demo works

Health and Safety Manual

Violence and Harassment Policy

2017



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Corporate Health and Safety Policy Statement

Demo Works Inc. is committed to preventing the accidental loss of any of its resources, including employees and physical assets.

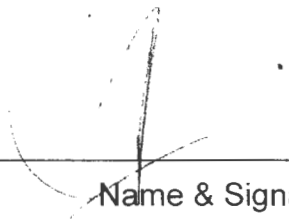
In fulfilling this commitment to protect both people and property, management will provide and maintain a safe and healthy work environment, in accordance with industry standards and in compliance with legislative requirements, and will strive to eliminate any foreseeable hazards which may result in property damage, accidents, or personal injury/illness.

We recognize that the responsibility for health and safety are shared. All employees will be equally responsible for minimizing accidents within our facilities and on our work sites. Safe work practices and job procedures will be clearly defined in the company's Health and Safety Manual for all employees to follow.

Accidental loss can be controlled through good management in combination with active employee involvement. Safety is the direct responsibility of all managers, supervisors, employees, and contractors.

All management activities will comply with company safety requirements as they relate to planning, operation and maintenance of facilities and equipment. All employees will perform their jobs properly in accordance with established procedures and safe work practices.

I trust that all of you will join me in a personal commitment to make safety a way of life.



Name & Signature

June 22, 2017

Date

***The safety information in this policy does not take precedence over Occupational Health and Safety legislation. All employees should be familiar with the *Occupational Health and Safety Act* and the *Regulations for Construction Projects* (current edition).**

Violence and Harassment Policies

What the law says.	*What should the employer do?*
• Employers are required to prepare policies on workplace violence and harassment and post them in the workplace. [OHSA s. 32.0.1(1)(a),(c)] [OHSA s.32.0.1(1)(b)] • These policies must be reviewed annually. • **If there are 5 or fewer workers regularly employed in the workplace, written policies are not required.** [OHSA s.32.0.1(2),(3)]	☑ Decide whether to prepare separate policies for workplace violence and workplace harassment or combine them with another policy (such as the company health & safety policy) ☑ Develop the policy using the guidelines listed below

Policy Requirements – Workplace Violence and Harassment

The workplace violence and harassment policies should:

- Show the employer's commitment to protecting worker's from workplace violence
- Address violence from all possible sources (clients, employees/employers, strangers and personal relationships)
- Acknowledge the right of every worker to work in a violence and harassment free workplace
- Set out roles and responsibilities of all workplace parties in supporting the policy and program
- Be signed and dated by the highest level of management at the workplace
- Be posted in a conspicuous place and explained to all employees
- Be reviewed annually

Workplace Violence Policy - Sample

Demo Works Inc.

The management of Demo Works Inc. recognizes the potential for workplace violence and is committed to working with its employees to provide a safe work environment.

Workplace violence will not be tolerated on company premises, or while an employee is conducting company business at other locations. Any act of violence committed by or against any employee is unacceptable and will be subject to Demo Works discipline policy and/or legal action.

For the purpose of this policy, violence includes but is not limited to:

- The use of, or attempt to use, physical force by a person against an employee, in the workplace, that causes or could cause physical injury. For example: hitting, shoving, pushing, or kicking.
- Any threat, behavior or action directed at an employee and interpreted to carry the potential to harm or endanger the safety of the employee. For example: Threatening language, shaking fists, destroying property or throwing objects.

Demo Works Inc. will take whatever steps are appropriate to protect our employees from the potential risks associated with workplace violence.

Management will investigate and deal with all incidents and complaints of workplace violence in a fair and timely manner. The policy and program will be reviewed and updated, if required, annually.

Supervisors must ensure that all measures and procedures set out in this policy and the supporting program are carried out in the workplace.

Workers are expected to comply with this policy and program and to report any concerns or complaints to their supervisor.

This policy prohibits reprisals against employees, acting in good faith, who report incidents of workplace violence or who are involved in an investigation. Management will take all reasonable and practical measures to prevent reprisals, threats of reprisal, or further violence.

With everyone's cooperation, Demo Works In. will continue to be a safe and healthy workplace.

January 21, 2017

Sam Sayed, Secretary Treasurer — Date

Workplace Harassment Policy - Sample

Demo Works Inc.

The management of Demo Works is committed to providing a work environment in which all individuals are treated with respect and dignity.

Workplace harassment will not be tolerated from any person in the workplace. All employees of this company are expected to follow this policy. on company premises, or while an employee is conducting company business at other locations. Any act of violence committed by or against any employee is unacceptable and will be subject to Demo Works' discipline policy and/or legal action.

For the purpose of this policy, violence includes but is not limited to:

- The use of, or attempt to use, physical force by a person against an employee, in the workplace, that causes or could cause physical injury. For example: hitting, shoving, pushing, or kicking.
- Any threat, behavior or action directed at an employee and interpreted to carry the potential to harm or endanger the safety of the employee. For example: Threatening language, shaking fists, destroying property or throwing objects.

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With everyone's cooperation, Demo Works will continue to be a safe and healthy workplace.

Sam Sayed, Secretary Treasurer — January 21, 2017

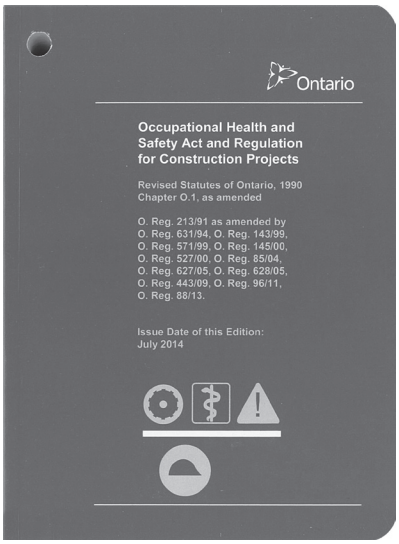
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Legal Responsibilities and Emergencies

1 LEGAL RESPONSIBILITIES

General

The health and safety responsibilities of all parties on a construction project are specified in the current *Occupational Health and Safety Act and Regulations for Construction Projects* (the "Green Book").



Responsibilities are prescribed in particular for constructor, employer, supervisor, and worker. Each workplace party has specific responsibilities to fulfill on a construction project that contribute to a safe and healthy workplace. Before beginning work, it is important for everyone to know and understand their legal rights and responsibilities.

For more detailed information, consult the current Act and Regulations.

Remember — safety begins with you!

Duties of Constructor

- Appoint a supervisor if 5 or more workers are on the project at the same time. Ensure that the project is supervised at all times.
- A project that lasts more than 3 months and has 20 or more workers must have a Joint Health and Safety Committee.
- If a Joint Health and Safety Committee is not required and there are more than 5 workers, the workers must select a Health and Safety Representative.
- Complete a Ministry of Labour (MOL) registration form.
- Keep a copy of all employer-approved registration forms on site while employers are on the project.
- Send a notification of project to the MOL.
- Develop written emergency procedures, make sure your employees know what they are, and post them on site.
- Ensure ready access to a telephone, two-way radio, or other system in the event of an emergency.
- Report a fatality, critical injury, or other prescribed incident such as a critical injury to the MOL.
- Ensure all workers on site are at least 16 years of age.

Duties of Employer

- Read Sections 25 and 26 of the *Occupational Health and Safety Act*. It lists many of your responsibilities.
- Appoint a supervisor if 5 or more of the employer's workers are on the project at the same time. Ensure that they are supervised at all times.
- Provide workers with training as required by law (Working at Heights, WHMIS, etc.).
- Ensure workers are qualified to do work that must be done only by qualified workers (electricians, pipe fitters, etc.).
- Develop written procedures for rescuing a worker whose fall has been arrested (i.e., a worker hanging by a harness).

Duties of Supervisor

- Ensure that workers usethe methods, procedures, and equipment required by the *Occupational Health and Safety Act and Regulations for Construction Projects*
- use or wear the equipment or clothing that the employer requires.
- Tell workers about actual or potential dangers.
- Give workers written instructions when required.
- Take every precaution reasonable to protect workers.

Duties of Worker

- Select worker representatives for the Joint Health and Safety Committee.
- Tell your supervisor or employer about equipment problems or other hazards that could hurt you or other workers.
- Follow your employer's instructions to use or wear equipment, protective devices, or clothing.
- Never engage in horseplay on site (pranks, competitions, showing off your strength, roughhousing, or unnecessary running).

Rights of Worker

1. The right to know what hazards are in the workplace.

2. The right to participate in keeping the workplace healthy and safe by joining a Health and Safety Committee or becoming a health and safety representative.

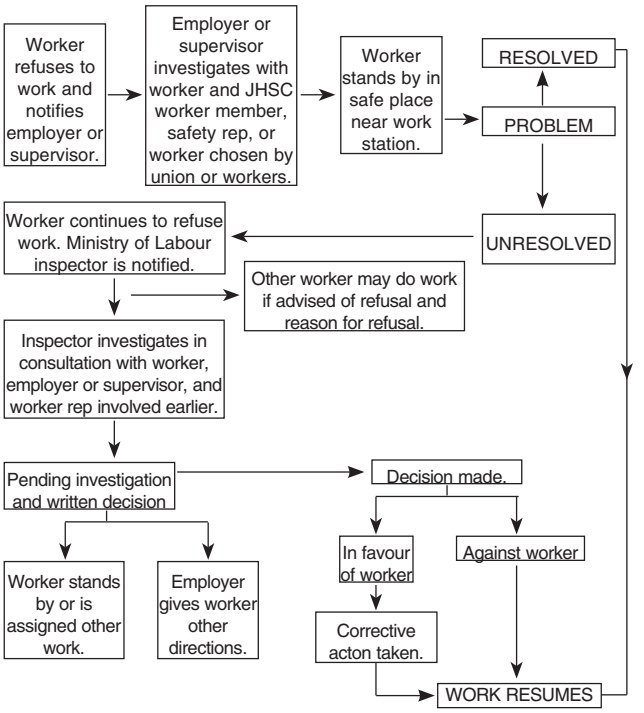
3. The right to refuse unsafe work that the worker believes endangers his or her health or safety or the health or safety of others (Figure 1). See section 43 of the Occupational Health and Safety Act.

Health and Safety Representative

The health and safety representative must be familiar with

– the current *Occupational Health and Safety Act and Regulations for Construction Projects*
– procedures in the event of an emergency (see chapter 2 on Emergency Procedures)
– procedures for refusal to work where health and safety are in danger (Figure 1).

Figure 1: Right to Refuse Work Where Health or Safety in Danger
***(Occupational Health and Safety Act,* Part V)**



Certified Committee Members

Where a project regularly employs 50 or more workers, the health and safety committee on the project must have at least one member representing workers and one member representing the constructor who are certified by the Workplace Safety and Insurance Board (Figure 2).

If no members of a health and safety committee are certified, the workers and constructor must each select one member of the committee to become certified.

A certified member who receives a complaint regarding a dangerous circumstance can investigate the complaint under the authority of the *Occupational Health and Safety Act.* The member may also ask a supervisor to investigate a situation where the member "has reason to believe" that a dangerous circumstance may exist.

The supervisor must investigate the situation promptly in the presence of the certified member.

The certified member may also request that another certified member representing the other party at the workplace investigate the situation if the first certified member "has reason to believe" that the dangerous circumstance still exists after the supervisor's investigation and remedial action, if any, has been taken.

The second certified member must promptly investigate the situation in the presence of the first certified member and, if both certified members agree, they may direct the constructor or employer to stop work or stop the use of any part of the workplace, including machines and other equipment. The constructor or employer must immediately comply with the order.

If both certified members do not agree that a dangerous circumstance exists, either may request that a Ministry of Labour inspector investigate the situation. The inspector must investigate and provide both members with a written report.

Ministry of Labour Inspectors

The inspector can visit a site at any time and exercise fairly broad powers to inspect, ask questions, and give orders. If the inspector approaches a worker directly, the worker must answer questions and cooperate. The supervisor must be informed of any orders given or recommendations made.

In some cases the health and safety representative, worker member of a health and safety committee, or worker selected by fellow workers or the union has a right to take part in accident investigation.

The results of accident investigation and reporting should be made known to all personnel on site. Recommendations should be implemented to prevent the accident from happening again.

Training and Orientation

Statistics show that about 20% of all injuries to workers occur within their first 30 days on the job. This fact highlights the importance of orientation.

Newly hired workers may be young or old, male or female, experienced or inexperienced in construction. The worker may be new to the site, new to the type of work, or new to the company. A worker coming to any project for the first time should be considered a new worker and should be given proper orientation and training.

New employees must be told and, if necessary, trained and shown what is expected of them in

- work performance
- safe operation of tools and equipment
- procedures around hazardous materials
- proper use of any required personal protective clothing and equipment.

They must also be told, and preferably shown, the location of

- first aid kit or first aid station
- fire alarms and exits
- fire extinguishers and standpipes
- emergency telephones
- eyewash station
- supervisor's office
- tool crib
- washrooms
- lunchroom.

Health and Safety Representatives and Committee Requirements Under the *Occupational Health and Safety Act*

Size and Duration of Project	Representative or Committee	Who Creates Committee	Number of Members	Membership Requirements	Selection of Members	Powers and Rights
5 Workers or Less						
6+ workers	One Health and Safety Representative				Representative selected by workers or union(s)	• Obtain information from a constructor or employer regarding the testing of equipment, materials, or chemicals in the workplace. • Inspect the workplace at least once a month, with the full cooperation of constructor, employers, and workers. • Ask for and obtain information regarding existing or potential hazards in the workplace. • Make health and safety recommendations to a constructor or employer, who must respond in writing within 21 days, either giving a timetable for implementation or giving reasons for disagreeing with the recommendations. • Where a person has been killed or critically injured in the workplace, investigate the circumstances of the accident and report findings to a director of the Ministry of Labour. • Exercise all the powers granted to the health and safety representative by virtue of a collective agreement.
20-49 workers and more than 3 months	Joint Health and Safety Committee	Constructor	At least two	At least one non-management worker at the project and one management representative from the project if possible.	Worker representatives selected from the site by workers or trade union(s) represented. Management representatives selected by constructor or employer.	• Identify situations that may be a source of danger or hazard to workers. • Make recommendations regarding health and safety matters. • Recommend the establishment, maintenance, and monitoring of programs. • Obtain information from constructors or employers regarding testing of equipment or environments and be present when testing is initiated.
50+ workers and more than 3 months	Joint Health and Safety Committee	Constructor	At least four	Half non-management workers from the workplace with at least one certified. Half management representatives from the workplace if possible with at least one certified.	Worker representatives selected from the site by workers or trade union(s) represented. Management representatives selected by constructor or employer.	
	Worker Trades Committee	Health and Safety Committee	At least one worker representative from each trade	One worker representative from each trade.	Members to be selected by trade workers or trade union(s) at the site. Members do not have to be workers at the site.	Advise the joint health and safety committee of the health and safety concerns of the workers in the trades at the workplace.

Figure 2

These locations can be pointed out during a tour of the workplace when the new worker is introduced to co-workers, supervision, and the health and safety representative. To make orientation successful, supervisors should follow some simple steps.

- Talk to new employees. Put them at ease. Find out how much they know already. Explain why their job must be done right, how it relates to the rest of the operation, and what hazards may be involved.
- Explain assignments carefully to new workers. Tell them, show them, ask questions to make sure they understand. Cover one step at a time. Make key operations and safety points clear. Be patient and go slowly.
- Test the new worker's performance. Watch while the job is being done. Commend good work. When necessary, show how the job can be done more safely and efficiently.
- Let new workers continue on their own. Tell them who to contact for help and encourage them to get help when needed.
- Follow up. Check on work frequently at first. Look for any bad habits, unnecessary motions, or unsafe acts that need correcting. Ease off when you're convinced that workers are doing the job safely and correctly.

Jobsite Safety Talks

Jobsite talks can help prevent accidents and injuries by promoting hazard awareness in the workplace. Supervisors should present safety talks on a regular basis and follow these guidelines.

- Before presenting a prepared talk, look it over. Instead of reading the talk to your crew, use your own words. Personnel will more likely accept your natural manner than a formal presentation.
- Choose subjects that are directly related to site conditions or the company's health and safety policy and program.
- Encourage participation. Get the crew to talk about close calls and hazards. Solutions to these problems can become the subject of future talks.
- Make a note of any hazards the crew may mention as

well as any suggestions for improving health and safety. Subjects requiring management attention should be referred to management.
- Always follow up. Tell the crew what has been done to correct problems and improve conditions on the job.

Safety Tips and **Safety Talks** are available from the IHSA. Check them out at ihsa.ca/resources/safetytalks.aspx or order the Safety Talks Manual (V005).

Post on Site Checklist

Construction employers are required to have the following items posted or available at each jobsite:

- ❑ *Occupational Health and Safety Act and Regulations for Construction Projects* (the "Green book")
- ❑ Regulation 1101 (First Aid Requirements)
- ❑ Company health and safety policy and program
- ❑ Company workplace violence and harassment policy
- ❑ Ministry of Labour inspector's orders and report
- ❑ Material Safety Data Sheets (available)
- ❑ Emergency response plan
- ❑ Fall arrest rescue procedures (available)
- ❑ *WSIB's In Case of Injury* poster (P085 available from IHSA)
- ❑ MOL's *Health & Safety at Work: Prevention Starts Here* poster
- ❑ MOL "Notice of Project" (Form 0175) if the project is valued at more than $50,000 or falls under one of the conditions in section 6 of the Construction Projects Regulation (213/91).
- ❑ MOL Form 1000 "Registration of Constructors and Employers Engaged in Construction" (available)
- ❑ Name of constructor and head office info
- ❑ Address and phone number of the nearest MOL office
- ❑ DANGER signs in hazardous areas (if applicable)
- ❑ Location of toilets and clean-up facilities
- ❑ Valid certificate of first aider on duty
- ❑ Inspection card for first aid box
- ❑ Employer records of first aid treatment given (available)

  Name, trade, and employer of (as applicable):
  - health and safety representative
  - each member of the JHSC.

- ❑ Emergency phone numbers and location of nearest hospital (Use P103: Emergency Response Poster)

Accidents and Injuries

All accidents and injuries, regardless of severity, must be reported immediately.

Procedures for reporting accidents—and the type of accidents that must be reported—are spelled out in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

Further information is available from the Workplace Safety and Insurance Board (WSIB) and Ministry of Labour (MOL).

In all cases of injury, the **EMPLOYER** must do the following.

1. Make sure that first aid is given immediately, as required by law.
2. Record the first aid treatment or advice given to the worker.
3. Complete and give to the worker a Treatment Memorandum (Form 156) if health care is needed.
4. Provide immediate transportation to a hospital or a physician's office, if necessary.
5. Submit to the Workplace Safety and Insurance Board (WSIB), within three days of learning of an accident, an Employer's Report of an Accident/Injury/Industrial Disease (Form 7) and any other information that may be required.
6. Pay full wages and benefits for the day or shift on which the injury occurred when compensation is payable for loss of earnings.
7. Notify the Ministry of Labour, health and safety representative and/or committee, and union as required by legislation.

The **WORKER** must do the following.

1. Promptly obtain first aid.
2. Notify the employer, foreman, supervisor, and worker safety representative immediately of an injury requiring health care and obtain from the employer a completed Treatment Memorandum (Form 156) to take to the physician or the hospital. Failure to report promptly can affect your benefits and subject your employer to fines.
3. Choose a physician or other qualified practitioner with the understanding that a change of physician cannot be made without permission of the WSIB.
4. Complete and promptly return all report forms received from the WSIB.

