d) Check that sufficient materials are on site before jacking commences, e.g. timber to construct pigsties; steel, aluminium or timber beams and bearers to provide support and bracing; adjustable props, ropes, wedges and sufficient jacks for lifting. Steel drums are not an adequate means of support.

(e) The jacks should be checked to ensure they are in good working condition. As a general rule of thumb, each jack should have a lifting capacity of 8 tonnes, and the safe working load (SWL) should be marked on them.

(f) Additional precautions may be necessary where the building has a heavy roof.

9.2 PRECAUTIONS DURING JACKING

(a) Check the ground condition at each jacking point and each point of intended support. It should be level, and all loose or poor material should be removed or made good.

(b) The jacks should bear on solid timber packing and be independent of other load supports.

(c) The jacked load should be held steadily throughout the jacking operation and ensure that the lift is vertical. At any sign of jack tilt, the load must be packed and the jack reset.

(d) As soon as practicable, the load should be transferred from jacks to temporary supports. Sufficient supports must be provided so that the failure of one will not cause a collapse or damage to the structure. It may be necessary to install steel or timber beams under the structure to spread the load or prevent excessive sag.

(e) Braces or inclined props will usually be necessary to support the structure against wind or earthquake loads. As a general rule, the capacity of such braces should be sufficient to resist a minimum horizontal force of one-tenth of the weight of the structure.

(f) Vibratory rollers must not be used nearby until the building is adequately supported and braced against lateral movement.

(g) Adequate drainage must be provided to prevent the ingress of water in and around the temporary supports.

9.3 PIGSTIES

Pigsties can be constructed from timber bearers each measuring 200 x 100 x 900 mm. At least three bearers covering an area 900 mm square should form the base of the sty. The height of the sty should not exceed three times its minimum width. The timber used should be sound and substantial enough not to crush, and have true faces to uniformly support the load.

10. DEMOLITION SAFETY CHECKLIST

10.1 BEFORE WORK STARTS

(a) Has the building been inspected by competent persons and checked for areas containing asbestos, lead coatings and other toxic substances?

(b) Have all public services, such as gas, water, electricity, sewers, and telephones been located? Have the authorities concerned been notified and have diversions been arranged as necessary?

(c) Has a demolition plan or method statement been prepared? (Note: this may be called for by the health and safety inspector.)

(d) Has the load-bearing capacity of floors to be used as working platforms been checked?

(e) Have the necessary props, scaffolds, fencing, protective screens, lighting, danger notices, fire protection equipment, etc., been arranged?

(f) Is permission required for street closure from the local authority?

(g) Has a building consent been obtained from the local authority?

(h) Has the Occupational Safety and Health inspector been notified?

(i) Has a competent supervisor experienced in demolition work been appointed?

(j) Have the neighbours been notified?

10.2 DURING THE COURSE OF THE WORK

(a) Is the site properly enclosed and are protective screens erected?

(b) Have danger notices been erected? Is all access to the site by the public barred?

(c) Is there sufficient propping to prevent premature structural collapse or damage to adjacent property?

(d) Are all ladders, cranes, cables, and other equipment in good order?

(e) Are any floors in danger of being overloaded?

(f) Is all protective clothing and equipment being used?

(g) Are all personnel (except crane operator and dogman) clear of the danger area when the ball is being used?

(h) Are all crane windows properly protected, and does the plant requiring a FOPS canopy have one fitted?

(i) Are pedestrians adequately protected?

(j) Is sufficient watering taking place to keep down dust?

(k) Are there sufficient fire extinguishers or other fire fighting equipment on site, and are they easily accessible?

APPENDIX A: THE SAFE USE OF TOOLS AND PERSONAL PROTECTIVE EQUIPMENT

A.1 HAND TOOLS

Common hand tool injuries can be avoided by observing the following safety rules:

(a) Select the right tool for the job.

(b) Keep tools in good condition.

(c) Inspect tools regularly, and either replace or repair at once if found to be defective.

(d) Use tools in a safe manner.

(e) Keep tools in a safe place at all times.

A.1.1 SLEDGE HAMMERS AND PICKS

These are dangerous tools when their heads chip or come loose from their handles. Hammer chipping can be reduced by:

(a) Replacing a hammer head that is beginning to mushroom;

(b) Swinging only as hard as is necessary and safe;

(c) Hitting the target straight-on, never at an angle.