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Asbestos	Worker who works in a Type 1, Type 2, or Type 3 asbestos operation.	Instruction and training in hazards, hygiene, work practices, respirators, protective clothing.	Asbestos Regulation 278/05, section 19
	Worker who is involved in a Type 3 operation.	Asbestos Abatement Worker Training Program, approved by the Ministry of Training, Colleges, and Universities.	Asbestos Regulation 278/05, section 20
	Supervisor who is involved in a Type 3 operation.	Asbestos Abatement Supervisor Training Program, approved by the Ministry of Training, Colleges, and Universities, OR equivalent training in another Canadian province or territory as determined by an MOL director.	Asbestos Regulation 278/05, section 20
Certified Member	Members of Joint Health & Safety Committee: at least one representing constructor/employer and at least one representing workers	- "Construction Health & Safety Representative" - "Sector-Specific Training" - "Simulated Hazard Analysis" (IHSA programs)	Occupational Health and Safety Act, section 9(12)
Chainsaw	Workers who use a chainsaw.	Adequate training in the chainsaw's use.	Construction Regulation, section 112
Compressed air	Worker who is appointed by employer as the superintendent of all work in compressed air at a project.	Competent person: knowledge, training, and experience to organize the work.	Construction Regulation, section 336 (1)
	Worker who is subjected to compressed air.	Full instruction in hazards and safeguards (signed acknowledgement by worker).	Construction Regulation, section 336 (2)
	Worker who is designated as lock tender by the superintendent at a project, and who attends to the controls of an air lock.	Competent worker: knowledge, training, and experience to perform the work.	Construction Regulation, section 337 (1)
	Worker (at least one in addition to the lock tender) who can perform the duties of the lock tender in an emergency.	Competent worker.	Construction Regulation, section 337 (3)
	Worker who is designated by superintendent to be in charge of the compressors for a work chamber and air lock.	Competent worker, AND either Hoisting Engineer certification (Trades Qualification & Apprenticeship Act) or Stationary Engineer certification (Operating Engineers Act).	Construction Regulation, section 359 (1)
Confined spaces	Firefighter or gas technician who performs emergency work in a confined space.	Training to work safely in confined spaces.	Confined Spaces Regulation, section 3
	Person who carries out an assessment of the hazards related to the confined space before a worker enters.	A person with adequate knowledge, training, and experience.	Confined Spaces Regulation, section 6
	Person who develops and implements the written plan for the confined space, including procedures for control of	Competent person.	Confined Spaces Regulation, section 7

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Confined spaces (continued)	Every worker who enters a confined space or performs related work. (Workplaces other than projects)	Adequate training to perform the work safely in accordance with the employer's written plan, including hazard recognition and safe work practices.	Confined Spaces Regulation, sections 8 and 9
	Person who delivers hazard recognition training. (Workplaces other than projects)	Adequate training to perform the work safely in accordance with the employer's written plan, including hazard recognition and safe work practices.	Confined Spaces Regulation, sections 8 and 9
	Every worker who enters a confined space or who performs related work. (Projects)	Adequate training to perform the work safely in accordance with the written plan.	Confined Spaces Regulation, section 9.1
	Person who, before each shift, verifies that the entry permit complies with the relevant plan.	Competent person.	Confined Spaces Regulation, section 10
	Adequate number of persons who are available for immediate implementation of the on-site rescue procedures.	Training in on-site rescue procedures, first aid, CPR, and the use of rescue equipment in accordance with the employer's written plan.	Confined Spaces Regulation, section 11
	Person who inspects the rescue equipment as often as necessary to ensure it is in good working order.	A person with adequate knowledge, training, and experience.	Confined Spaces Regulation, section 12
	Worker who performs tests before and while a worker is in a confined space to ensure that acceptable atmospheric levels are maintained in accordance with the	A person with adequate knowledge, training, and experience.	Confined Spaces Regulation, section 18
	Person who inspects respiratory protective equipment, locating and rescue equipment, and any other safety equipment.	A person with adequate knowledge, training, and experience.	Confined Spaces Regulation, sections 19 & 20
Cranes, hoisting and rigging (continued on next page)	Workers who operate a crane or similar hoisting device capable of raising, lowering, or moving material that weighs more than 7,260 kg.	Hoisting Engineer certification training under Trades Qualification & Apprenticeship Act.	Construction Regulation, section 150 (1)
	Workers who operate a crane or similar hoisting device capable of raising, lowering, or moving material that weighs less than 7,260 kg.	Training in the safe operation of the crane or similar hoisting device (written proof).	Construction Regulation, section 150 (2), (3)
	Worker who is designated by the professional engineer to inspect a crane to ensure structural integrity.	Competent worker.	Construction Regulation, section 153 (8)
	Workers involved with the hoisting operation of a cable-supported platform, bucket, basket, etc. that is used as a workplace.	Adequate instructions about requirements, restrictions, hazards of the hoisting operation.	Construction Regulation, section 153 (12)
	Worker who visually inspects the crane's structural elements and rigging for defects before each use.	Competent worker.	Construction Regulation, section 153 (9)
	Worker who sets-up, assembles, extends, and dismantles a crane or similar hoisting device.	Competent worker.	Construction Regulation, section 154 (1)

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Cranes, hoisting and rigging	Worker who is designated by a professional engineer and who inspects structural elements and components of a tower crane before and after erection, before	Competent worker.	Construction Regulation, sections 158 (1) and 159 (1) (3)
	Worker who is designated as a signaller and who warns the operator each time equipment or load may approach the minimum distance when operating near an energized overhead electrical	Competent worker.	Construction Regulation, section 187 (3)
	Worker who performs operational tests on the automatic limit switches and overload limit devices of a tower crane.	Competent worker.	Construction Regulation, section 161 (1)
	Worker who visually inspects all cable used by a crane or similar hoisting device when in use (at least once a month).	Competent worker.	Construction Regulation, section 170 (1)
Drowning protection	Workers (at least two) who shall be available to perform rescue operations, if a worker may drown.	Training to perform rescue operations.	Construction Regulation, section 27 (2) (a)
Electrical hazards	Workers who connect, maintain, or modify electrical equipment or installations.	Electrician certification training under Trades Qualification and Apprenticeship Act, OR permission under the Trades Qualification and Apprenticeship Act or Technical Standards Safety Act.	Construction Regulation, section 182 (1)
	Worker who is designated as a signaller and who warns the operator of a crane/ similar hoisting device/backhoe/power shovel/other vehicle or equipment each time the equipment or load approaches the minimum distance from an energized overhead electrical conductor.	Competent worker.	Construction Regulation, section 188 (8)
	Worker ensures that a circuit (300 to 600 volts) is not inadvertently energized while work is being done on or near electrical equipment/installation that has been disconnected but not locked out.	Competent worker	Construction Regulation, section 190 (9) (b) (ii)
	Worker who can perform rescue operations, including CPR, and who can see a worker who is performing work on or near energized exposed parts of electrical equipment/installation.	Competent worker	Construction Regulation, section 191 (8)
	Worker who may be exposed to the hazard of electrical shock or burn while performing work.	Training in the proper use, care, and storage of rubber gloves and leather protectors.	Construction Regulation, section 193 (6)

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Elevating work platform	- Workers who will operate an elevating work platform for first time - Workers who inspect an elevating work platform each day before use	Oral and written instruction on the operation AND training in the operation of that class of elevating work platform, including a hands-on demonstration	Construction Regulation, sections 147 and 144 (3)
Equipment	Worker who inspects mechanically-powered vehicles, machines, tools and equipment (rated at greater than 10 hp)	Competent worker	Construction Regulation, section 94 (1)
Explosives	Worker who is designated by the blasting employer to be in charge of the blasting operations	Competent worker	Construction Regulation, section 196 (1)
	Worker who handles, transports, prepares, and uses explosives on a project	Competent worker	Construction Regulation, section 197
Explosive-actuated fastening tool	Workers who use an explosive-actuated fastening tool	Adequate training in the tool's use (carry written proof)	Construction Regulation, section 117 (1), (2)
Excavation	Person who supervises the removal of a support system for the walls of an excavation	Competent person	Construction Regulation, section 239 (4)
Fall protection	Workers who use a fall protection system	Training in its use AND adequate oral and written instructions (written records)	Construction Regulation, section 26.2 (1)
	Person who trains and gives adequate oral and written instructions to worker who uses a fall protection system	Competent person	Construction Regulation, section 26.2 (1)
	Worker who inspects the travel-restraint system before each use	Competent worker	Construction Regulation, section 26.4 (3)
	Worker who inspects the fall-restricting system before each use.	Competent worker.	Construction Regulation, section 26.5 (2)
	Worker who inspects the fall-arrest system before each use.	Competent worker.	Construction Regulation, section 26.6 (6)
	Worker who installs the safety net.	Competent worker.	Construction Regulation, section 26.8 (2)
	Person who is under the supervision of professional engineer, and who inspects and tests installation of safety net before it is put in service.	Competent person.	Construction Regulation, section 26.8 (3)
	Worker who is designated by a supervisor to inspect the horizontal lifeline system before each use.	Competent worker.	Construction Regulation, section 26.9 (8) 5

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Fire safety	Workers who may be required to use fire extinguishing equipment.	Training in its use.	Construction Regulation, section 52 (1.1)
	Worker who inspects the fire extinguishers (at least once a month).	Competent worker.	Construction Regulation, section 55
First aid	At least one worker for work crew of five or less.	"Emergency First Aid" training program.	First Aid Reg. 1101, sections 8 (2), 9 (2), and 10 (2)
	At least one worker for crew of five or more.	"Standard First Aid" training program.	
Formwork	Worker who is designated in writing by the professional engineer to inspect formwork/falsework before concrete placement.	Competent worker.	Construction Regulation, section 89 (3)
Hazardous material	Workers who work with or in proximity to a controlled product.	"Workplace Hazardous Materials Information System" training program.	WHMIS Reg. 860, sections 6 & 7
Helicopter	Ground personnel including a signaller for a helicopter being used to hoist materials.	Competent worker.	Construction Regulation, section 167 (3)
PPE	Workers who wear protective clothing or use personal protective equipment or devices.	Instruction and training in the care and use of the clothing, equipment, or device.	Construction Regulation, section 21 (3)
Pipeline repair	Worker who carries out hot-tapping and boxing-in when repairing or altering a pipeline, under controlled conditions that provide for the protection of all persons.	Competent worker.	Construction Regulation, section 48 (2)
Propane	Workers who use construction heaters and hand-held torches.	"Propane in Construction", IHSA training program, or applicable ROT (record of training).	Propane Storage, and Handling Reg. 211/01, sections 6 & 8
	Workers who use propane-fuelled roofing equipment.	"Propane in Roofing", IHSA program, or applicable ROT (record of training).	

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Roofing	Worker who operates a hoist used on a roof.	Competent worker.	Construction Regulation, section 209 (2)
	Worker who operates a hot tar or bitumen road tanker or kettle.	Competent worker.	Construction Regulation, section 211 (1)
Scaffolds	Worker who is designated by the project supervisor and who inspects the scaffold before it is used.	Competent worker.	Construction Regulation, section 130 (3)
	Worker who supervises the erection, alteration, and dismantling of a scaffold.	Competent worker.	Construction Regulation, section 131
	Worker who inspects mechanically-powered suspended platform, suspended scaffold, or boatswain's chair, before use each day.	Competent worker.	Construction Regulation, section 137 (11)
Signaller	Worker who is a signaller and who assists the operator of a vehicle, machine, equipment, shovel, backhoe, crane, or similar excavating machines and hoisting devices.	Competent worker AND - Adequate oral training in his or her duties - Adequate oral and written instructions, in a language that he or she understands.	Construction Regulation, sections 104 (3), (4), and 106 (1), (1.5)
Stilts	Worker who uses stilts.	An adequate training program in accordance with Construction Regulation, section 116 (10).	Construction Regulation, section 116
Supervision	Person who has been appointed a supervisor by the employer.	Competent person.	Occupational Health and Safety Act, section 25 (2) (c)
	Person who is the supervisor's assistant and who supervises the work in place of the supervisor.	Competent person.	Construction Regulation, section 14 (2)
	Person who is appointed by the supervisor and who inspects the project in place of the supervisor.	Competent person.	Construction Regulation, section 14 (3)
	Person who performs the necessary tests and observations for detection of hazardous conditions on a project.	Competent person.	Construction Regulation, section 14 (5)
Traffic control	Worker who sets up or removes traffic control measures on a roadway or shoulder of a roadway.	Competent worker AND adequate oral and written instruction to set up or remove the traffic control measures, in a language the worker understands.	Construction Regulation, section 67 (6)
	Worker who directs vehicular traffic.	Competent worker AND adequate oral and written instruction to direct vehicular traffic, including a description of the signals that are used, in a language the worker understands.	Construction Regulation, section 69 (4)

REQUIRED TRAINING—CONSTRUCTION HEALTH AND SAFETY

Topic	Who?	What is required?	Legislation
Tunnels, shafts, caissons, and cofferdams	Workers (at least four) who are readily available to perform rescues of underground workers.	Training (30 days before tunneling begins) to perform rescues of underground workers.	Construction Regulation, sections 265 (1) and 265 (5)
	Workers who perform underground rescue on project where tunnel and shaft have combined length exceeding forty-five metres (150 ft).	Training in the proper operation of the provided self-contained breathing apparatus.	Construction Regulation, section 266
	Workers who are on a tunnel project.	Instruction in the proper use, care, maintenance, and limitations of their self-rescue respirator.	Construction Regulation, section 268 (2)
	Person who is appointed by a Director, and who trains workers to perform underground rescue and to properly operate their	Competent person.	Construction Regulation, sections 265 (3) and 266 (3)
	Person who inspects every self-contained breathing apparatus at least once a month, or as required by the manufacturer.	Competent person.	Construction Regulation, section 266 (12)
	Worker who will give first aid at a shaft or tunnel project.	Competent worker.	Construction Regulation, section 261
	Worker who is appointed by supervisor in charge of project and who operates a hoist in a hoistway or shaft.	Competent worker.	Construction Regulation, section 291 (1)
	Worker who uses a device used for firing a charge.	Competent worker.	Construction Regulation, section 325 (2)
	Worker who tests the air and the mechanical ventilation for an underground workplace.	Competent worker.	Construction Regulation, section 330 (2)
Vehicle	Worker who operates a vehicle at a project.	Competence to operate the vehicle.	Construction Regulation, section 96 (1)
	Person who instructs and supervises a worker while the worker is being trained in the operation of a vehicle.	Competent person.	Construction Regulation, section 96 (2)
Window cleaning	Workers who use suspended scaffolds, boatswain's chairs or similar single-point suspension equipment while engaged in window cleaning.	Training in common core skills for safe use of suspended scaffolds, boatswain's chairs, and similar single-point suspension equipment.	Window Cleaning Regulation 859, section 45

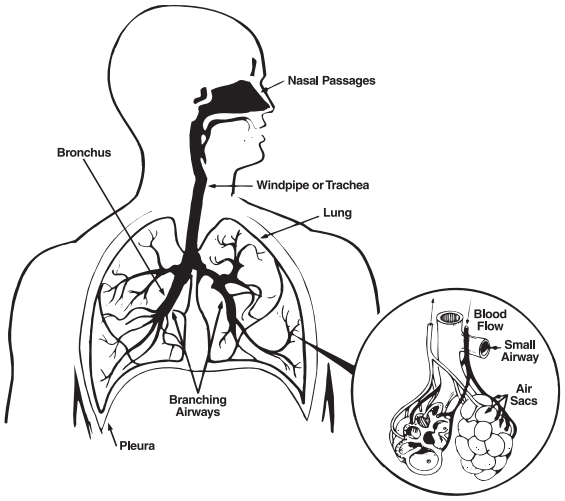
5 OCCUPATIONAL HEALTH

Routes of entry

Hazardous materials in the workplace may cause disease in the body at four main sites:

- where they enter the body—entry routes such as the lungs, skin, and intestines
- in the blood that carries the hazardous materials throughout the body
- in the central nervous system
- in the organs which have the ability to remove toxic agents from the body: (i.e., the liver, kidneys, and bladder–exit routes).

This section briefly describes four routes of entry—inhalation, absorption, ingestion, and injection—and some of the workplace hazards and diseases commonly associated with them.



THE RESPIRATORY SYSTEM

Inhalation

The body's respiratory—or breathing—system is one of the most common routes of entry for a toxic substance. The substance may cause damage to the system itself or it can pass through the lungs to other parts of the body.

The main function of the respiratory system is to absorb oxygen from the air and pass it on to the blood. It also removes carbon dioxide—the waste gas produced by the body's processes—from the blood and releases it in exhaled air.

Air reaches the lungs through a branching system of tubes, starting with the trachea, or windpipe, which divides to form two bronchi, one to each lung. Each bronchus, in turn, branches into many smaller divisions, finally ending in a small cluster of tiny air sacs which are known as alveoli. The oxygen and carbon dioxide exchange takes place through a very thin membrane surrounding these air sacs.

The lung is covered by a delicate lining known as the pleura. (Mesothelioma, one of the cancers caused by asbestos, is a cancer of the pleura.)

Cancer

It's not well understood exactly how a chemical produces cancer. Some **carcinogens** (cancer-causing substances) are thought to interact with the genetic material of the cell; others may interact with the immune system; and still others are thought to act with other agents, but not initiate cancer themselves. Whatever the mechanism, the effect is very often delayed, sometimes up to 30 years.

Defining a chemical as carcinogenic usually involves animal studies as a first step. If the substance causes cancer in animals, particularly those that have biological systems similar to humans, it is classed as a suspected carcinogen. Two examples are silica and refractory ceramic fibres which cause lung cancer. Some chemicals have also been shown to be cancer-causing through industrial experience. These include asbestos (cancer of the larynx, lung, and abdomen), vinyl chloride (liver cancer), coal tar pitch (skin cancer), chromium (lung cancer), and benzidine (bladder cancer). All chemicals which have been classified as carcinogens should be handled with extra care.

Asbestos

Inhaling asbestos dust has been shown to cause the following diseases:

- asbestosis
- lung cancer
- mesothelioma (cancer of the lining of the chest and/or abdomen).

Asbestosis is a disease of the lungs caused by scar tissue forming around very small asbestos fibres deposited deep in the lungs. As the amount of scar tissue increases, the ability of the lungs to expand and contract decreases, causing shortness of breath and a heavier workload on the heart. Ultimately, asbestosis can be fatal.

Lung cancer appears quite frequently in people exposed to asbestos dust. While science and medicine have not yet been able to explain precisely why or how asbestos causes lung cancer to develop, it is clear that exposure to asbestos dust can increase the risk of contracting this disease. Studies of asbestos workers have shown that the risk is roughly five times greater than for people who are not exposed to asbestos.

Cigarette smoking, another cause of lung cancer, multiplies this risk. Research has shown that the risk of developing cancer is at least fifty times higher for asbestos workers who smoke than for workers who neither smoke nor work with asbestos.

Mesothelioma is a relatively rare cancer of the lining of the chest and/or abdomen. While this disease is seldom observed in the general population, it appears frequently in groups exposed to asbestos.

Other illnesses—There is also some evidence of an increased risk of cancer of the stomach, rectum, and larynx. However, the link between asbestos exposure and the development of these illnesses is not as clear as with lung cancer or mesothelioma.

The diseases described above do not respond well to current medical treatment and, as a result, are often fatal.

See the chapter on Asbestos in this manual.

How hazardous materials evade the lung's defences

The airways of the respiratory system have developed an elaborate system of defences which trap all but the smallest dust particles. This system consists of hairs in the nose and mucus in the trachea or bronchi. The mucus is produced continuously by special cells in the walls of the larger airways. It is moved upward and to the back of the throat by the whipping action of cilia—tiny, hair-like projections on the cells of the trachea and bronchi.

Large dust particles are trapped in the mucus and are either swallowed or spit out. Particles smaller than 0.5 microns (1 inch has 25,400 microns) may remain airborne and are exhaled. The most dangerous size of dust particles is 0.5-7.0 microns. Much too small to be seen with the naked eye, they can evade the defence system and reach the lungs. Once in the lungs, these tiny particles of dust may cause extensive scarring of the delicate air sacs. This scarring starts the disease process which produces severe shortness of breath.

Most dust particles are too large to pass through the walls of the alveoli, but gases, vapours, mists, and fumes can all enter the bloodstream through the lungs. In addition, welding fumes or truck exhausts can stimulate the lung's defences to produce large amounts of phlegm, causing the condition known as chronic bronchitis. These same substances can destroy the delicate air sacs of the lungs, causing emphysema.

The lungs are the prime target for occupational carcinogens because the lungs

- are in intimate contact with workplace air pollutants
- have such a large surface area (100-140 m^2).

Asphyxiants

Chemicals that interfere with the transfer of oxygen to the tissues are called asphyxiants. The exposed individual literally suffocates because the bloodstream cannot supply enough oxygen for life.

There are two main classes of asphyxiants—simple and chemical. **Simple asphyxiants** displace oxygen in the air, thereby leaving less or none for breathing. **Chemical asphyxiants** cause the same effect by interfering with the body's ability to take up, transport, or use oxygen.

Simple asphyxiants are a major hazard in confined spaces, where breathable air can be displaced by gas from sewage, for instance.