Hammer heads flying off handles can be eliminated by carefully inspecting handles for cracks, splinters and looseness.

A.1.2 CHISELS

The safe use of chisels begins with the selection of a sharp instrument of the right size for the job, and a hammer of appropriate weight. Chisel heads that have begun to mushroom should be ground to avoid the danger of flying chips. Goggles must always be worn when chisels are in use.

A.1.3 CROWBARS

A safe crowbar has a point that grips the object to be moved, and a heel to act as a fulcrum. Makeshift crowbars, such as pieces of pipe or

iron bars, should be avoided. They are more likely to slip or break and cause injury.

A.1.4 SHOVELS

Back injuries are the most serious injuries resulting from the use of shovels. To avoid such injuries, proper attention should be paid to the employee's stance, their lifting technique, and the way they turn and empty the shovel. Twisting the spine should be avoided: the legs, rather than the arms, shoulders, and back should be used wherever possible. Employees should use the ball of the foot rather than the arch to push the shovel. That way, if the foot slips the shovel's sharp corner will not cut the ankle.

A.2 POWER TOOLS

Power tools pose additional hazards, i.e. electric shock, particles in the eyes, burns, cuts, and strain while using power tools. Most hazards can be eliminated by attention to these rules:

(a) Keep power lines and hoses out of passageways. Lines and hoses deteriorate dangerously as materials are dropped, dragged or driven over them. Employees might trip and fall over lines in passageways, presenting the additional danger that the tool may be wrenched out of the operator's control.

(b) Keep lines and hoses out of oil, chemicals, and heat, and away from sharp edges.

(c) Disconnect tools from power sources before making repairs or adjustments.

(d) Before turning on the tool, the area should be checked, and potential hazards identified and/or corrected. This permits the operator to concentrate on the work at hand.

A.2.1 ELECTRIC POWER TOOLS

Electrocution, burns, and shocks can be prevented by observing safe work practices. Before each use, electric tools should be inspected for proper earthing, frayed or broken wires, and cracked plugs. Only properly earthed or double-insulated tools should be used on the job site. An isolating transformer or similar approved device should be used for additional protection, particularly when working in damp conditions.

A.2.2 PNEUMATIC POWER TOOLS

These tools present special hazards because their pressurised hoses can be cut or punctured by a careless operator, another employee, or falling debris. Deterioration from contact with heat or chemical agents,

or poorly fastened couplings, can also cause an air hose to whip. Particular care must be taken to protect hoses from damage from debris or traffic. Only approved couplings for the type of hose and working pressure should be used, and only with the appropriate coupling devices. Air hoses must have a safety device at the source of supply to lower the air pressure in case of hose failure.

Employees must be informed and made aware of the hazards of compressed air. Pointing or touching the compressed air hose opening can cause air bubbles to get into the blood stream and cause death, damage to ear drums, blow out an eye or inflate part of a body. Blowing clothes with compressed air is hazardous and should not be permitted.

A.2.3 PETROL- OR DIESEL-POWERED TOOLS

As well as the hazards associated with the use of flammable liquids, there are dangers from toxic fumes. Do not fuel an engine while it is operating. To avoid the dangerous or deadly build-up of toxic fumes, adequate ventilation should be provided when using petrol- or diesel-powered tools in enclosed spaces.

A.2.4 ABRASIVE BLADE TOOLS

When using abrasive blade tools, it is essential to select the proper blade for the particular material being worked on. Abrasive blades used for cutting concrete, masonry or metal should be examined for cracks or scratches before each use. A blade guard must always be used and should cover a substantial portion of the blade. The manufacturer's installation and operating instructions must always be followed. Safety goggles must be worn. Operators should avoid pushing the blade too hard to prevent overheating.

A.2.5 CHAINSAWS

Chainsaws may be used for cutting timber, concrete and masonry. The chainsaw is one of the most dangerous hand tools used in demolition. Serious injuries can result from the kickback reaction that occurs when the nose of the chain comes in contact with a solid object. To avoid being directly in the kickback path, the operator should position their body entirely to one side of the saw. The operator should never reach above chest height with the saw. A firm grip with both hands is an essential basic handling precaution. Protective gear, including eye, ear, head and hand protection, should be worn at all times. Protective "leggings" (chaps) are available and should be worn by chainsaw operators. Chainsaws must never be drop started. Special precautions may be necessary if working at height.