When the normal oxygen level of 21% drops to 16%, breathing and other problems begin, such as lightheadedness, buzzing in the ears, and rapid heartbeat. Simple asphyxiants in construction include argon, propane, and methane. These chemicals usually have no other toxic properties.

Carbon monoxide is one example of a chemical asphyxiant. It combines with the oxygen-carrying compound in the blood and reduces its ability to pick up "new" oxygen. Hydrogen sulphide, on the other hand, interferes with the chemical pathways which transfer the oxygen, while hydrogen cyanide paralyzes the respiratory centre of the brain.

Skin absorption

Absorption through the skin is another common form of entry for toxic substances (e.g., organic solvents).The skin is the largest organ of the body, with a surface area of 1 to 2 m^2. Some chemicals can penetrate through the skin, reach the bloodstream, and get to other parts of the body where they can cause harm. Toluene and Cellosolve are examples of chemicals which are absorbed through the skin. Mineral spirits and other solvents used in the manufacturing of paint can easily penetrate the skin.

The skin

The skin protects the internal organs of the body from the outside environment. Its outer layer is composed of hardened, dead cells which make the skin resistant to daily wear and tear. Sweat glands cool the body when the environment is hot. Sebaceous glands produce oils which repel water. A network of small blood vessels, or capillaries, plays a key role in controlling body temperature. These capillaries open when it is hot, radiating heat outward into the air, and constrict when it is cold, conserving heat in the body. The skin also has a protective layer of oils and proteins which helps to prevent injury or penetration by harmful substances.

A substance may be absorbed and travel to another part of the body, or it may cause damage at the point of entry (the skin), and start the disease process. Such substances are usually identified in an MSDS with a notation "skin" along with their exposure limits, indicating that the exposure can occur through the skin, mucous membranes, or eyes, or may damage the skin itself.

The Skin

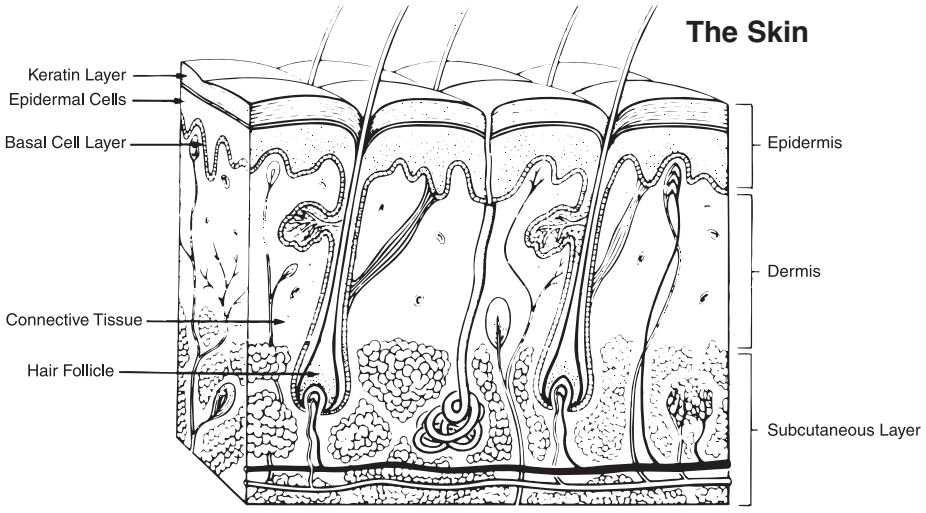


Table 1: Major Dermatitis Hazards in Construction

MATERIAL	TYPE	OCCUPATION/ACTIVITY	CONTROLS
Wet Concrete	Allergic/Corrosive	- Concrete Workers	- Rubber boots, rain pants, rubber gloves if necessary.
Epoxy Materials	Allergic/Defatting (solvents may aggravate allergy)	- Cement Finishers - Seamless Floor Installers - Painters - Tile/Terrazzo Installers	- Barrier creams - Gloves resistant to specific solvents (see Glove Selection Chart in this manual) - Good personal hygiene
Coal Tar	Allergic	- Roofers - Waterproofers	- Change work clothing daily if doing dusty work - Barrier creams usually work well - Good personal hygiene
Solvents/Degreasers	Defatting	- Mechanics - Painters - Service Trades - Millwrights	- Appropriate gloves (see Glove Selection Chart in this manual) - Minimize skin contact - Good personal hygiene
Cleaners	Corrosive/Defatting	- Labourers - Service Trades	- Usually rubber gloves, boots and maybe rain pants - Good personal hygiene

Skin irritation

Dermatitis is an inflammation of the skin which can be caused by hundreds of workplaces substances like solvents (paints), epoxy resins, acids, caustic substances, and metals. Dermatitis appears as redness, itchiness, or scaling of the skin. There are two types of dermatitis:

- primary irritation dermatitis (contact dermatitis), and
- sensitization dermatitis (allergic dermatitis).

Major dermatitis hazards in construction are listed in Table 1.

Contact dermatitis is caused by friction, heat or cold, acids, alkalis, irritant gases, and vapours. Skin in contact with the chemical turns red, becomes itchy, and may develop eczema (inflammation, scaling, and collection of fluid droplets under the skin's surface). Typical hazards in construction include caustics, acids, many chlorinated solvents, wet concrete, chromic acid, and calcium hydroxide.

Allergic contact dermatitis, on the other hand, is the result of an allergic reaction to a given substance. Sensitization may be the result of prolonged or repeated contact and becomes established usually within 10 to 30 days. The process could also take years.

Once sensitized, even a minute exposure can produce a severe reaction. Substances like organic solvents (paints), chromic acid, and epoxy resins can produce both primary and contact dermatitis. Sensitizers include epoxy materials (especially the hardener), nickel, and chromium.

Certain agents such as coal tar and creosote can have a strong sensitizing effect when combined with exposure to sunlight—they are known as photosensitizers.

Solvents

Keratin solvents: These injure or dissolve the outer layer of the skin producing dry, cracked skin. All the alkalis such as ammonium hydroxide, sodium hydroxide, and calcium chloride are keratin solvents.

Fat and oil solvents: These remove the surface oils of the skin so that it can no longer hold water efficiently. Dry, cracked skin results. Organic solvents such as toluene and xylene will cause this condition.

Keratin stimulants: On contact these primary irritants cause a change in the skin so that unusual growth appears, as with exposure to coal tar pitch and arsenic.

Some hazardous materials used in the workplace have been linked with skin cancer. A number of them are listed in Table 2.

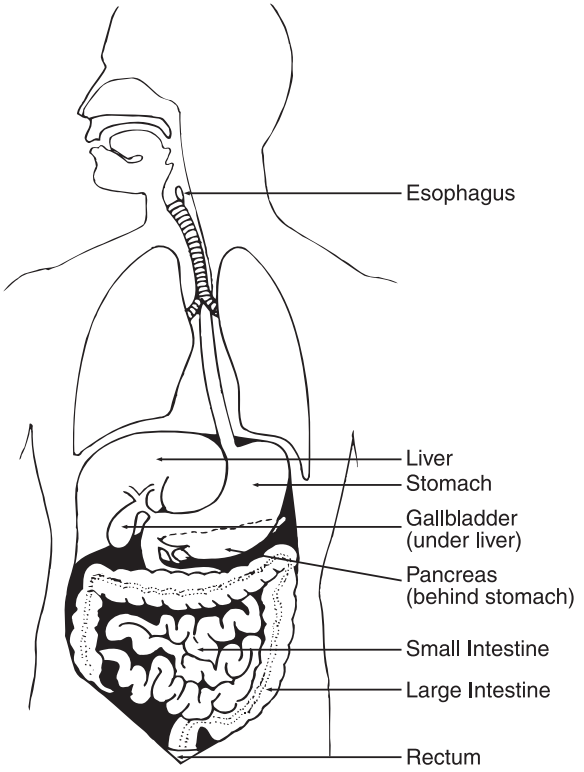
Table 2

Some Suspected Workplace Causes of Skin Cancer		
Pitch	Arsenic	Ultraviolet Light
Asphalt	Tar	X-Rays
Benzo(a)pyrene	Creosote	Anthracene Shale Oil
Cutting Oils	Soot	

Ingestion

A third major route of entry for toxic substances is through the mouth and digestive tract. Toxic materials may reach the stomach when food or drink is consumed, when cigarettes are smoked in a dusty work area, when clean lunchrooms are not provided, when workers fail to wash their hands before eating or smoking, or when food is left unwrapped in a dusty place. Lead dust, for example, is easily ingested in this way and can have serious health effects. Once swallowed, the substances enter the digestive tract and may enter the bloodstream.

The digestive tract is a continuous tube that extends from the mouth to the rectum. The organs of the digestive system provide the means of ingestion, digestion, and absorption of food. Almost all digestion and absorption of food and water take place in the small intestine. The large intestine generally absorbs vitamins and salts.



THE DIGESTIVE SYSTEM

Once swallowed, the toxic substances enter the digestive tract, where they may enter the bloodstream and move on to the liver. The liver and kidneys try to remove the poisons and make the substances less harmful to the body, but they are not always successful.

Injection

In rare cases the chemical may enter the body by injection. Skin can be punctured by paint from a high-pressure spray gun or oil from a high-pressure hydraulic hose. This is very serious and requires prompt medical attention. Chemicals in the paint or oil can damage the immediate area and be transported by the blood to a target organ. Chemicals can also be injected into the body by means of puncture wounds from nails or staples, for example.

Hazardous substances in the body

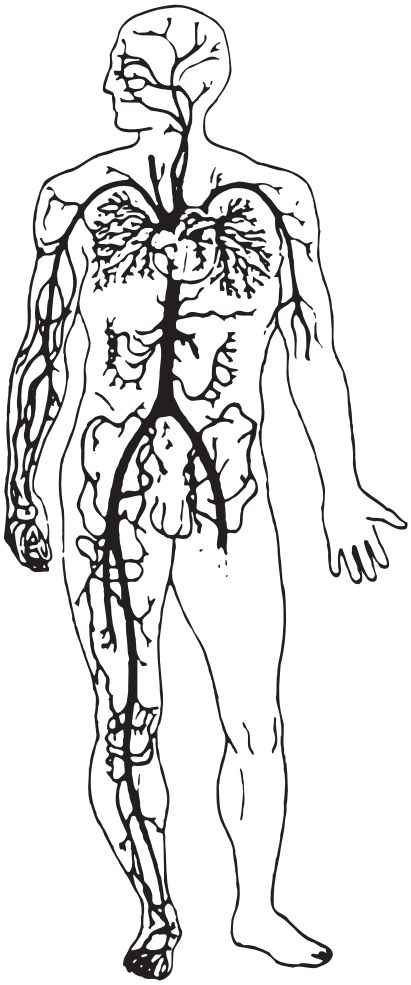
The circulatory system

The circulatory system is not usually in direct contact with hazardous materials. Once in the bloodstream, however, harmful substances can be transported to any part of the body.

The centre of the circulatory system is the heart. It pumps blood outward through a vast network of blood vessels which branch like a tree, becoming smaller and smaller as they go. The vessels branch so extensively that no cell is more than a few millimeters from a blood vessel or capillary.

Table 3

Some Substances Which May Cause Anemia	
Arsine Gas	Cadmium
Selenium	Copper
Lead	Gallium
Stibine	Mercury Compounds
Beryllium	Benzene
	Toluene



Hazards to the circulatory system

Food and oxygen reach every cell in the body through capillaries, but so do toxic substances from the workplace. Oxygen is carried by a protein called hemoglobin, which is contained in the red blood cells. Oxygen binds strongly to hemoglobin, but unfortunately, so does carbon monoxide, a common workplace hazard produced by combustion engines in trucks, machinery, etc. In fact, carbon monoxide binds or attaches to hemoglobin about 200-300 times more readily than oxygen.

In high concentration, carbon monoxide can kill because it overloads the hemoglobin in the red cells and replaces the oxygen which the body needs to survive. But even low levels of repeated carbon monoxide exposure may have serious effects on the heart and the central nervous system.

Many toxic substances attack the blood cells directly. The body forms blood cells continually in the marrow cavity inside the bones. Hazardous materials like benzene can interfere with this formative process and cause anemia, a shortage of red blood cells. Table 3 lists some of the materials which may cause anemia.

The liver

The liver is the chemical factory of the body. The cells which make up the liver contain enzymes which can convert certain toxic substances into forms that are more easily handled by the body. But the liver itself may be damaged if it is overwhelmed by toxic substances.

The liver may become inflamed, producing the condition known as **hepatitis**. This disease may be caused by a virus or by chemicals like alcohol, carbon tetrachloride, and other chlorinated hydrocarbons. Repeated bouts of hepatitis may lead to liver scarring and a disease called **cirrhosis** of the liver. Generally speaking, it means that there are not enough normal liver cells remaining to detoxify body chemicals.

Overexposure to chemicals like acrylonitrile, benzene, carbon tetrachloride, DDT, chloroform, phenol, styrene, tetrachloroethane, and tetrachloroethylene may also cause liver damage. Vinyl chloride, a substance used in the production of plastics, has been linked to a rare and deadly form of liver cancer called angiosarcoma. Table 4 lists some substances that may cause liver damage.

Table 4

Some Substances Suspected of Causing Liver Damage		
Antimony	Acrylonitrile	Ethylidene Dichloride
Arsine	Benzene	Hydrazine
Beryllium	Carbon Tetrabromide	Methyl Alcohol
Bismuth	Carbon Tetrachloride	Methyl Chloride
Cadmium	Chlorinated Benzenes	Methylene Dianiline
Copper	Chloroform	Naphthalene
Indium	Cresol	Phenol
Manganese	DDT	Pyridine
Nickel	Dimethyl Sulfate	Styrene
Phosphorus	Dioxane	Tetrachloroethane
Selenium	Epichlorohydrin	Tetrachloroethylene
	Ethyl Alcohol	Toluene
	Ethylene Chlorohydrin	Trichloroethane
		Trichloroethylene

The kidneys and bladder

The kidneys act as a filter for substances in the blood. Each kidney contains over a million small filters. These filters clean the blood, removing a number of impurities which they deposit in the urine. The urine then passes to little tubes which monitor the levels of acid and the amount of water in the body, and keep them balanced. From these tubes, the urine moves to the bladder, which stores it until it is released from the body.

Since the kidneys act as filters, they can be seriously injured by toxic substances passing through the body. Kidney disorders may result in high or low blood pressure, which in turn may cause heart strain or heart failure. Kidney malfunction may also upset the body's delicate chemical balance, resulting in further harm to the body.

Just as the lungs are vulnerable to hazardous materials because they are a major route of entry, the kidneys and bladder are vulnerable because they are a major route of exit.

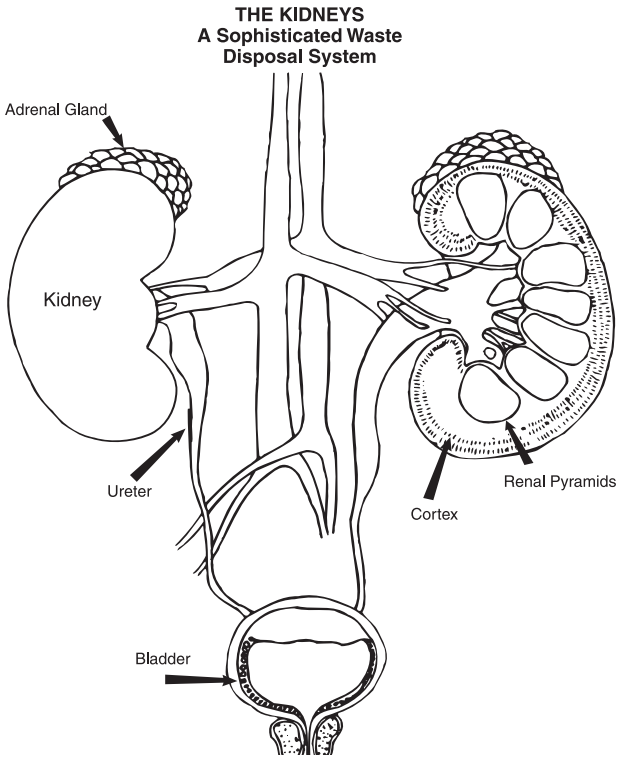


Table 5 shows some of the suspected causes of kidney damage.

Table 5

Suspected of Causing Kidney Damage	
Lead	Naphthalene
Mercury	Carbon Tetrachloride
Cadmium	Tetrachloroethane
Chromates	Carbon Monoxide
Copper	Gasoline Vapours
Uranium	Turpentine
Beryllium	Bismuth
Arsenic	Oxalic Acid
Arsine	Intense Heat
Sodium Fluoride	Vibration
Iodine	High Voltage Shocks
Carbon Disulfide	Blood Loss

The nervous system

To stay alive, we must breathe continuously, our heart must pump constantly, and all the other organs must function. We also think and respond to emotions and sensations. All these functions performed by the mind and body are controlled by the nervous system.

Table 6: Some Chemicals That May Affect the Nervous System

Depression of Central Nervous System	Brain Poisoning	Brain Damage by Oxygen Deprivation	Nerve Function Disorders
Acetates Alcohols Brominated chemicals Chlorinated chemicals Ethers Ketones	Carbon disulfide Hydrogen cyanide Hydrogen sulfide Stibine Arsine	Asphyxiating gases Carbon monoxide	Organo-phosphate pesticides Organo-phosphate plasticizers Heavy Metals Mercury Lead Manganese Arsenic

The central nervous system is the control centre. The spinal cord connects the brain to the nervous system. Part of the nervous system reaches the outer areas and is called the peripheral nervous system.

Most injuries of the central nervous system are permanent, although damage to the peripheral nervous system can sometimes be reversed. Exposure to metals like lead and mercury may interfere with nerve impulses and result in tremors and loss of reflexes or feeling.

Central nervous system depression covers effects such as headache, lightheadedness, drowsiness, and unconsciousness. The organ affected is the brain and the result is depressed performance. Many solvents such as toluene, xylene, ether, and acetone produce this effect if the vapour concentration is high enough. Workers exposed to these chemicals in cleaning solvents, paints, thinners, and degreasers may have experienced these effects.

The brain needs a constant supply of oxygen. Some toxic chemicals interfere with the functioning of the central nervous system and disrupt the oxygen supply. The first warning signs are dizziness and drowsiness. Warning signs should be heeded immediately and appropriate action taken. For example, you should immediately leave the area and seek medical assistance.

The operations of the nervous system are very complicated. It is a delicately balanced system and several chemicals can damage it, such as those shown in Table 6.

The reproductive system

Workplace hazards affect the worker, but the problem reaches into the worker's home as well.

The reproductive organs—the testes in men and the ovaries in women—produce the cells that allow us to reproduce. Any damage to these cells can have disastrous consequences. Deformities in children may result or the developing embryo may be so severely damaged that it is unable to survive and is miscarried.

Some chemicals cause miscarriages or birth defects by attacking the genetic material of cells or the systems which control its functions. Similar damage may also be involved in cancer—cancer-causing substances are often the cause of birth defects and miscarriages.

Factors	Reduced fertility	Miscarriages	Chromosomal damage	Malformations	Sperm damage
Anaesthetic gases	♂	♂♀		♀	
Benzene	♂		♂♀		
Mercury		♀		♀	
Epichlorohydrin			♂♀		
Ethylene dibromide	♂				
Ethylene oxide		♀	♂♀		
Glutaraldehyde		♀			
Ionizing radiation	♀	♀	♂♀	♀	
Chloroprene	♂	♂			♂
Lead	♂♀	♀			♂
Organic solvents	♂	♀	♀	♀	
Carbon disulphide	♂	♀			
Vinyl chloride		♂	♂		

Legend:

♂ = Male exposure

♀ = Female exposure

Source: Finland's Institute for Occupational Health, Helsinki.

Effects of hazardous substances

The effects of exposure to workplace safety hazards are sometimes immediate, painful, and obviously damaging, but it is not always easy to observe when and how the body's cells are attacked by hazardous materials in the workplace. Many of the most serious diseases do not occur until 10 to 30 years after exposure.

Latency of workplace disease

Latency refers to the time lag between exposure to a hazardous material and the eventual development of a disease. The latency period does not refer to the total duration of exposure to a substance, but to the time that has elapsed since the first exposure. For many occupational hazards, the latency period is from ten to twenty years. It may even be as long as thirty or forty years.