A.3 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Safety equipment protects only if it is being used. A number of hazards in demolition work require the use personal protective equipment. These hazards range from the sharp edges on debris to exposure to hazardous chemicals.

A.3.1 PROTECTIVE CLOTHING

Special clothing is required for employees handling certain hazardous materials.

A.3.2 SAFETY FOOTWEAR

Safety footwear must be worn to protect against foot injuries caused by:

(a) Objects dropping on or rolled over the front of the foot;

(b) Stepping on nails or other sharp objects;

(c) Slips and falls.

A.3.3 SAFETY HELMET

Safety helmets must be worn to prevent head injuries.

A.3.4 EYE AND FACE PROTECTION

Employees who are exposed to eye and face hazards when carrying out certain activities such as welding and cutting, or using abrasive wheels and paving breakers, must use safety glasses, goggles, face shields, welding goggles and welding helmets.

A.3.5 HEARING PROTECTION

Day-to-day exposure to loud noise can result in permanent hearing loss. Some form of personal protective equipment such as ear muffs, disposable fibre or foam plugs, or reusable foam or rubber plugs must therefore be provided for employees who are exposed to excessive noise levels. The hearing protective devices should be appropriate to the noise levels of the workplace.

A.3.6 RESPIRATORY PROTECTION

The use of suitable respirators is required whenever employees enter areas in which the concentration of dust, asbestos, or hazardous chemicals exceeds the concentrations specified in Workplace Exposure Standards, or when employees enter areas deficient in oxygen. (Refer to the OSH publications *Workplace Exposure Standards* and *A Guide to Respirators and Breathing Apparatus.)*

APPENDIX B: CUTTING AND WELDING

B.1 PERSONAL PROTECTIVE EQUIPMENT

In addition to fire and explosion hazards, welders and cutters may be exposed to health hazards in the form of intense light rays and toxic fumes. The intense flame at the tip of the torch, or the electrode, emits light rays of three types: visible, infrared, and ultraviolet rays which can cause "welder's flash". To prevent damage to the eyes, goggles or safety glasses with impact-resistant glass filters in accordance with an appropriate standard should be worn during cutting. Tinted lenses drastically reduce visibility, and should only be worn while actually cutting. Face shields are required when there is a chance that splatter will hit the employee's face.

To eliminate skin damage, employees should wear proper protective clothing. Synthetic fabric should not be worn, because it may melt when struck by hot slag. Cuffs and open pockets catch burning metal and should be eliminated. Flame-resistant gloves and safety shoes should always be worn while cutting. Clothes should be kept free from oil and grease, because these increase the clothing's flammability.

B.2 FUMES AND GASES

Hazardous fumes and gases are released into the air during welding and cutting (see table). Some of these are released regardless of the material being cut; others depend on the type of metal or its coating. The two most hazardous are cutting through lead-based paint or lead pipes and cutting in the presence of degreasers. Cutting materials which have been cleaned with a degreaser, or even in the vicinity of a degreasing operation, can produce deadly phosgene gas. Adequate ventilation should be ensured before starting any cutting job.

Operation or Source	Gas or Fume Given Off
Cutting	Carbon monoxide
Cutting and welding	Ozone
Welding rods	Fluorides
Chrome-plated fixtures	Chromates
Cadmium	Cadmium
Materials cleaned with degreasers	Phosgene gas and hydrochloric acid

B.2.1 VENTILATION

Cutting in enclosed spaces such as tanks, tunnels or small closed rooms, demands particular attention to employees' safety. A hazardous situation can develop because oxygen can easily be replaced by gases or toxic fumes. A fume eductor is a hose attached to a cutting torch or welding gun through which fumes are exhausted at high velocity. If adequate mechanical ventilation cannot be provided, employees should be equipped with air-supplied respirators and a lifeline which is constantly watched by an outside observer. Cylinders should be kept outside the enclosed space, and gases should be shut off at the cylinder when work stops for more than a few minutes. A leaky hose or fitting in an enclosed space can easily result in an explosive or oxygen-deficient, or oxygen-enriched, atmosphere.