Latency has a number of important implications for the worker. An individual exposed to a highly dangerous substance may feel no ill effects at the time of exposure. The effects may only show up many years later. For instance, exposure to ionizing radiation or asbestos causes very little in the way of symptoms at the time of actual exposure, but the long-term effects can be deadly.

Past scientific studies have often failed to address the problem of latency in evaluating the incidence of disease (such as asbestosis). In order to develop a clear picture of diseases which appear many years after exposure, researchers must study not only the current workforce (including many workers who have worked in a particular environment for less than twenty years), but also those workers who had exposure in the past.

Finally, a workplace free of disease is not necessarily a workplace free of hazards. The diseases of today generally reflect the working conditions of several decades ago. Similarly, the workplace hazards of today may produce the health problems of the future.

Acute and chronic effects of workplace hazards

Workplace hazards may have both immediate and long-term effects on the body. These are termed acute and chronic effects. The sudden collapse of a worker who has been exposed to massive doses of carbon monoxide, or the headaches of a backhoe operator working in a poorly ventilated cab, are examples of acute effects.

The acute effects of toxic substances occur immediately or very soon after the worker's exposure, and are generally caused by high levels of exposure. They may cause death, but are often treatable if caught quickly. Sudden and dramatic, they result from the direct action of the hazardous material on the cells of the body.

Often more serious, however, are the chronic effects of toxic substances. Chronic effects become apparent only after many years. By and large, they are not treatable. They often result from the body's attempts to repair itself or to compensate for the acute effects of a substance. For example, cancer is a chronic effect, as is the lung scarring caused by silica dust or the hearing damage caused by excessive noise. Chronic disease becomes evident only after severe damage has occurred.

The acute effects of hazardous material are usually very different from the chronic effects. Table 7 illustrates the difference between the acute and chronic effects of some of the hazards discussed earlier.

Table 7

Acute and Chronic Effects of Some Common Workplace Hazards

	Acute	Chronic
Acid Mists	Irritation of the eyes and throat, watering of the eyes, cough, sore throat, chest pain	Chronic bronchitis and emphysema
Asbestos	Mild respiratory irritation, cough, sneezing	Asbestosis; cancer of the lung, pleura, larynx, stomach, and intestines
Carbon Monoxide	Drowsiness, headache, confusion; in very high amounts, unconsciousness and death	May contribute to heart attacks
Dust (containing silica)	Cough, irritation, bronchitis, asthma	Silicosis, cancer, bronchitis
Noise	Temporary threshold shift, tinnitus, pain	Noise-induced hearing loss, tinnitus
Trichloroethylene	Lightheadedness, euphoria, "drunken" feeling, numbness	Liver and kidney damage; possibly liver cancer
Vibration	Tingling and stiffness in the joints	Arthritis, tendonitis

Exposure limits have been developed for various hazardous materials to protect workers, but they should not be treated as a fine line between safe and unsafe workplaces. Not all individuals react in the same manner to the same amount of a harmful material. The levels of workers' exposures should be reduced to the lowest practical level achievable. Efforts to reduce workers' exposures should start at half the exposure limit. This is known as the "action level."

Factors influencing toxic effect

Factors related to the substance

a) Chemical composition

Different chemicals produce different effects, but changes in composition may influence the toxic effect. For example, pressure-treated wood presents very little problem when dry. However, when the wood is burned the preservative decomposes, producing more toxic chemicals.

In some instances exposure to more than one chemical may change the toxic effect. For example, a person who works with solvents and then has a drink after work will get drunk faster and may have an increased risk of liver damage than from either factor alone.

b) Physical properties

With respiratory hazards, the two main concerns are particle size and vapour pressure.

Particles greater than 10 micrometers in diameter are removed from inhaled air in the nose and upper respiratory

system. As particle size decreases, the system's ability to remove particles also decreases until it is unable to filter out the substance.

Vapour pressure measures the potential of a liquid to vaporize. The higher the vapour pressure, the greater the hazard. If, for example, two solvents of equal toxicity are available for use, the one with the lower vapour pressure will present less of a vapour hazard and will therefore be the safer choice.

c) Solubility in body fluids

Certain chemicals are more soluble in body fluids than others. Chemicals termed lipid soluble are soluble in cell membranes. They can very easily penetrate the body and are more mobile once inside. By being lipid soluble they may also remain longer in the body before being excreted. Organic solvents such as toluene, xylene, acetone, and methanol are considered lipid soluble.

Factors related to exposure situation

a) Dose

With most chemicals, the frequency and severity of toxic effect is directly related to **how much** of the hazard the individual is exposed to and for **how long**. This is commonly referred to as the dose/effect or dose/response relationship. With ethyl alcohol, for example, there is no adverse effect if the dose is within the body's ability to control it. However, if the dose exceeds that capacity, the effect increases with the amount consumed.

By examining the past use of toxic materials in the workplace, by conducting animal studies, and by comparison with other substances, it is possible to assign "safe working levels" of exposure for many materials. The "threshold" is the level up to which no significant adverse effect is likely to occur in most people.

With some substances, mainly carcinogens, the safe working levels are difficult to define or may not exist. For this reason, exposures to known or suspected cancer-causing substances must be very closely controlled.

b) Co-factors

Most of the standards that are set for "safe working levels" are based upon exposure to one chemical at a time. In many cases this does not occur. For example, exposure to asbestos increases the risk of lung cancer five times, while smoking increases the risk 10 times. A smoker exposed to asbestos, however, is 50 times more likely to develop lung cancer than a person who does not smoke and is not exposed to asbestos. The concept of multiple exposures has not been extensively studied. As a result, exposures to complex mixtures should be kept as low as possible.

Factors related to the individual

Certain individuals are more susceptible to chemical exposure than others. These are some factors which may influence toxic effect.

a) Genetic status

Individual susceptibility may be explained by genetic make-up. It is suspected that the sites where toxic agents react is determined by genes that differ from person to person. This theory may help to explain why only some people exposed to a particular substance develop an illness while others do not.

b) Allergic status

In people allergic to certain substances, antibodies cause the body to overproduce its own chemical defences, leading to symptoms such as asthma and dermatitis.

For example, when a person is first exposed to epoxies or isocyanates a number of antibodies are produced. On subsequent exposure, the reaction is much more severe because of this store of antibodies. With repeated exposure, the allergic reaction can be triggered by smaller and smaller doses. This process is called "sensitization."

c) Presence of predisposing disease

Disease may make a person more susceptible to certain toxic agents as the body is already in a weakened condition.

For example, a person with a heart ailment such as angina may have a heart attack if exposed to levels of carbon monoxide which would have little effect on normal healthy people. Similarly, people who suffer from a lung ailment such as emphysema will have a much more severe reaction to lung irritants than a healthy person.

d) Age

Be aware that chemicals may have a greater effect on both older and younger workers.

3 COMMUNICATION

In the construction trades, workers and supervisors must constantly act and react to their changing environment. In doing so, they exchange facts, plans, and proposals. The one essential ingredient in all of these activities is communication.

Think for a moment of the types of communication common to worksites in construction:

- contracts
- blueprints
- safety talks
- health and safety committee minutes
- hand signals for hoisting and traffic control
- radio transmissions
- training sessions
- accident reports
- WSIB forms
- instructions to new workers
- specifications
- WHMIS labels and material safety data sheets
- regulations
- operating manuals.

All of these communications involve ***messages*** of different types being sent to and from ***senders*** and ***receivers***.

These are the elements in the communications cycle, which consists of a sequence of steps. If any step is interfered with, blocked, or left incomplete the result will be miscommunication or no communication at all.

Step 1

Using his or her knowledge and experience, a "sender" creates a message in his or her mind.

Step 2

The message is "encoded." This means the message is put into speech for oral communication; into writing for written communication; or into signals or images for visual communication.

Step 3

After encoding the message, the sender sends or "transmits" it. In verbal communication, the message is transmitted by speech. Written communications are delivered by hand, mail, FAX, or over a computer network. In visual communication, a signal is transmitted by hand, flag, pictures, or images.

Step 4

The "receiver" receives, that is, hears, reads, or sees the message.

Step 5

Using his or her own unique knowledge and experience, the receiver interprets the message.

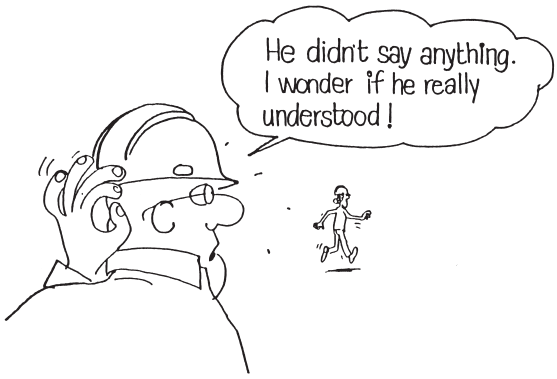


Step 6

The receiver acknowledges that the message has been received and/or acts on the message. The full cycle has not been completed until the sender has some indication that

a) the message has been received and

b) action has resulted from the communication.



All the steps in the communication cycle are of equal importance. If you overlook or inadequately perform any of them, the result will be miscommunication or, in some cases, a complete lack of communication.

Understanding the communication cycle helps you to know when your message is not being received or is being misunderstood. By checking each step in the communication cycle you can see where you've gone wrong. This provides a practical framework for solving communications problems.

Remember — to communicate effectively you must make sure that the communication cycle is **complete** for every message you send. Each step in the cycle must be taken, and each completed, **every** time.

The following will ensure success in communication.

- Gather all the information you need before putting your message together.
- Organize your facts.
- Take the time to put together a message that makes sense and can be understood.
- Compose the message using words and/or visual aids the receiver can understand.
- Use a sending method (written, spoken, or visual) that will get the message across clearly.

- Take the receiver's ability to receive your message into account when choosing your method of transmission; be willing to change your choice if you discover a problem in communication.
- Take the receiver's ability to interpret your message into account when formulating your message.
- Check with the receiver to ensure that your message has been received and understood.
- Check results to ensure that your message has been properly acted upon.

Effective communications result when
- a message contains all the important details it should contain to be complete
- the message is delivered in a way which allows the receiver to receive it clearly, and
- the receiver understands the message completely and acts upon it properly.

To sum up, the three important elements of communications are
- message
- delivery method
- receiving method.

A message is complete when it contains all the information the receiver needs to understand and, if necessary, to act upon the message.

Try to include all the information necessary to answer any questions likely to arise in the mind of the receiver. One good way of doing this is to check whether the information covers

- who
- what
- when
- where
- why
- how.

Consider the following example.

"Hey! Make sure that pump is tagged and locked out."

This can raise all sorts of questions in the receiver's mind: "Who's supposed to make sure? Which pump? Where? How should it be locked out?"

On the other hand, consider a message like this.

"Hey Frank! **(Who)**

Before we begin, **(When)**

I want you to tag and lock out **(What #1)**

that pump **(What #2)**

in the washroom **(Where #1)**

up on the sixth floor. **(Where #2)**

We've got to be sure no one starts it while we're down here **(Why #1)**

or the place will be flooded. **(Why #2)**

Use the lockout procedure we went over yesterday." **(How)**

The second message is more complete, leaves less room for error, and is therefore more effective.

Once a message is formed, the next step is delivery. There are three modes: verbal, written, and visual.

Verbal communication involves two or more people sending messages and expecting feedback. Lots of information can be exchanged in a short time.

With **written** communication, the cycle is generally slower. It takes time for the sender to compose the message, time to deliver it, time to read it, and time for the receiver to compose and send a reply. But written communication can produce results when verbal communication cannot.

Visual delivery includes such methods as hand signals to crane operators and signs for traffic control.

Receiving modes correspond to each of these delivery modes. Verbal messages are heard or, better, listened to. Written messages are read. Visual messages are seen.

All must be finally understood for the communication cycle to be complete.

2 EMERGENCY PROCEDURES

In order for everyone to be prepared for emergencies, every project needs an emergency response plan before work begins.

Emergency Response Plan and Procedures

An emergency is any situation that has the potential to harm the life, health, or safety of a person, public property, or the environment. It is an unplanned event.

The purpose of an emergency response plan is to ensure that emergency procedures are in place and every worker is prepared to respond to any emergency in a correct, timely, consistent, and dependable manner.

An effective plan must include the following:

1. **Hazard Identification/Assessment**
   Identify hazards and assess potential risk by answering the questions: What can go wrong? What are the consequences?

2. **Emergency Resources**
   Determine the resources available for the hazards identified and assessed. Verify that 911 operates in area. If not, make alternate arrangements. Maintain on-site resources such as fire extinguishers, spills containment equipment, and first aid kits. Outside help may be so far away that on-site resources are necessary, such as fire protection or ambulance/medical resources in remote areas.

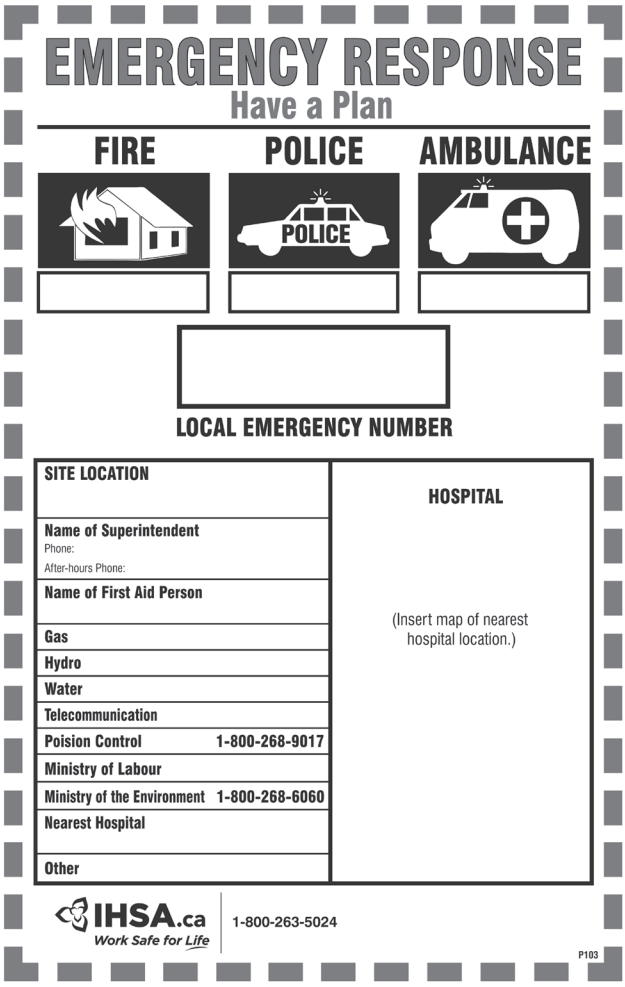
3. **Communication Systems**
   To relay accurate information quickly, reliable communications equipment must be used, procedures developed, and personnel trained. A backup system is a good idea in case the emergency destroys phone lines, for instance. The type and location of emergency communication systems must be posted on the project. Emergency phone numbers and the site address/location should be posted beside all site phones. The *Emergency Response Poster* (P103), available from IHSA, can be used to record this and other information.

4. **Administration of the Plan**
   The person in charge of administering and organizing the plan must ensure that
   - everyone clearly understands their roles and responsibilities within the plan
   - adequate emergency resources are kept in step with the progress of the project
   - the plan is reviewed regularly and always after an emergency to correct any shortcomings.

5. **Emergency Response Procedure**
   The Emergency Procedures chart (page 2-2) outlines standard emergency response procedures. STOP and ASSESS the situation before performing any of the tasks. Stay calm to provide an example to others.

6. **Communication of the Procedure**
   - Review with subcontractors, workers, and suppliers to ensure that it covers their activities.
   - Review with owner/client in operating plants to ensure that hazards are identified and covered.
   - Review with JHSC or health and safety rep on a regular basis to address new hazards or significant changes in site conditions.
   - Post the procedure in a conspicuous location.

When developing your plan, make sure it always reflects current conditions on the jobsite. For more detailed information on developing emergency response plans, refer to the *Emergency Response Planning* (B030) booklet available from IHSA and the Emergency Response Planning Checklist at the end of this chapter.



Emergency Procedures

1



TAKE COMMAND

Assign the following duties to specific personnel.

2



PROVIDE PROTECTION

Protect the accident scene from continuing or further hazards–for instance, traffic, operating machinery, fire, or live wires.

3



GIVE FIRST AID

Give first aid to the injured as soon as possible. Information on basic first aid is included in this manual.

4



CALL AN AMBULANCE

Call an ambulance and any other emergency service required. In some locales, dialing 911 puts you in touch with all emergency services.

5



GUIDE THE AMBULANCE

Meet and direct the ambulance to the accident scene.

6



GET NAME OF THE HOSPITAL

For follow-up, find out where the injured is being taken.

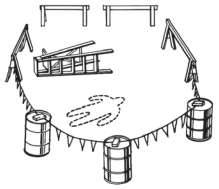
7



ADVISE MANAGEMENT

Inform senior management. They can contact relatives, notify authorities, and start procedures for reporting and investigating the accident.

8



ISOLATE THE ACCIDENT SCENE

Barricade, rope off, or post a guard at the scene to make sure that nothing is moved or changed until authorities have completed their investigation.

EMERGENCY PROCEDURES FOR FALL RESCUE

If a worker is involved in a fall arrest, it is important that the worker be brought to a safe place as quickly as possible without causing further injury or putting the rescuers at risk.

The Construction Projects regulation (O. Reg. 213/91, s.26.1(4) requires that before workers use any fall arrest system or safety net on a project, the employer must develop written rescue procedures.

In many cases, the rescue plan can be simple. A ladder or elevated work platform can be used to reach suspended workers and get them down safely. In other cases, it makes more sense to haul the worker back up to the level from which they fell or pull the worker in through a nearby window or other opening.

Sometimes the rescue may be more complicated. You may need specially trained and equipped rescue workers from the local fire department. Aerial ladder trucks or other high-reach equipment may be necessary. In extreme cases, the fire department may use rappelling techniques to reach trapped workers and lift or lower them to a safe place.

Create a rescue plan that is specific to your jobsite and that covers the different types of fall-related rescues that may be necessary. The plan should cover the on-site equipment that you will use, the personnel who will use it, and the procedures for different types of rescue. Any off-site rescue services that might be needed should be contacted in advance to check the resources that they have available (equipment, specially trained personnel, etc). The constructor should make arrangements to familiarize rescue services with the project and any hazards that they may encounter.

Use IHSA's *Emergency Response Poster* (P103) to list the nearest hospital and the phone numbers of fire, ambulance, and police services.

Once the written plan is developed, you must ensure that

- everyone on site is aware of the rescue plan
- equipment and other resources you will need are available.

Take note: There are differences between equipment from different manufacturers as well as from different product lines in the same company. Therefore the training must cover the *same* harness, lanyard, energy absorber, rope grab, lifeline, and anchorage that each worker will rely on, as well as the ways in which each will be used.

Sample Fall Rescue Procedures

Here are some examples of general fall rescue procedures to give you an idea of what your plan should include.

A. If an elevating work platform (EWP) is available on site:

1. Take it to where the suspended worker is.
2. Make sure that rescue workers using the EWP are protected against falling.
3. Be sure the EWP has the load capacity for both the rescuer(s) and the victim.
4. Use the EWP to reach the suspended worker.
5. Position the EWP platform below the worker.
6. Disconnect the suspended worker from his or her lanyard or lifeline when it is safe to do so. If the worker is unconscious or can't help with the rescue, two rescuers may be needed to handle the worker safely.
7. Treat the worker for suspension trauma and any other injuries.
8. Arrange to take the worker to the nearest hospital.

B. If an elevating work platform is not available:

1. Where possible, use a ladder (or ladders) to reach the suspended worker.
2. If the suspended worker is not in an area that rescuers can reach by ladders, move the suspended worker by his or her lifeline to an area that can be safely reached by ladder (if possible).
3. Rig a separate lifeline for each rescuer to use while carrying out the rescue.
4. Position the ladder(s) so that the rescuers can get beneath the suspended worker.
5. Securely attach a separate lowering line to the suspended worker's harness.
6. Rescuers on the ground lower the worker while the rescuers on the ladder(s) guide the worker. If the suspended worker is unconscious or can't help with his or her own rescue, two rescuers may be needed to handle the worker.
7. Once the worker has been taken to a safe location, administer first aid for suspension trauma and any other injuries.
8. Arrange to take the worker to the nearest hospital.

C. If the injured person is suspended near the work area and can be reached safely from the floor below or from the place from which the worker fell:

1. Make sure that all rescuers are protected against falling (such as by travel restraint or fall arrest).
2. If possible, attach a second line securely to the worker's harness to help pull him or her to a safe place. At least two strong workers will probably be needed to pull someone up.
3. Eliminate slack in the retrieving line to avoid slippage.
4. Once the worker has been taken to a safe place, administer first aid for suspension trauma and any other injuries.
5. Arrange to take the worker to the nearest hospital.

D. If a person has fallen and is suspended in an inaccessible place (e.g., on a tower, against a building, or in a structure that has no openings), you may need trained personnel and specialized rescue techniques to rescue the worker. For example, the rescuer may have to lower himself down to the suspended worker or use a lifeline to retrieve him or her.

Because of the inherent risk in this type of rescue, only people with specialized training should do it.

(Download a sample "Working at Heights Rescue Procedure" from www.ihsa.ca/resources/emergency_preparedness.aspx)

EMERGENCY RESPONSE PLANNING CHECKLIST

Use the checklist on the next two pages as a guide to help you develop the emergency response plan for your workplace. Remember that the plan must be specific to the location where you are working. When the plan is complete, make sure that everyone involved knows their role.

Emergency Response Planning Checklist

Company:	Date
Completed by:	Site:

	In Progress	Date Completed
Program Administration (Who is responsible for implementing the plan?)	❑	
Develop an Emergency Response Standard.	❑	
Develop a Site Emergency Plan.	❑	
• Identify emergency access routes.	❑	
• Indicate location of first aid stations/boxes and fire extinguishers.	❑	
• Show job office(s) and storage facilities (storage for blankets and special rescue equipment).	❑	
• Ensure specialized PPE equipment is on site. (Indicate location.)	❑	
• Ensure sufficient medical aid supplies are available on site (splints, stretchers, etc.) and indicate location.	❑	
• Locate other firefighting equipment (standpipes, Siamese connections, and hydrants).	❑	
• Locate main power supply to the project.	❑	
• Identify the location of emergency phones. (Post emergency list.)	❑	
• Identify nearest hospital or medical centre.	❑	
• Identify worker evacuation route(s) and assembly area(s).	❑	
• Contact local fire, police, and ambulance and provide them with your site plan and list of potential emergencies.	❑	
• Locate services to the project (both above ground and underground).	❑	
• Develop on-site traffic routes.	❑	
• Locate outside materials storage and fabricating areas.	❑	
• Locate cranes, man/material hoists, and unloading docks.	❑	
• Locate flammable/combustible materials and cylinder storage.	❑	
• Locate garbage dumpsters and recycling bins.	❑	

Emergency Response Planning Checklist (continued)

	In Progress	Date Completed
• Complete *Hazard Identification and Risk Assessment Form.**	❑	
• Determine if "high-level" rescue is a possibility.	❑	
• Develop Emergency Response procedures for items identified in your hazard assessment.	❑	
• Ensure that all trades on site keep daily personnel lists. (In the event of a major emergency, check names against personnel gathered in the assembly area.)	❑	
• Include requirements for written notices. (What's required? When? Completed by whom? Who does it go to?) See legal obligations.	❑	
• Identify the emergency response (ER) team and alternates. (Post names.)	❑	
• Provide specialized training for ER team members.	❑	
• Designate a contact person to call necessary emergency services and MOL, MOEE, etc.	❑	
• Select member of ER team to meet and direct emergency services vehicles to incident scene.	❑	
• Select team member to deal with media, MOL, MOEE, etc.	❑	
• Ensure all required rescue equipment/materials are readily available on site.	❑	
• Provide for emergency traffic control person (properly trained).	❑	
• Make provisions for cordoning off the accident scene to protect workers.	❑	
• Ensure someone on the ER team documents where the injured worker has been taken (hospital, medical centre, etc.).	❑	
• Set out method of communicating the plan.	❑	

*Form can be downloaded from ihsa.ca/resources/hazard_assessment_analysis_control.aspx

3 WHMIS

Frequently construction trades are required to work with new hazardous materials or previously installed hazardous materials requiring repair, maintenance, or removal. Some materials used for many years and thought to be harmless are now known to be hazardous.

Proper handling requires careful planning, training, and use of personal protective equipment or controls.

Some hazardous materials common in construction are

- compressed gas (acetylene, nitrogen, oxygen)
- flammable and combustible materials (solvents)
- oxidizing materials (epoxy hardeners)
- solvents, coatings, and sealers
- asbestos and silica
- acids and alkalis.

Right to Know

The **Workplace Hazardous Materials Information System (WHMIS)** gives everyone the right to know about the hazards of materials they work with and provides the means to find out that information. It does this through

- labels
- material safety data sheets
- worker training and education.

All employers are required by law to provide WHMIS training for specific controlled products the worker will be working with or near. Training should be provided as new products are introduced – with a general updating on new products at least annually.

Controlled products under WHMIS include six classes, identified by symbols (Figure 6).

The requirements for supplier and workplace labels are shown in Figure 7.

CLASS SYMBOL	EXAMPLE	
Class A: Compressed Gas		oxygen
Class B: Flammable and Combustible Material		acetone
Class C: Oxidizing Material		chromic acid
Class D: Poisonous and Infectious material		
1. Materials causing immediate and serious toxic effects		ammonia
2. Materials causing other toxic effects		asbestos
3. Biohazardous Infectious Material		contaminated blood products
Class E: Corrosive Material		hydrochloric acid sodium hydroxide
Class F: Dangerously Reactive Material		acetylene

Figure 6

Supplier labels are required on controlled products with a volume of more than 100 millilitres and must include

- product identifier
- appropriate hazard symbol(s)
- risk phrases (such as “dangerous if inhaled”)
- precautions (such as “wear rubber gloves”)
- first aid measures
- supplier identifier
- statement that a material safety data sheet (MSDS) is available for the product.

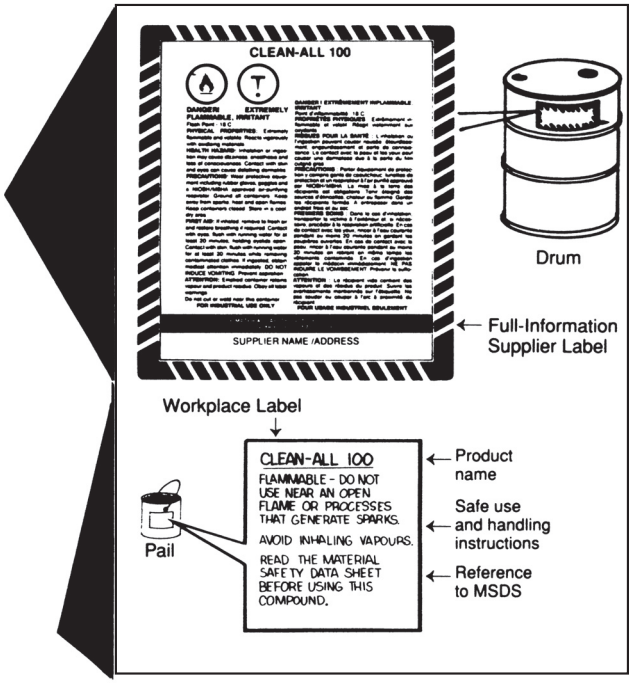


Figure 7

Workplace labels are required when controlled products are produced onsite or have been transferred from a supplier-labelled container to a different container. Workplace labels must include

- product identifier
- safe handling instructions
- statement that an MSDS is available for the product.

If details on the ingredients, health effects, handling, and other aspects of a hazardous product are not available from suppliers or employers, call the Infrastructure Health & Safety Association at 1-800-263-5024 and provide the following information.

- Product name (e.g., Solvex 100)
- Manufacturer's name and place of manufacture (e.g., ABC Chemical, Montreal, Quebec)
- What is the product being used for? (e.g., to clean parts)
- How is it being used? (e.g., sprayed on)
- Is it being mixed with something else?
- Is it being heated?
- In what area is it being used? (e.g., outdoors or in a holding tank)
- What does the label say?
- How can information be conveyed to you?

Designated Substances

"Designated substances" are substances that have been targeted for special regulation by the Ministry of Labour. Generally these substances are well-known toxic materials which present serious risk of illness.

Designated substances encountered in construction include asbestos, lead, coal tar products, and silica. If any designated substances are present where construction, maintenance, or renovation is planned, the parties involved must be notified and informed.

The *Occupational Health and Safety Act* requires that owners notify contractors of the presence of any designated substance. Contractors also have a responsibility to advise subcontractors. This notification must take place before binding contracts are arranged.

For more information on designated substances, contact the Ministry of Labour.

4 FIRST AID

According to St. John Ambulance, "First aid is emergency help given to an injured or suddenly ill person using readily available materials." It may be as simple as cleaning and bandaging a minor cut on a worker's finger, or it can be complicated, such as providing care for a worker who has been struck by a piece of moving equipment.

The objectives of first aid are the same, regardless of the situation. They are to

- preserve life
- prevent the injury or illness from becoming worse
- promote recovery.

The First Aid Requirements Regulation (Regulation 1101 under the *Workplace Safety and Insurance Act*) details the obligations of employers regarding first aid equipment, facilities, trained personnel, and first aid procedures in all workplaces. The Act authorizes the WSIB to penalize employers who do not comply with these requirements. Here is a brief outline.

Equipment

Employers must provide and maintain a first aid station in the workplace. Pick a location for the kit that it is accessible at all times. Companies who use service vehicles should ensure that first aid kits are provided for each vehicle. As well, provide a first aid kit when workers are operating heavy construction and maintenance equipment at a distance from the first aid station. The contents will vary according to the number of employees regularly employed in that workplace. Regulation 1101 provides the details of the contents. Inspect each kit at least quarterly, then sign and date the inspection card.

Facilities

In a workplace with few employees, the first aid station may be as simple as a first aid kit placed in an accessible area. Large companies (over 200 employees) are required to have a first aid room. On construction projects, it's the responsibility of the general contractor to provide the first aid station. It should be located in the site office. On a large project, set up additional first aid stations to ensure timely access to treatment. In all cases, the regulation requires you to post the WSIB Form 82 ("In Case of Injury at Work" poster), a first aid kit inspection card, and the valid first aid certificates of the first aid providers in the workplace.



First aid station

Trained personnel

Employers must ensure that first aid is provided by trained and knowledgeable workers. Regulation 1101 specifies training either to the St. John Ambulance Emergency or Standard First Aid levels (or equivalent) depending on the number of workers in the workplace.

Emergency-level first aid training generally includes the following mandatory topics

- Emergency Scene Management
- Shock, Unconsciousness, and Fainting
- Choking – Adult
- Severe Bleeding
- One Rescuer CPR – Adult

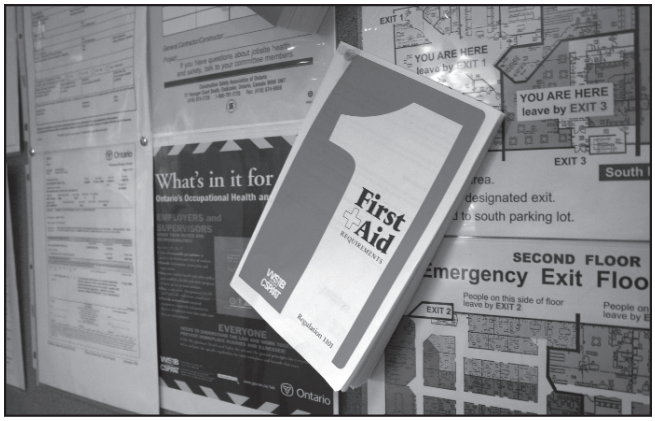
Standard-level first aid training is a more extensive program that generally includes the

five mandatory topics from emergency first aid, as well as elective topics. Some elective topics suitable for first aid providers are

- Fractures
- Head and Spinal Injuries
- Joint Injuries
- Chest Injuries
- Hand injuries
- Eye injuries
- Multiple injury management
- Pelvic, abdominal, and crush injuries
- Burns
- Poisoning
- Medical conditions (diabetes, epilepsy, convulsions, and allergies)
- Environmental illnesses and injuries (exposure to heat or cold)
- Artificial respiration – Adult
- Automated External Defibrillator (additional instruction time must be added to the course to accommodate this component and a separate certification card must be issued for AED certification)

Since procedures may change from time to time, it is important that training be kept up to date. Recertification is usually required every three years (check with your training organization for details).

In a workplace with five or fewer workers, the employer must ensure that a worker trained in at least St. John Ambulance Emergency First Aid (or equivalent) is available to provide first aid. This also applies when a crew of two to five workers is working away from their company facility, such as a painting crew working in a vacant office. When six or more workers are employed in a workplace, the regulation requires St. John Ambulance Standard First Aid (or equivalent) training for the first aid provider. Additional workers should be trained in the event of the designated provider's absence.



The First Aid Requirements Regulation

First Aid Procedures

To ensure that an injured or ill worker receives appropriate and timely first aid treatment, an employer should have a written first aid procedure as part of their Health and Safety Program. The procedure should cover

- mandatory reporting and recording requirements
- provision of first aid kits
- availability of trained first aid providers and training recertification
- transportation to medical treatment
- document posting requirements.

The First Aid Requirements Regulation requires that each first aid kit contain a current edition of the St. John Ambulance First Aid Manual. The manual contains details of first aid treatment for a worker who is injured or who suddenly becomes ill. The first aid provider can use it as a reference for specific protocols.

For details on signs, symptoms, and treatment of illnesses and injuries related to heat or cold exposure, refer to the chapters on Heat Stress and Cold Stress in this manual.

8 BACK CARE

Nearly 25% of the lost-time injuries in construction are related to the back. More than half of these injuries result from lifting excessive weight or lifting incorrectly.

To prevent injuries, you need

1. proper posture
2. correct lifting techniques
3. regular exercise.

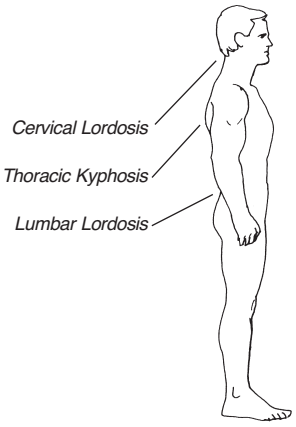
Posture

Correct posture is not an erect, military pose. It means maintaining the naturally occurring curves in your spine.

You have two inward curves – at the neck and low back – and one outward curve at the upper back.

Keeping your spine aligned in this manner reduces everyday stresses on your back and minimizes the effects of the normal aging process on the spine.

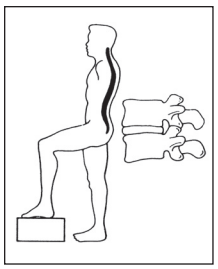
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Correct Posture

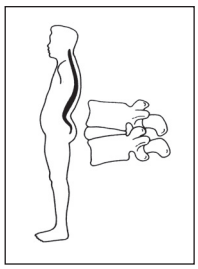
You have two inward curves (lordosis), one each at the neck and low back, and one outward curve (kyphosis) at the upper back.

Common Posture



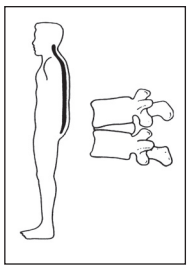
Normal

Prolonged standing often causes an increased curve in your back. Elevating one foot on a stool or any other object (a phone book or brick will do) will take stress off the lower spine.



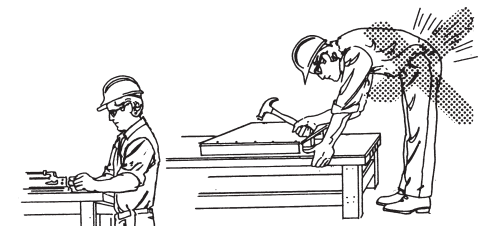
Sway Back

An increased curve in your lower back will jam the vertabrae together (sway back). If held too long, the position will cause lower back muscles and ligaments to tighten and lead to lower back pain.

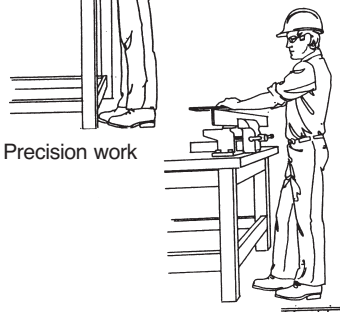


Flat Back

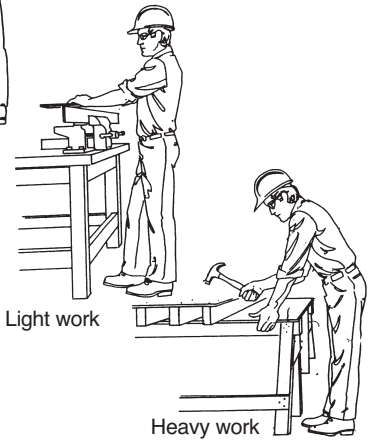
Too little curve (flat back) will put extra pressure on the front of your discs. This may contribute to disc problems and pain.



For bench work, the right height is vital.



Precision work



Light work

Heavy work



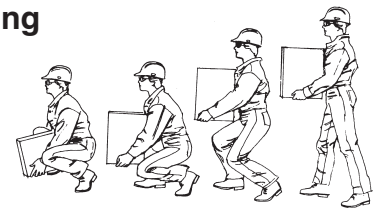
Work Overhead

When working overhead in an arched position for prolonged periods, take regular breaks by returning to stable footing and bending forward three times.

If possible avoid working on ladders. Use scaffolds instead, especially for long-term tasks or for jobs where you must handle heavy materials.

Materials Handling

Proper Lifting



1. Plan your move.
   - Size up the load and make sure pathway is clear.
   - Get help as needed.
   - Use a dolly or other device if necessary.
2. Use a wide-balanced stance with one foot slightly ahead of the other.
3. Get as close to the load as possible.
4. Tighten your stomach muscles as the lift begins.
5. When lifting, keep your lower back in its normal arched position and use your legs to lift.
6. Pick up your feet and pivot to turn – don't twist your back.
7. Lower the load slowly, maintaining the curve in your lower back.

Your back can manage most lifts – if you lift correctly.

Avoid lifting above shoulder height. This causes the back to arch, placing heavy stress on the small joints of the spine.

Do not catch falling objects. Your muscles may not have time to coordinate properly to protect the spine.

Push rather than pull. Pushing allows you to maintain the normal curves in your back.

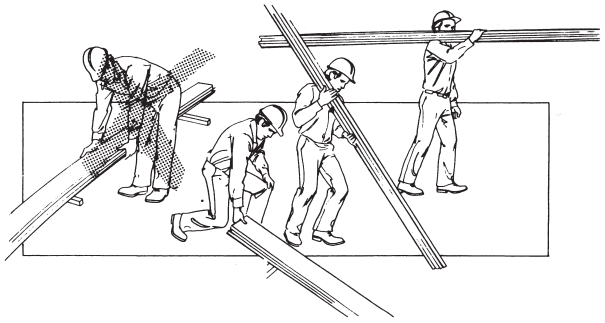
Weight Transfer

Pull the object toward you while transferring your weight to the lift side.

Lift only to the level required.

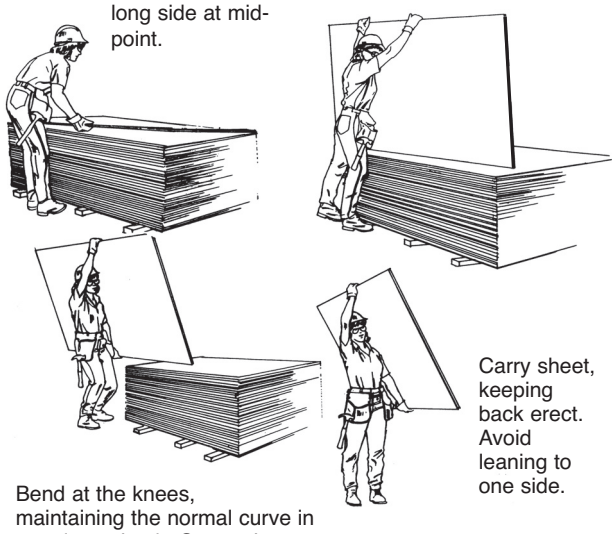
Shift your weight to your other leg while pushing the object into position.