B.2.2 CONTAINERS THAT HAVE HELD COMBUSTIBLES

Welding and cutting work on containers (refer also part 5.13) that have held combustible solids, liquids, gases, or dusts can result in fire or explosion if the containers are not entirely free of these materials. It is important that a rigorous cleaning process is undertaken and that instructions for cleaning are rigidly followed. Containers which have held any of the following materials are considered dangerous, and hot work should not be started before they are properly cleaned:

(a) Petrol, kerosene, solvents, or light oils;

(b) Acids which react with metal and produce explosive hydrogen gas;

(c) Heavy oils, tars, or solids which release combustible gases when exposed to heat;

(d) Combustible solids which could form an explosive dust cloud.

As a general rule, any container which has held combustibles should be considered unsafe until proven otherwise by a qualified person.

Safety precautions consistent with appropriate standards shall be taken when welding is required.

B.3 SAFE USE OF CUTTING TORCHES

B.3.1 CYLINDER HANDLING

Cylinders should never be dropped, dragged or struck in any way. Pry bars and hammers must never be used on any part of the cutting torch system. Cylinders must always be kept in an upright position and secured. When cylinders are transported or moved at the job site while connected for use, the cylinder valves must be closed, and the cylinders secured in place. Valve protection caps or other protective devices must be in place when cylinders are not connected for use.

When cylinders are hoisted by crane, they must be secured to a cradle or platform. Cylinders must never be lifted by their valve protection caps or with electromagnets. Oil or grease must never be used on threads.

B.3.2 CYLINDER STORAGE

The contractor should set aside separate areas for the storage of fuel, gas and oxygen cylinders. These areas should be at least 6 metres apart, outside the range of falling debris, and away from heavily trafficked areas. Storage areas should be kept clear of combustibles, including fuels, and be designated as "NO SMOKING" areas. Cylinders should not be placed where they could become part of an electrical circuit, such as near radiators and piping systems that may be used for grounding electrical equipment such as arc welding machines. Storage areas should be protected from direct sunlight.

B.3.3 EMPTY CYLINDERS

Empty cylinders should be treated the same way as full cylinders. Empties should be stored in a designated area after the following procedure has been completed:

(a) Cylinder marked "EMPTY" or "MT";

(b) Valve closed;

(c) Valve protection device replaced;

(d) Cylinder secured.

B.3.4 TORCH SET-UP

Setting up a cutting torch requires careful attention to a detailed procedure. Only properly trained employees should set up this equipment. There should be no smoking while setting up the equipment.

After removing the valve protection cap, the regulator is attached according to the procedure outlined by the manufacturer. Pressure regulators should be serviced and tested for accuracy on a regular basis. No oil or grease should be used on the threads. Flashback arresters must be fitted to all cutting torch assemblies and should be mandatory.

B.3.5 HOSES

It is important that the regulators are used only for those gases listed on the regulator. Oxygen fittings have right-hand threads and fuel gas fittings have left-hand threads to prevent accidental switching. To avoid confusion, oxygen, acetylene, propane and other fuel gases should be called by their proper names, and not by "air" or "gas".

Once the regulators are in place, the hoses (maroon for fuel, black for oxygen) are connected and the torch is attached. Fittings must not be forced. Any sign of wear means a hose must be repaired or replaced at once. Hoses which are kept neatly coiled are less likely to become kinked, tangled or run over.

Torch valves and fittings should not be oiled or greased. Torches should be treated with the respect deserving a fine tool and never as a slag hammer.

B.3.6 LEAKS

A leak test can be performed to assure that fittings and valves are correctly seated. The test involves pressurising the lines and applying soapy water on each fitting and valve. Leaks, which show up as bubbles, must be repaired. If, when the valve on a fuel gas cylinder is opened, there is a leak around the valve stem, the valve should be closed and the gland nut tightened. If this action does not stop the leak, the use of the cylinder should be discontinued, and it should be properly tagged and removed from the work area. If the fuel gas should leak from the cylinder valve and cannot be shut off, the cylinder should be tagged and removed from the work area. If a leak develops at a fuse plug or other safety device, the cylinder should be removed from the work area.