Sheet Materials



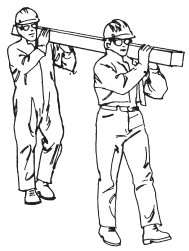
If sheets are on the floor, use the same technique as for lifting long lumber. Lift one end first.

When you handle sheet materials, use proper techniques to protect your back. Where possible, store sheets at a convenient height and above ground on timbers or trestles.



For long carries, use carrying handles. Better yet, if surface is smooth and hard use a drywall cart.





Two-Person Lift

Lifters should be of similar height. Before starting they should decide on lifting strategy and who will take charge.

For a two-person lift of a long load, the lifter who takes charge must see that the load is carried on the same side, with a clear line of vision. Begin by lifting load from ground to waist height. Then lift the load from waist to shoulder.

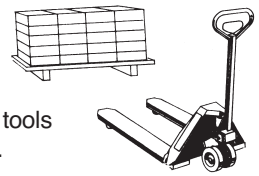
Carrying on Stairs



Use your stomach muscles to help support and protect your back. If possible, the tallest and/or strongest person should be at the bottom of the load.

Balance

Avoid one-handed carrying if possible. Try to distribute the weight evenly on each side. If you can't avoid one-handed carrying, such as with a single pail, hold the free arm either straight out or on your hip as a counterbalance.

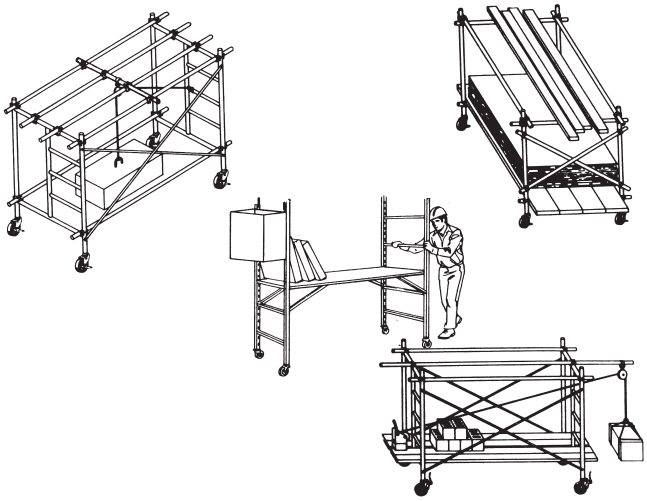


Mechanical Help

Use a cart or dolly for transporting tools and equipment wherever possible.

Consider using pallets where surface conditions allow.

Rolling frame scaffolds with a few tube-and-clamp components may be useful for moving heavy objects such as motors or drives where other devices such as forklifts are not available.





Wheelbarrows with dual wheels are a great improvement over single wheels. Better balance and increased flotation over soft ground make wheeling easier on the back.

Lift tables with casters for heavy components can be helpful. These tables are light, carry loads of several hundred pounds, and have adjustable heights from one to several feet.

Exercise

Construction work strengthens some muscles while others become shorter and weaker, creating a muscle imbalance. A regular exercise program can help to prevent this from happening.

A good exercise program should consist of four basic parts:
1. warm-up
2. main workout
3. strength and stretch
4. cool-down.

Warm-Up

This is a general exercise program only. Before starting any exercise program, consult your doctor first.



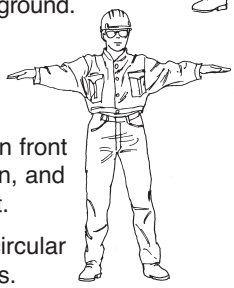
If you have any concerns or experience any pain while doing the exercises, stop and consult your doctor.

1. March in Place

Start: Stand in position.

Action: Pump arms and legs in opposite directions. Make sure heels contact ground. Continue 3 to 5 minutes.

2. Arm Circles



Start: Stand with arms raised horizontally and slightly in front of shoulders, palms down, and feet shoulder-width apart.

Action: Rotate arms in forward circular motion for 15-30 seconds. Relax. Repeat 3-5 times.

Stretching Program

The following stretching exercises are of greatest value before work starts. They may, however, be done at any convenient time. Whenever they are done, a brief warm-up (walking briskly or jogging on the spot) is most beneficial.

The exercises should be performed in a slow, controlled manner and held in a sustained stretch. Avoid bouncy, jerky movements which may tear muscle fibres.

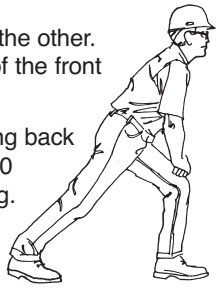
3. Knees to Chest



Start: Support yourself securely with one hand.

Action: Pull your knee toward your chest and grasp around your knee with your free hand. Hold the stretch for 30 seconds. Lower your leg to the ground and repeat with the other leg. Repeat three times for each leg.

4. Hip Stretch



Start: Stand with one foot in front of the other. Place hands above the knee of the front leg.

Action: Gently bend front knee, keeping back foot flat on the floor. Hold 20-30 seconds. Repeat with other leg. Repeat three times for each leg.

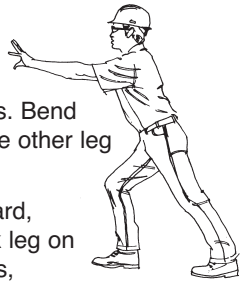
5. Thigh Stretch



Start: Support yourself with one hand on something secure.

Action: Bend your leg back and grasp your ankle with your free hand. Gently pull your ankle toward your body, keeping your trunk straight. Hold 20 to 30 seconds; repeat with other leg. Repeat three times for each leg.

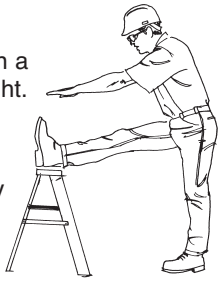
6. Calf Stretch



Start: Stand slightly away from a solid support and lean on it with your outstretched hands. Bend the forward leg and place the other leg straight behind you.

Action: Slowly move your hips forward, keeping the heel of the back leg on the ground. Hold 30 seconds, relax, and repeat with other leg. Repeat three times for each leg.

7. Hamstring Stretch



Start: Place the back of your heel on a platform at a comfortable height. Bend your supporting leg slightly.

Action: Looking straight ahead, slowly bend forward at the hips until you feel a good stretch at the back of the raised leg. Hold 30 seconds and repeat with other leg. Repeat three times for each leg.

8 BACK CARE AND MATERIALS HANDLING

Nearly 25% of the lost-time injuries in construction are related to the back. More than half of these injuries result from lifting excessive weight or lifting incorrectly.

To prevent injuries, you need

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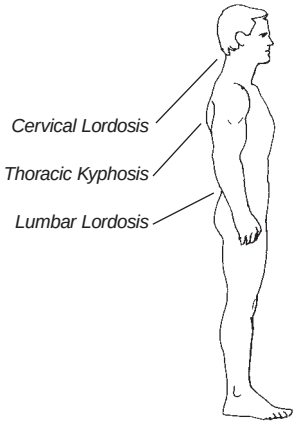
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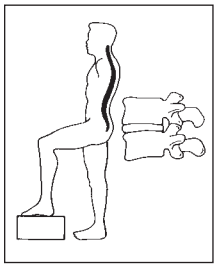
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Correct Posture

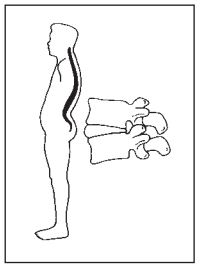
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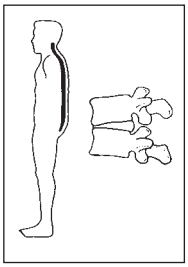
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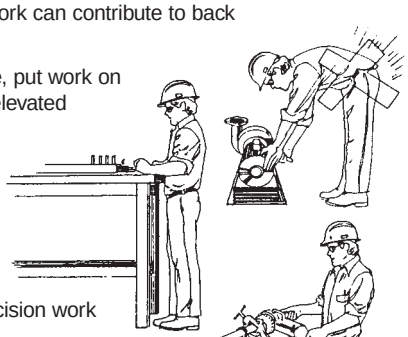
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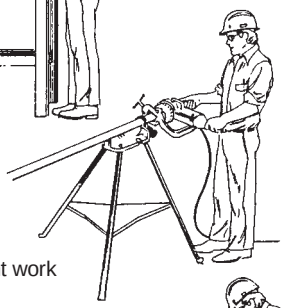
Bending over to work can contribute to back pain and injury.

Wherever possible, put work on a bench or other elevated surface.

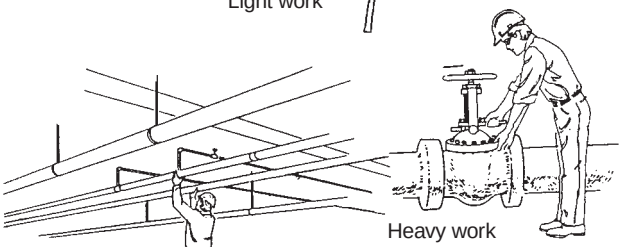
Ideally, the work should be kept between waist and shoulder height.



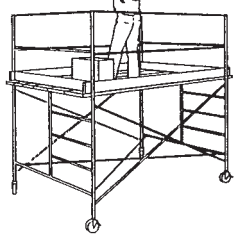
Precision work



Light work



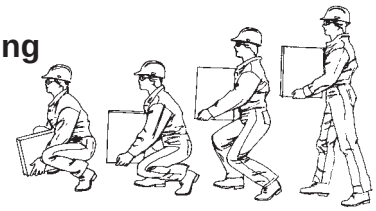
Heavy work



For long-term work overhead or at heights, use scaffolds, scissor lifts, or other work platforms rather than ladders.

Remember — take regular stretch breaks to relieve muscle tension.

Materials Handling



Proper Lifting

1. Plan your move.
   - Size up the load and make sure your pathway is clear.
   - Get help as needed.
   - Use a dolly or other device if necessary.
2. Use a wide-balanced stance with one foot slightly ahead of the other.
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4. Tighten your stomach muscles as the lift begins.
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Do not catch falling objects. Your muscles may not have time to coordinate properly to protect the spine.

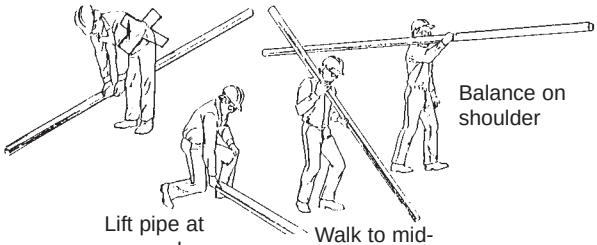
Push rather than pull. Pushing allows you to maintain the normal curves in your back.

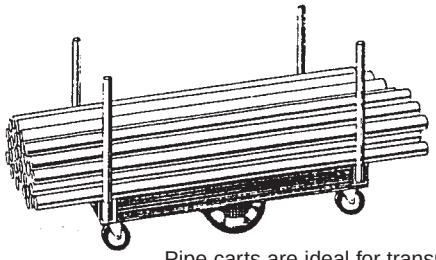
Weight Transfer
Pull the object toward you while transferring your weight to the lift side.

Lift only to the level required.

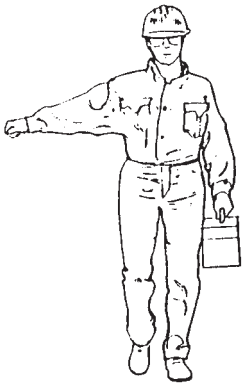
Shift your weight to your other leg while pushing the object into position.

Lifting Pipe





Pipe carts are ideal for transporting a load of pipe.





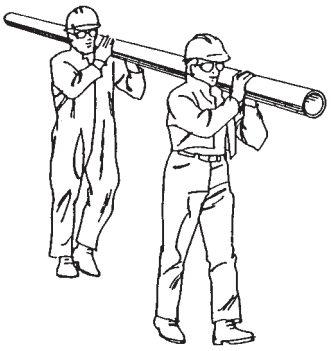
Lifting with Support

Supporting yourself by placing one hand on a secure object or on your thigh can reduce stress on your spine and knees.

Balancing a Load

Any activity that unevenly loads the spine may aggravate your back. Avoid one-handed carrying if possible. Try to distribute the weight evenly on each side. If you can't avoid one-handed carrying, such as with a single pail, hold the free arm straight out as a counterbalance.

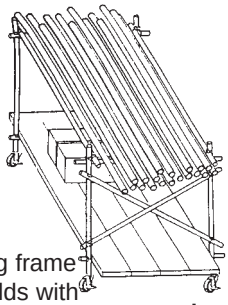
Two-Person Lift
Lifters should be of similar height. Before starting, they should decide on a lifting strategy and who will take charge.

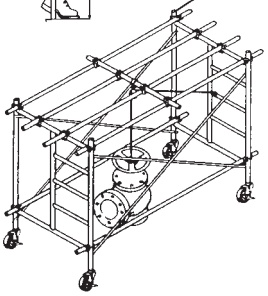


For a two-person lift of a long load, the lifter who takes charge must see that the load is carried on the same side, with a clear line of vision. Begin by lifting the load from ground to waist height. Then lift the load from waist to shoulder.

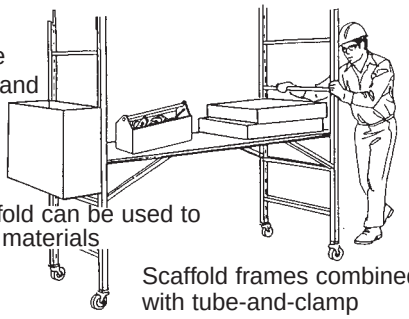
Carrying on Stairs
Use your stomach muscles to help support and protect your back. If possible, the tallest and/or strongest person should be at the bottom of the load.





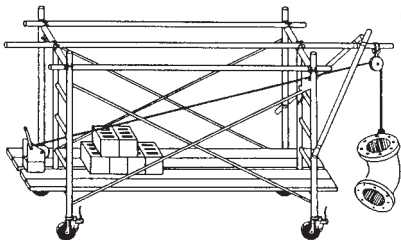


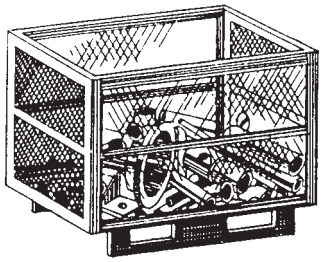
Rolling frame scaffolds with tube-and-clamp components can be used to move pipe and other material.



A small rolling scaffold can be used to transport tools and materials

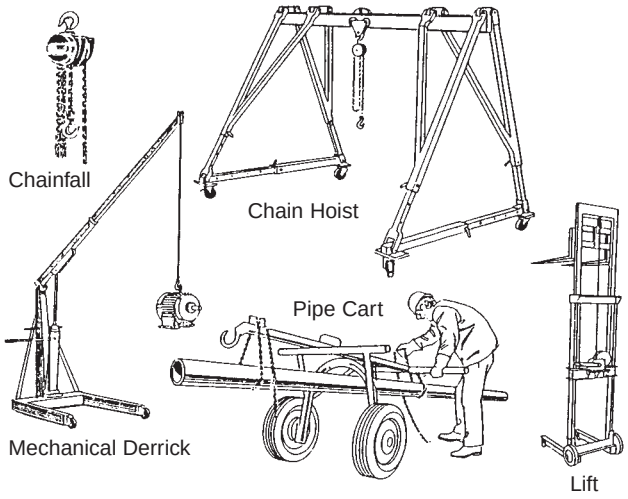
Scaffold frames combined with tube-and-clamp components, casters, and a small boat winch have many uses in moving and lifting.





Loose fittings and short lengths of pipe can be efficiently stored and transported in metal baskets equipped for lifting and moving by forklifts.

In addition to the equipment mentioned so far, there are a number of inexpensive hand-operated devices which make materials handling safer, more efficient, and less of a pain in the back.



Exercise

Construction work strengthens some muscles while others become shorter and weaker, creating a muscle imbalance. A regular exercise program can help to prevent this from happening.

A good exercise program should consist of four basic parts:

- warm-up
- main workout
- strength and stretch
- cool-down.

Warm-Up

This is a general exercise program only. Before starting any exercise program, consult your doctor first.

If you have any concerns or experience any pain while doing the exercises, stop and consult your doctor.

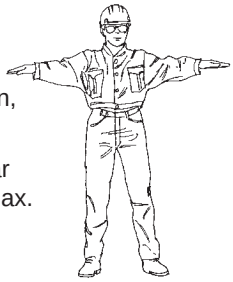


1. March in Place

Start: Stand in position.

Action: Pump arms and legs in opposite directions. Make sure heels contact ground. Continue 3 to 5 minutes.

2. Arm Circles



Start: Stand with arms raised horizontally and slightly in front of shoulders, palms down, and feet shoulder-width apart.

Action: Rotate arms in forward circular motion for 15-30 seconds. Relax. Repeat 3-5 times.

Stretching Program

The following stretching exercises are of greatest value before work starts. They may, however, be done at any convenient time. Whenever they are done, a brief warm-up (walking briskly or jogging on the spot) is most beneficial.

The exercises should be performed in a slow, controlled manner and held in a sustained stretch. Avoid bouncy, jerky movements which may tear muscle fibres.

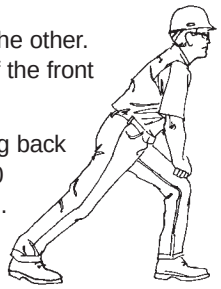
3. Knees to Chest



Start: Support yourself securely with one hand.

Action: Pull your knee toward your chest and grasp around your knee with your free hand. Hold the stretch for 30 seconds. Lower your leg to the ground and repeat with the other leg. Repeat three times for each leg.

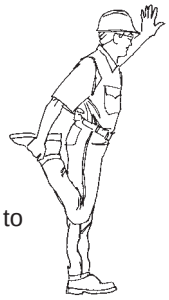
4. Hip Stretch



Start: Stand with one foot in front of the other. Place hands above the knee of the front leg.

Action: Gently bend front knee, keeping back foot flat on the floor. Hold 20-30 seconds. Repeat with other leg. Repeat three times for each leg.

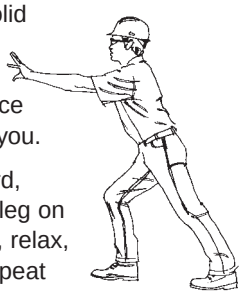
5. Thigh Stretch



Start: Support yourself with one hand on something secure.

Action: Bend your leg back and grasp your ankle with your free hand. Gently pull your ankle toward your body, keeping your trunk straight. Hold 20 to 30 seconds; repeat with other leg. Repeat three times for each leg.

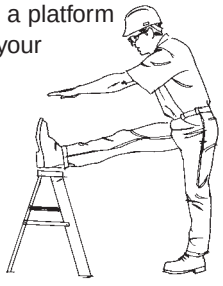
6. Calf Stretch



Start: Stand slightly away from a solid support and lean on it with your outstretched hands. Bend the forward leg and place the other leg straight behind you.

Action: Slowly move your hips forward, keeping the heel of the back leg on the ground. Hold 30 seconds, relax, and repeat with other leg. Repeat three times for each leg.

7. Hamstring Stretch



Start: Place the back of your heel on a platform at a comfortable height. Bend your supporting leg slightly.

Action: Looking straight ahead, slowly bend forward at the hips until you feel a good stretch at the back of the raised leg. Hold 30 seconds and repeat with other leg. Repeat three times for each leg.

6 HEAT STRESS

The Infrastructure Health & Safety Association thanks the following organizations for their help in developing this chapter:

- American Conference of Governmental Industrial Hygienists (ACGIH)
- Sarnia Regional Labour-Management Health and Safety Committee.

Where Does Heat Stress Occur?

Workplaces involving heavy physical work in hot, humid environments can put considerable heat stress on workers. Hot and humid conditions can occur either indoors or outdoors.

Indoors	Outdoors
steel mills and foundries	roadbuilding
boiler rooms	homebuilding
pulp and paper mills	work on bridges
generation plants	trenching
petrochemical plants	pouring and spreading tar or asphalt
smelters	working on flat or shingle roofs
furnace operations	excavation and grading
oil and chemical refineries	electrical utilities
electrical vaults	
interior construction and renovation	

Asbestos removal, work with hazardous wastes, and other operations that require workers to wear semi-permeable or impermeable protective clothing can contribute significantly to heat stress. Heat stress causes the body's core temperature to rise.

What Happens When the Body's Core Temperature Rises?

The human body functions best within a narrow range of internal temperature. This "core" temperature varies from 36°C to 38°C. A worker performing heavy work in a hot environment builds up body heat. To get rid of excess heat and keep internal temperature below 38°C, the body uses two cooling mechanisms:

1) The heart rate increases to move blood—and heat—from heart, lungs, and other vital organs to the skin.
2) Sweating increases to help cool blood and body. Evaporation of sweat is the most important way the body gets rid of excess heat.

When the body's cooling mechanisms work well, core temperature drops or stabilizes at a safe level (around 37°C). But when too much sweat is lost through heavy labour or working under hot, humid conditions, the body doesn't have enough water left to cool itself. The result is dehydration. Core temperature rises above 38°C. A series of heat-related illnesses, or heat stress disorders, can then develop.

How Can We Recognize Heat Stress Disorders?

Heat stress disorders range from minor discomforts to life-threatening conditions:

- heat rash
- heat cramps
- heat exhaustion
- heat stroke.

Heat rash

Heat rash—also known as prickly heat—is the most common problem in hot work environments. Symptoms include

- red blotches and extreme itchiness in areas persistently damp with sweat
- prickling sensation on the skin where sweating occurs.

Treatment—cool environment, cool shower, thorough drying. In most cases, heat rashes disappear a few days after heat exposure ceases. If the skin is not cleaned frequently enough the rash may become infected.

Heat cramps

Under extreme conditions, such as removing asbestos from hot water pipes for several hours in heavy protective gear, the body may lose salt through excessive sweating. Heat cramps can result. These are spasms in larger muscles—usually back, leg, and arm. Cramping creates hard painful lumps within the muscles.

Treatment—stretch and massage muscles; replace salt by drinking commercially available carbohydrate or electrolyte replacement fluids.

Heat exhaustion

Heat exhaustion occurs when the body can no longer keep blood flowing to supply vital organs and send blood to the skin to reduce body temperature at the same time. Signs and symptoms of heat exhaustion include

- weakness
- difficulty continuing work
- headache
- breathlessness
- nausea or vomiting
- feeling faint or actually fainting.

Workers fainting from heat exhaustion while operating machinery, vehicles, or equipment can injure themselves and others. Here's one example from an injury description filed with the Workplace Safety and Insurance Board:

High temperature and humidity in the building contributed to employee collapsing. When he fell, his head struck the concrete floor, causing him to receive stitches above the right eye.

Treatment—heat exhaustion casualties respond quickly to prompt first aid. If not treated promptly, however, heat exhaustion can lead to heat stroke—a medical emergency.

- Call 911.
- Help the casualty to cool off by
  - resting in a cool place
  - drinking cool water
  - removing unnecessary clothing
  - loosening clothing
  - showering or sponging with cool water.

It takes 30 minutes at least to cool the body down once a worker becomes overheated and suffers heat exhaustion.

Heat stroke

Heat stroke occurs when the body can no longer cool itself and body temperature rises to critical levels.

WARNING: Heat stroke requires immediate medical attention.

The following case is taken from a coroner's report.

On June 17, 1994, a rodworker was part of a crew installing rebar on a new bridge. During the lunch break, his co-workers observed him in the hot sun on the bulkhead of the bridge; the recorded temperature by Environment Canada for that day was 31ºC with 51% humidity. Shortly thereafter the rodworker was found lying unconscious on the scaffold, apparently overcome by the intense heat. He was taken to a local hospital, then transferred to a Toronto hospital. However, despite aggressive treatment by numerous specialists, he died. Cause of death: heat stroke.

The primary signs and symptoms of heat stroke are
- confusion
- irrational behaviour
- loss of consciousness
- convulsions
- lack of sweating
- hot, dry skin
- abnormally high body temperature—for example, 41°C.

Treatment

For any worker showing signs or symptoms of heat stroke,

- Call 911.
- Provide immediate, aggressive, general cooling.
  - Immerse casualty in tub of cool water or
  - place in cool shower or
  - spray with cool water from a hose.
  - Wrap casualty in cool, wet sheets and fan rapidly.
- Transport casualty to hospital.
- Do not give anything by mouth to an unconscious casualty.

WARNING

- Heat stroke can be fatal even after first aid is administered. Anyone suspected of suffering from heat stroke should not be sent home or left unattended unless that action has been approved by a physician.
- If in doubt as to what type of heat-related disorder the worker is suffering from, call for medical assistance.

Heat Stress Disorders

	Cause	Symptoms	Treatment	Prevention
Heat rash	Hot humid environment; plugged sweat glands.	Red bumpy rash with severe itching.	Change into clean dry clothes often and avoid hot environments. Rinse skin with cool water.	Wash regularly to keep skin clean and dry.
Heat cramps	Heavy sweating from strenuous physical activity drains a person's body of fluid and salt, which cannot be replaced just by drinking water. Cramps occur from salt imbalance resulting from failure to replace salt lost from heavy sweating.	Painful cramps commonly in the most worked muscles (arms, legs or stomach) which occur suddenly at work or later at home. Heat cramps are serious because they can be a warning of other more dangerous heat-induced illnesses.	Move to a cool area; loosen clothing, gently massage and stretch affected muscles and drink cool salted water (1/4 to 1/2 tsp. salt in 1 litre of water) or balanced commercial fluid electrolyte replacement beverage. If the cramps are severe or don't go away after salt and fluid replacement, seek medical aid. Salt tablets are not recommended.	Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke.
Fainting	Fluid loss, inadequate water intake and standing still, resulting in decreased blood flow to brain. Usually occurs in unacclimatized persons.	Sudden fainting after at least 2 hours of work; cool moist skin; weak pulse.	GET MEDICAL ATTENTION: assess need for CPR. Move to a cool area; loosen clothing; make person lie down; and if the person is conscious offer sips of cool water. Fainting may also be due to other illnesses.	Reduce activity levels and/or heat exposure. Drink fluids regularly. Move around and avoid standing in one place for too long. Workers should check on each other to help spot the symptoms that often precede heat stroke.
Heat exhaustion	Fluid loss and inadequate salt and water intake causes a person's body's cooling system to start to break down.	Heavy sweating; cool moist skin; body temperature over 38°C; weak pulse; normal or low blood pressure; person is tired and weak, and has nausea and vomiting; is very thirsty or is panting or breathing rapidly; vision may be blurred.	GET MEDICAL ATTENTION: This condition can lead to heat stroke, which can kill. Move the person to a cool shaded area; loosen or remove excess clothing; provide cool water to drink; fan and spray with cool water. Do not leave affected person alone.	Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke.
Heat stroke	If a person's body has used to all its water and salt reserves, it will stop sweating. This can cause the body temperature to rise. Heat stroke may develop suddenly or may follow from heat exhaustion.	High temperature (over 41°C) and any one of the following: the person is weak, confused, upset or acting strangely; has hot dry, red skin; a fast pulse; headache or dizziness. In later stages, a person may pass out and have convulsions.	CALL AMBULANCE. This condition can kill a person quickly. Remove excess clothing; fan and spray the person with cool water if the person us conscious.	Reduce activity levels and/or heat exposure. Drink fluids regularly. Workers should check on each other to help spot the symptoms that often precede heat stroke.

Table courtesy of the Ontario Ministry of Labour: www.labour.gov.on.ca/english/hs/pubs/gl_heat.php

What Factors Are Used to Assess Heat Stress Risk?

Factors that should be considered in assessing heat stress include

- personal risk factors
- environmental factors
- job factors.

Personal risk factors

It is difficult to predict just who will be affected by heat stress and when, because individual susceptibility varies. There are, however, certain physical conditions that can reduce the body's natural ability to withstand high temperatures:

- **Weight**
  Workers who are overweight are less efficient at losing heat.
- **Poor physical condition**
  Being physically fit aids your ability to cope with the increased demands that heat places on your body.
- **Previous heat illnesses**
  Workers are more sensitive to heat if they have experienced a previous heat-related illness.
- **Age**
  As the body ages, its sweat glands become less efficient. Workers over the age of 40 may therefore have trouble with hot environments. Acclimatization to the heat and physical fitness can offset some age-related problems.
- **Heart disease or high blood pressure**
  In order to pump blood to the skin and cool the body, the heart rate increases. This can cause stress on the heart.
- **Recent illness**
  Workers with recent illnesses involving diarrhea, vomiting, or fever have an increased risk of dehydration and heat stress because their bodies have lost salt and water.
- **Alcohol consumption**
  Alcohol consumption during the previous 24 hours leads to dehydration and increased risk of heat stress.
- **Medication**
  Certain drugs may cause heat intolerance by reducing sweating or increasing urination. People who work in a hot environment should consult their physician or pharmacist before taking medications.
- **Lack of acclimatization**
  When exposed to heat for a few days, the body will adapt and become more efficient in dealing with raised environmental temperatures. This process is called acclimatization. Acclimatization usually takes six to seven days. Benefits include
  - lower pulse rate and more stable blood pressure
  - more efficient sweating (causing better evaporative cooling)
  - improved ability to maintain normal body temperatures.

  Acclimatization may be lost in as little as three days away from work. People returning to work after a holiday or long weekend—and their supervisors—should understand this. Workers should be allowed to gradually re-acclimatize to work conditions.

Environmental factors

Environmental factors such as ambient air temperature, air movement, and relative humidity can all affect an individual's response to heat. The body exchanges heat with its surroundings mainly through radiation and sweat evaporation. The rate of evaporation is influenced by humidity and air movement.

Radiant Heat

Radiation is the transfer of heat from hot objects through air to the body. Working around heat sources such as kilns or furnaces will increase heat stress. Additionally, working in direct sunlight can substantially increase heat stress. A worker is far more comfortable working at 24°C under cloudy skies than working at 24°C under sunny skies.

Humidity

Humidity is the amount of moisture in the air. Heat loss by evaporation is hindered by high humidity but helped by low humidity. As humidity rises, sweat tends to evaporate less. As a result, body cooling decreases and body temperature increases.

Air Movement

Air movement affects the exchange of heat between the body and the environment. As long as the air temperature is less than the worker's skin temperature, increasing air speed can help workers stay cooler by increasing both the rate of evaporation and the heat exchange between the skin surface and the surrounding air.

Job factors

Clothing and Personal Protective Equipment (PPE)

Heat stress can be caused or aggravated by wearing PPE such as fire- or chemical-retardant clothing. Coated and non-woven materials used in protective garments block the evaporation of sweat and can lead to substantial heat stress. The more clothing worn or the heavier the clothing, the longer it takes evaporation to cool the skin. Remember too that darker-coloured clothing absorbs more radiant heat than lighter-coloured clothing.



Workload

The body generates more heat during heavy physical work. For example, workers shoveling sand or laying brick in hot weather generate a tremendous amount of heat and are at risk of developing heat stress without proper precautions. Heavy physical work requires careful

evaluation even at temperatures as low as 23°C to prevent heat disorders. This is especially true for workers who are not acclimatized to the heat.



Are There Measures for Evaluating Heat Stress Risk?

To prevent heat stress, scientists from the World Health Organization (WHO) have determined that workers should not be exposed to environments that would cause their internal body temperature to exceed 38°C. The only true way of measuring internal body temperature is rectally (oral or inner ear measurements are not as accurate). As an alternative, the American Conference of Governmental Industrial Hygienists (ACGIH) has developed a method of assessing heat stress risk based on a wet bulb globe temperature (WBGT) threshold (Table 2).

This method of assessment involves the three main components of the heat burden experienced by workers:

1) thermal environment
2) type of work
3) type of clothing.

Thermal environment

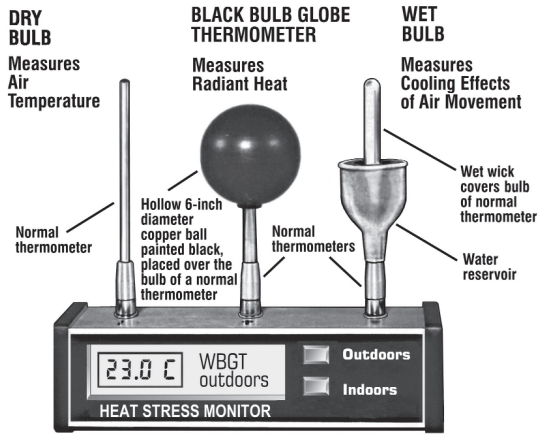
The first factor in assessing heat stress is the thermal environment as measured by WBGT index. WBGT is calculated in degrees Celsius using a formula which incorporates the following three environmental factors:

- air temperature
- radiant heat (heat transmitted to the body through the air from hot objects such as boilers or shingles heated by the sun)
- cooling effects of evaporation caused by air movement (humidity).

To measure WBGT, a heat stress monitor consisting of three types of thermometers is required:

1) A normal thermometer called a **dry bulb thermometer** is used to measure air temperature.
2) Radiant heat is measured by a **black bulb globe thermometer**. This consists of a hollow, 6-inch diameter copper ball painted flat black and placed over the bulb of a normal thermometer.
3) A **wet bulb thermometer** measures the cooling effect of evaporation caused by air movement (wind or fan). It consists of a normal thermometer wrapped in a wick kept moist at all times. As air moves through the wet wick, water evaporates and cools the thermometer in much the same way that sweat evaporates and cools the body.

Heat Stress Monitor



Heat stress monitors currently available calculate WBGT automatically. The equipment required and the method of measuring WBGT can be found in the ACGIH booklet *TLVs® and BEIs®: Threshold Limit Values…Biological Exposure Indices*. The booklet also outlines permissible exposure limits for heat stress. Older instruments, however, require calculation by the operator.

Calculation depends on whether sunlight is direct (outdoors) or not (indoors).

Working outdoors in direct sunlight

For work in direct sunlight, WBGT is calculated by taking 70% of the wet bulb temperature, adding 20% of the black bulb temperature, and 10% of the dry bulb temperature.

WBGT (out) = [70% (0.7) x wet bulb temperature] + [20% (0.2) x black bulb globe temperature] + [10% (0.1) x dry bulb temperature]

Working indoors (no sunlight)

For work indoors or without direct sunlight, WBGT is calculated by taking 70% of the wet bulb temperature and adding 30% of the black bulb temperature.

WBGT (in)= [70% (0.7) x wet bulb temperature] + [30% (0.3) x black bulb globe temperature]

Example

Suppose it's a bright sunny day and a crew of roofers is working 20 feet above ground. Our assessment yields the following readings:

Wet bulb temperature (cooling effects of evaporation) = 20°C

Black bulb globe temperature (radiant heat) = 36°C

Dry bulb temperature (air temperature) = 33°C

Using the formula for work in direct sunlight, we calculate as follows:

WBGT = (0.7 x wet bulb temperature) + (0.2 x black bulb globe temperature) + (0.1 x dry bulb temperature)
= (0.7 x 20) + (0.2 x 36) + (0.1 x 33)
= 14 + 7.2 + 3.3
WBGT (outdoors) = 24.5 °C

Type of work

The second factor in assessing heat stress is the type of work being performed. Following are the four categories, with some examples of each:

Light work	• Using a table saw • Some walking about • Operating a crane, truck, or other vehicle • Welding
Moderate work	• Laying brick • Walking with moderate lifting or pushing • Hammering nails • Tying rebar • Raking asphalt • Sanding drywall
Heavy work	• Carpenter sawing by hand • Shoveling dry sand • Laying block • Ripping out asbestos • Scraping asbestos fireproofing material
Very Heavy Work	• Shoveling wet sand • Lifting heavy objects

Type of clothing

Free movement of cool, dry air over the skin maximizes heat removal. Evaporation of sweat from the skin is usually the major method of heat removal. WBGT-based heat exposure assessments are based on a traditional summer work uniform of long-sleeved shirt and long pants. With regard to clothing, the measured WBGT value can be adjusted according to Table 1.

Table 1: Additions to measured WBGT value for some types of clothing

Clothing Type	Addition to WBGT (°C)
Work clothes (long-sleeved shirt and pants)	0
Cloth (woven material) coveralls	0
SMS polypropylene coveralls	+0.5
Polyolefin coveralls	+1
Double-layer woven clothing	+3
Limited-use vapour-barrier coveralls	+11

Note: These values must not be used for completely encapsulating suits, often called Level A. Clothing adjustment factors cannot be added for multiple layers. The coveralls assume that only modesty clothing is worn underneath, not a second layer of clothing.

Determine work/rest schedules

The WBGT can be used to determine work/rest schedules for personnel under various conditions. Knowing that the WBGT is 24.5°C in the example above, you can refer to Table 2 and determine that workers accustomed to the heat ("acclimatized"), wearing summer clothes, and doing "heavy" work can perform continuous work (100% work).

Suppose work is being performed indoors at a pulp and paper mill under the following conditions:

- Workers are wearing cloth coveralls.
- Boilers are operational.
- Work load is moderate.
- General ventilation is present.

Our assessment yields the following readings:

Wet bulb temperature
(cooling effects of evaporation) = 23°C
Black bulb globe temperature (radiant heat) = 37°C
Dry bulb temperature (air temperature) = 34°C

Using the formula for work indoors, we calculate as follows:

WBGT = (0.7 x wet bulb temperature)
+ (0.3 x black bulb globe temperature)
= (0.7 x 23) + (0.3 x 37) = 27.2°C
Addition for cloth coveralls (Table 1) = 0
WBGT (indoors) = 27.2°C

Referring to Table 2, we determine that workers accustomed to the heat, wearing cloth coveralls, and performing "moderate" work can work.

The WBGT must never be used as an indicator of safe or unsafe conditions. It is only an aid in recognizing heat stress. The ultimate assessment and determination of heat stress must lie with the individual worker or co-worker trained to detect its symptoms. Supervisors must allow individual workers to determine if they are capable of working in heat.

Table 2 is intended for use as a screening step only. Detailed methods of analysis are fully described in various technical and reference works. Contact IHSA for further information.

Table 2: Screening Criteria for TLV® and Action Limit for Heat Stress Exposure

Allocation of work in a cycle of work and recovery	TLV*				Action Limit*			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 to 100%	31.0	28.0	–	–	28.0	25.0	–	–
50 to 75%	31.0	29.0	27.5	–	28.5	26.0	24.0	–
25 to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0 to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

*(WBGT values in °C)

Table 2 is intended as an initial screening tool to evaluate whether a heat stress situation may exist. These values are not intended to prescribe work and recovery periods.

Notes

- WBGT values are expressed in °C. WBGT is NOT air temperature.
- WBGT-based heat exposure assessments are based on a traditional summer work uniform of long-sleeved shirt and long pants.
- If work and rest environments are different, hourly time-weighted averages (TWA) should be calculated and used. TWAs for work rates should also be used when the demands of work vary within the hour.
- Because of the physiological strain produced by very heavy work among less fit workers, the table does not

provide WBGT values for very heavy work in the categories *100% Work* and *75% Work; 25% Rest*. Use of the WBGT is not recommended in these cases. Detailed and/or physiological monitoring should be used instead.
- Consult the latest issue of *TLVs® and BEIs®*: *Threshold Limit Values® and Biological Exposure Indices®*, published by the American Conference of Governmental Industrial Hygienists, for guidance on how to properly measure, interpret, and apply the WBGT.

Because many workplaces are transient and variable in nature it may not be practical to measure WBGT. It's therefore reasonable to ask if there are other ways to evaluate heat stress risk.

Is it Possible to Use the Humidex to Evaluate Heat Stress Risk?

The humidex is a measure of discomfort based on the combined effect of excessive humidity and high temperature. As noted already, heat-related disorders involve more than air temperature and humidity. **Other factors—air movement, workload, radiant heat sources, acclimatization—must also be considered in assessing heat stress.** But humidex readings can signal the need to implement procedures for controlling heat stress in the workplace.

Environment Canada provides the following humidex guidelines.

- Where humidex levels are less than 29°C, most people are comfortable.
- Where humidex levels range from 30°C to 39°C, people experience some discomfort.
- Where humidex levels range from 40°C to 45°C, people are uncomfortable.
- Where humidex levels are over 45°C, many types of labour must be restricted.

In the guideline *Heat Stress*, the Ontario Ministry of Labour recommends using the WBGT to evaluate heat stress. However, the humidex can be permissible instead if equivalency is demonstrated.