B.3.7 START-UP PROCEDURES

Operators must be properly trained in the safe and correct methods of setting up, lighting and shutting down of cutting and welding equipment.

CAUTION: A squealing sound means that gases have flashed back into the torch. This fire could burn back into the hoses. Torch valves and cylinder valves must be quickly closed, and the cause of the flashback remedied before relighting the torch. Common causes of flashbacks are: improper pressures; kinked hoses; loose, clogged, or overheated tips; or faulty or damaged O-rings between the handpiece and torch head. Hoses that have been damaged should be replaced.

B.4 SAFETY IN ARC WELDING

The hazards encountered in electric arc welding are similar to those encountered in cutting, with compressed gas hazards being replaced by those of electricity. The dangers of flying sparks must be guarded against, particularly near floor and wall openings where other employees or combustibles may be hidden from view. Personal protective equipment requirements are identical, except that arc welders are required to wear a welding helmet fitted with the correct shade of filter in accordance with an appropriate standard. The higher intensity of the light rays emitted requires that arc welding be shielded by screens or curtains which will protect any person in the vicinity.

B.4.1 ELECTRIC SHOCK

The avoidance of electric shock is, in most cases, within the control of the welder. Therefore, it is particularly important to be aware of and observe safe work practices. The employer should provide employees with instruction and training on the procedures to avoid electric shock while welding. Printed rules and instructions covering the safe operation of the equipment should be made available to the employees, and supervisors should ensure that these are strictly followed.

Although the voltages used in arc welding are considered low, they can be quite dangerous under certain conditions. Mild shocks can cause an involuntary contraction of muscles which might cause an employee to fall from the work platform. Skin which is damp from perspiration or wet working conditions may be conductive enough to cause violent muscular contractions that could prevent the welder from letting go of the live part. Careful adherence to these safe work practices will minimise the dangers of electric shock to the welder and to other employees.

B.4.2 CABLES

Cables should be inspected regularly for wear and damage. Cables with damaged insulation should be replaced or repaired. Lengths of cable produce heat when in use, so cables should be neatly uncoiled to prevent damage to the insulation.

B.5 LIQUID OXYGEN

The use of liquid oxygen on construction sites is not generally recommended due to the hazards associated with it.

Where liquid oxygen usage is intended, the OSH health and safety inspector may require a formal work method statement and drawings. If required, the drawings should include the complete layout, foundations and fencing, equipment, and the workfaces where the oxygen is to be used. The method statement should include the installation, filling and maintenance, usage, training, personnel protection supplied, manufacturer's specification sheets for the equipment, and periods of usage of the installation.

The liquid oxygen tank must comply with the requirements of the Hazardous Equipment Regulations (1994) issued under the HSE Act. The tank must be sited on a secure concrete pad of adequate dimensions and must be securely fenced. Adequate means of access for filling and maintenance are to be provided. The area must be a non-smoking area.

All equipment used (including but not limited to vaporisers, valves, flashback arrestors, pressure gauges, etc.) must be in good condition

and suitable for its purpose. All proprietary equipment must be used in accordance with the supplier's and manufacturer's instructions.

Adequate training must be given to staff on the correct usage and the hazards associated with liquid oxygen. Adequate signposting shall be erected, warning both the employees and any members of the public of the dangers and hazards. Liquid oxygen data sheets are to be freely available to the workforce and posted in smoko sheds.

APPENDIX C: ADDITIONAL REFERENCES

(1) BS 6187:1982 *Code of Practice for Demolition.*

(2) AS 2601:1983. *Australian Standard Demolition Code* .

(3) *Construction and Demolition Hazards.* Building Industry Authority Approved Document F5.

(4) *Health and Safety in Demolition Work.* Parts 1 to 4 of Guidance Note GS 29/1 from the Health and Safety Executive.

(5) *Demolition of Reinforced and Prestressed Concrete Structures.* Fédération Internationale de la Précontrainte, Wexham Springs.

(6) *Demolition Safety Manual.* National Association of Demolition Contractors, Illinois.

(7) *Demolition.* ACT Code of Practice 1993. Australian Capital Territory Government.

(8) *Decommissioning and Demolition.* Proceedings of the Second International Conference 1990, University of Manchester.

(9) Various OSH publications.