In the absence of any heat-related incidents, a Ministry of Labour inspector is not likely to issue orders against any employer with a comprehensive heat stress program based on the humidex.

If the humidex rather than the WBGT is being used to monitor conditions, the employer should have

- documentation describing the heat stress policy
- training that emphasizes recognition of heat stress symptoms
- thorough investigation of any heat stress incidents to determine whether the heat stress policy is deficient.

Because humidex readings can vary substantially from point to point it is important that a reading be taken at the actual workplace.

See the Appendix for a five-step approach for using the humidex.

How Can Heat Stress Be Controlled?

Heat stress can be controlled through education, engineering, and work procedures. Controls will

- **Protect health**
  Illness can be prevented or treated while symptoms are still mild.
- **Improve safety**
  Workers are less likely to develop a heat-related illness and have an accident. Heat stress often creeps up without warning. Many heat-induced accidents are caused by sudden loss of consciousness.
- **Increase productivity**
  Workers feel more comfortable and are likely to be more productive as a result.

Training and education

According to the U.S. National Institute of Occupational Safety and Health (NIOSH), heat stress training should cover the following components:

- knowledge of heat stress hazards
- recognition of risk factors, danger signs, and symptoms
- awareness of first-aid procedures for, and potential health effects of, heat stroke
- employee responsibilities in avoiding heat stress
- dangers of using alcohol and/or drugs (including prescription drugs) in hot work environments.

Engineering controls

Engineering controls are the most effective means of preventing heat stress disorders and should be the first method of control. Engineering controls seek to provide a more comfortable workplace by using

- reflective shields to reduce radiant heat
- fans and other means to increase airflow in work areas
- mechanical devices to reduce the amount of physical work.

When engineering controls are not feasible or practical, work procedures are required to prevent heat stress disorders.

Work procedures

The risks of working in hot environments can be diminished if labour and management cooperate to help control heat stress.

Management

- Give workers frequent breaks in a cool area away from heat. The area should not be so cool that it causes cold shock—around 25°C is ideal.
- Increase air movement by using fans where possible. This encourages body cooling through the evaporation of sweat.
- Provide unlimited amounts of cool (not cold) drinking water conveniently located.
- Allow sufficient time for workers to become acclimatized. A properly designed and applied acclimatization program decreases the risk of heat-related illnesses. Such a program exposes employees to work in a hot environment for progressively longer periods. NIOSH recommends that for workers who have had previous

experience in hot jobs, the regimen should be
- 50% exposure on day one
- 60% on day two
- 80% on day three
- 100% on day four.

For new workers in a hot environment, the regimen should be 20% on day one, with a 20% increase in exposure each additional day.

- Make allowances for workers who must wear personal protective clothing and equipment that retains heat and restricts the evaporation of sweat.
- Schedule hot jobs for the cooler part of the day; schedule routine maintenance and repair work in hot areas for the cooler seasons of the year.
- Consider the use of cooling vests containing ice packs or ice water to help rid bodies of excess heat.

Labour

- Wear light, loose clothing that permits the evaporation of sweat.
- Drink small amounts of water—8 ounces (250 ml)—every half hour or so. Don't wait until you're thirsty.
- Avoid beverages such as tea, coffee, or beer that make you pass urine more frequently.
- Where personal PPE must be worn,
  - use the lightest weight clothing and respirators available
  - wear light-colored garments that absorb less heat from the sun
  - use PPE that allows sweat to evaporate.
- Avoid eating hot, heavy meals. They tend to increase internal body temperature by redirecting blood flow away from the skin to the digestive system.
- Don't take salt tablets unless a physician prescribes them. Natural body salts lost through sweating are easily replaced by a normal diet.

What Are the Responsibilities of Workplace Parties Regarding Heat Stress?

Employers

The *Occupational Health and Safety Act* and its regulations do not specifically cover worker exposure to heat. However, under the *Occupational Health and Safety Act* employers have a general obligation to protect workers exposed to hot environments. Employers should develop a written health and safety policy outlining how workers in hot environments will be protected from heat stress. As a minimum, the following points should be addressed.

- Adjust work practices as necessary when workers complain of heat stress.
- Make controlling exposures through engineering controls the primary means of control wherever possible.
- Oversee heat stress training and acclimatization for new workers, workers who have been off the job for a while, and workers with medical conditions.
- Provide worker education and training, including periodic safety talks on heat stress during hot weather or during work in hot environments.
- Monitor the workplace to determine when hot conditions arise.
- Determine whether workers are drinking enough water.
- Determine a proper work/rest regime for workers.
- Arrange first-aid training for workers.

When working in a manufacturing plant, for instance, a contractor may wish to adopt the plant's heat stress program if one exists.



Workers

- Follow instructions and training for controlling heat stress.
- Be alert to symptoms in yourself and others.
- Avoid consumption of alcohol, illegal drugs, and excessive caffeine.
- Find out whether any prescription medications you're required to take can increase heat stress.
- Get adequate rest and sleep.
- Drink small amounts of water regularly to maintain fluid levels and avoid dehydration.

Reference

Ontario Ministry of Labour. *Heat Stress.* Toronto: Queen's Printer, May 2011.

APPENDIX

Assessing Heat Stress Hazards Using the Humidex

WBGT is the most common and useful index for setting heat stress limits, especially when sources of radiant heat are present. It has proven to be adequate when used as part of a program to prevent adverse health effects in most hot environments.

However, taking WBGT measurements properly is quite complicated.

This section provides a simplified version of the WBGT by converting the WBGT into **humidex**. The method was developed by the Occupational Health Clinics for Ontario Workers, Inc. It allows workplace parties to measure heat stress using only workplace temperature and humidity. The following five steps are designed to help workplaces determine whether conditions require action to reduce heat stress.

Step 1: Clothing

- The humidex plan assumes workers are wearing regular summer clothes (light shirt and pants, underwear, and socks and shoes).
- If workers wear cotton coveralls on top of summer clothes, add 5°C humidex to the workplace humidex measurement.
- Estimate correction factor for other kinds of clothing by comparing them with cotton coveralls (e.g., gloves, hard hat, apron, and protective sleeves might be equivalent to a little less than half the evaporation resistance of coveralls, so add 1°C or 2°C humidex).

Step 2: Training

- Measurements by themselves cannot guarantee workers protection from heat stress. It is essential that workers learn to recognize the early signs and symptoms of heat stress and know how to prevent them.
- If it's possible, workers need to be able to alter their pace of work, take rest breaks, and drink in response to early symptoms (a cup of water every 20 minutes). The ideal heat stress response plan would let workers regulate their own pace by "listening to their body."

Step 3: Select a measurement location

- Divide the workplace into zones which have similar heat exposures.
- Select a representative location in each zone where you can take measurements. **Note:** the Humidex Heat Stress Response (Table B) is based on **workplace** measurements, **not** weather station/media reports (temperatures inside buildings do not necessarily correspond with outside temperatures).

Step 4: Measure workplace humidex

- A thermal hygrometer (usually $20–$60 at hardware or office supply stores) is a simple way to measure the temperature and relative humidity in your workplace. Avoid placing the thermal hygrometer in direct sunlight or in contact with a hot surface. Once you have the temperature and humidity, use Table A (or the humidex calculator located at: http://www.ohcow.on.ca/menuweb/heat_stress_calculator.htm) to determine the corresponding humidex value.
- From Table B, select Humidex 1 or Humidex 2 according to the amount of physical activity involved with the work and the level of acclimatization. This helps you determine what steps should be taken to reduce the heat stress. Humidex 1 is for moderate unacclimatized and heavy acclimatized work; Humidex 2 is for light unacclimatized work (sitting/standing doing light arm work).

Step 5: Adjust for radiant heat

- For outdoor work in direct sunlight between the hours of 10 am and 5 pm, add 1–2°C (pro-rate according to percentage cloud cover) to your humidex measurement.
- For indoor radiant heat exposures (such as boilers or furnaces), use common sense to judge whether the exposure involves more or less radiant heat than direct sunlight and adjust the 1–2°C correction factor appropriately.

See Table A and Table B on the following pages.

Table 1: Humidex Table

Humidex																			
	Relative Humidity (in %)																		
Temp (in °C)	**100**	**95**	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**10**	**Temp (in °C)**
49																			50	**49**
48	-																		49	**48**
47																		50	47	**47**
46			**Never ignore someome's symptoms no matter what you measure!**															49	46	**46**
45																	50	47	45	**45**
44																	49	46	43	**44**
43																49	47	45	42	**43**
42															50	48	46	43	41	**42**
41															48	46	44	42	40	**41**
40														49	47	45	43	41	39	**40**
39													49	47	45	43	41	39	37	**39**
38												49	47	45	43	42	40	38	36	**38**
37											49	47	45	44	42	40	38	37	35	**37**
36									50	49	47	45	44	42	40	39	37	35	34	**36**
35								50	48	47	45	43	42	40	39	37	36	34	33	**35**
34							49	48	46	45	43	42	40	39	37	36	34	33	31	**34**
33					50	48	47	46	44	43	41	40	39	37	36	34	33	32	30	**33**
32			50	49	48	46	45	44	42	41	40	38	37	36	34	33	32	30	29	**32**
31	50	49	48	47	45	44	43	42	40	39	38	37	35	34	33	32	30	29	28	**31**
30	48	47	46	44	43	42	41	40	39	37	36	35	34	33	31	30	29	28	27	**30**
29	46	45	43	42	41	40	39	38	37	36	35	33	32	31	30	29	28	27	26	**29**
28	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	**28**
27	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25			**27**
26	39	38	37	36	35	34	33	33	32	31	30	29	28	27	26	25				**26**
25	37	36	35	34	33	33	32	31	30	29	28	27	26	26	25					**25**
24	35	34	33	33	32	31	30	29	28	28	27	26	25							**24**
23	33	32	31	31	30	29	28	28	27	26	25									**23**
22	31	30	30	29	28	27	27	26	25	25										**22**
21	29	29	28	27	26	26	25													**21**
	100%	**95%**	**90%**	**85%**	**80%**	**75%**	**70%**	**65%**	**60%**	**55%**	**50%**	**45%**	**40%**	**35%**	**30%**	**25%**	**20%**	**15%**	**10%**	

Table B: Response

Humidex 1 moderate unacclimatized and heavy acclimatized work	**Response** Never ignore someone's symptoms no matter what you measure!	**Humidex 2** light unacclimatized work (sitting/standing doing light arm work)
30-37	**Low** • Alert workers to potential for heat stress. • Ensure access to water.	**34-41**
38-39	**Medium** • Reduce physical activity (e.g., slower pace, double up, breaks). • Drink a cup of water every 20-30 minutes.	**42-43**
40-42	**Moderate** • Reduce physical activity further. • Drink a cup of water every 15-20 minutes.	**44-45**
43-44	**High** • Ensure sufficient rest and recovery time. Severely curtail physical activity. • Drink a cup of water every 10-15 minutes.	**46-48**
45 or over	**Extreme** • It is hazardous to continue physical activity.	**49 or over**

7 COLD STRESS

Contents

- Core temperature
- Wind chill
- Hypothermia
- Frostbite
- Risk factors
- Controls
- Exposure limits

Cold stress or **hypothermia** can affect workers who are not protected against cold. The cold may result naturally from weather conditions or be created artificially, as in refrigerated environments.

Cold is a physical hazard in many workplaces. When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, leading to permanent tissue damage and even death.

Workplaces exposed to cold, wet, and/or windy conditions include

- roofs
- open or unheated cabs
- bridges or other projects near large bodies of water
- large steel structures that retain cold or are exposed to cold
- high buildings open to the wind
- refrigerated rooms, vessels, and containers.

This section provides information on

- effects of overexposure to cold
- factors that can worsen these effects
- control measures.

Knowing this information can help construction workers avoid hypothermia and frostbite.

Core Temperature

The body tries to maintain an internal (core) temperature of approximately 37°C (98.6°F). This is done by reducing heat loss and increasing heat production.

Under cold conditions, blood vessels in skin, arms, and legs constrict, decreasing blood flow to extremities. This minimizes cooling of the blood and keeps critical internal organs warm. At very low temperatures, however, reducing blood flow to the extremities can result in lower skin temperature and higher risk of frostbite.

Wind Chill

Wind chill involves the combined effect of air temperature and air movement. The wind-chill cooling rate is defined as heat loss (expressed in watts per metre squared) resulting from the effects of air temperature and wind velocity upon exposed skin.

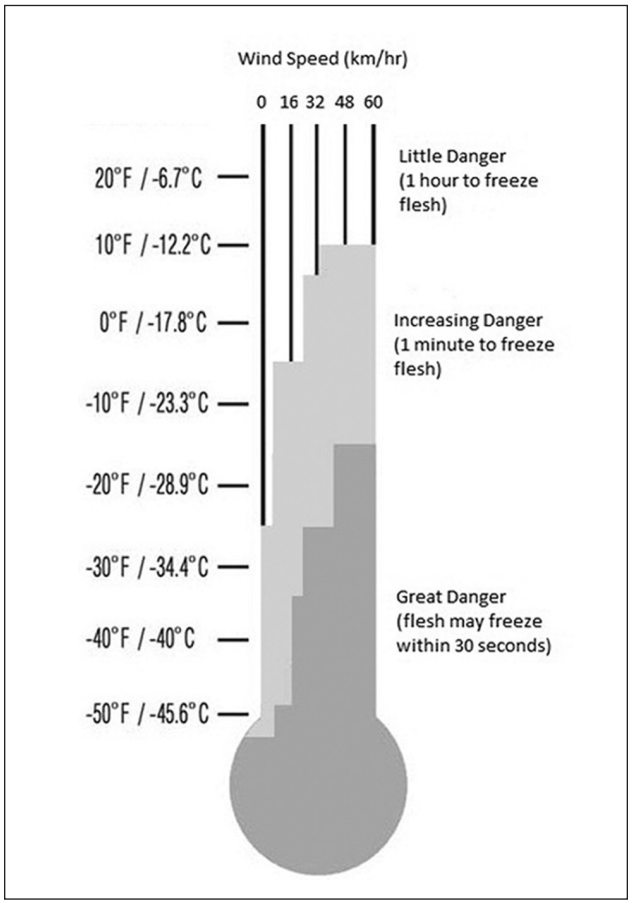


Chart 1: Equivalent chill temperatures

Adapted from *TLVs® and BEIs®: Threshold Limit Values® for Chemical Substances and Physical Agents and Biological Exposure Indices®*, American Conference of Governmental Industrial Hygienists, 2011.

The higher the wind speed and the lower the temperature in the work environment, the greater the insulation value of the protective clothing required.

Chart 1 provides equivalents between air temperatures with and without wind. For example, -12.2°C with a wind of 48 km/h is equivalent to -45°C with no wind. When air speed and temperature produce an equivalent chill temperature of -32°C (-25.6°F), continuous skin exposure should not be permitted. Unprotected skin will freeze only at temperatures below -1°C (30.2°F), regardless of wind speed.

When weather information is not available, the following signs may help to estimate wind speeds in the field:

- 8 km/h (5 mph) light flag just moves
- 16 km/h (10 mph) light flag is fully extended by the wind
- 24 km/h (15 mph) raises a newspaper sheet off the ground
- 32 km/h (20 mph) wind capable of blowing snow.

Exposure to cold causes two major health problems: frostbite and hypothermia.

Hypothermia—*Signs and symptoms*

When the body can no longer maintain core temperature by constricting blood vessels, it shivers to increase heat production. Maximum severe shivering develops when the body temperature has fallen to 35°C (95°F).

The most critical aspect of hypothermia is the body's failure to maintain its deep core temperature. Lower body temperatures present the following signs and symptoms:

- persistent shivering—usually starts when core temperature reaches 35°C (95°F)
- irrational or confused behaviour
- reduced mental alertness
- poor coordination, with obvious effects on safety
- reduction in rational decision-making.

In addition, acute exertion in cold can constrict blood vessels in the heart. This is particularly important for older workers or workers with coronary disease who may have an increased risk of heart attack.

Hypothermia—*Stages*

Mild

Early signs of hypothermia include

- shivering
- blue lips and fingers
- poor coordination.

Moderate

The next stage includes

- mental impairment
- confusion
- poor decision-making
- disorientation
- inability to take precautions from the cold
- heart slowdown
- slow breathing.

Severe

In severe cases, hypothermia resembles death. Patients must be treated as though they are alive.

Symptoms of severe hypothermia include

- unconsciousness
- heart slowdown to the point where pulse is irregular or difficult to find
- no shivering
- no detectable breathing.

Hypothermia—*First aid*

Stop further cooling of the body and provide heat to begin rewarming.

- Carefully remove casualty to shelter. Sudden movement or rough handling can upset heart rhythm.
- Keep casualty awake.
- Remove wet clothing and wrap casualty in warm covers.
- Rewarm neck, chest, abdomen, and groin—but not extremities.
- Apply direct body heat or use safe heating devices.
- Give warm, sweet drinks, but only if casualty is conscious.
- Monitor breathing. Administer artificial respiration if necessary.
- Call for medical help or transport casualty carefully to nearest medical facility.

Frostbite—*Signs and symptoms*

Frostbite is a common injury caused by exposure to severe cold or by contact with extremely cold objects.

Frostbite occurs more readily from touching cold metal objects than from exposure to cold air. That's because heat is rapidly transferred from skin to metal.

The body parts most commonly affected by frostbite are face, ears, fingers, and toes. When tissue freezes, blood vessels are damaged. This reduces blood flow and may cause gangrene.

Frostbite symptoms vary, are not always painful, but often include a sharp, prickling sensation.

The first indication of frostbite is skin that looks waxy and feels numb. Once tissues become hard, the case is a severe medical emergency. Severe frostbite results in blistering that usually takes about ten days to subside.

Once damaged, tissues will always be more susceptible to frostbite in future.

Frostbite—*First aid*

- Warm frostbitten area gradually with body heat. Do not rub.
- Don't thaw hands or feet unless medical aid is distant and there is no chance of refreezing. Parts are better thawed at a hospital.
- Apply sterile dressings to blisters to prevent breaking. Get medical attention.

Risk Factors

Various medical conditions can increase the risk of cold injury:

- heart disease

- asthma/bronchitis
- diabetes
- vibration/white finger disease.

Check with your health practitioner to learn whether medications you are taking may have adverse effects in a cold environment.

Controls

The best protection against cold-related health risks is to be aware and be prepared. Workers should recognize the signs and symptoms of overexposure in themselves and others. Pain in the extremities may be the first warning sign. Any worker shivering severely should come in out of the cold.

General

- Ensure that the wind-chill factor is understood by workers, especially those working on bridges or out in the open on high buildings.
- Ensure that workers are medically fit to work in excessive cold, especially those subject to the risk factors highlighted in the previous section.
- Make sure that workers understand the importance of high-caloric foods when working in the cold. Warm sweet drinks and soups should be arranged at the worksite to maintain caloric intake and fluid volume. Coffee should be discouraged because it increases water loss and blood flow to extremities.
- Personnel working in isolated cold environments, whether indoors or outdoors, should have backup.
- Provide hot drinks and regular breaks under extremely cold working conditions.

Clothing

Select protective clothing to suit the cold, the job, and the level of physical activity.

- Wear several layers of clothing rather than one thick layer. The air captured between layers is an insulator.
- Wear synthetic fabrics such as polypropylene next to the skin because these wick away sweat. Clothing should not restrict flexibility.
- If conditions are wet as well as cold, ensure that the outer clothing worn is waterproof or at least water-repellent. Wind-resistant fabrics may also be required under some conditions.
- At air temperatures of 2°C (35.6°F) or less, workers whose clothing gets wet for any reason must be immediately given a change of clothing and be treated for hypothermia.
- Encourage the use of hats and hoods to prevent heat loss from the head and to protect ears. Balaclavas or other face covers may also be necessary under certain conditions.
- Tight-fitting footwear restricts blood flow. Footwear should be large enough to allow wearing either one thick or two thin pairs of socks. Wearing too many socks can tighten the fit of footwear and harm rather than help.
- Workers who get hot while working should open their jackets but keep hats and gloves on.

Hand Protection

Manual dexterity is essential to safety and production.

- Fine work performed with bare hands for more than 10-20 minutes in an environment below 16°C (60.8°F) requires special measures to keep workers' hands warm. These measures may include warm air jets, radiant heaters (fuel burning or electric), or contact warm plates.
- Metal handles of tools and control bars should be covered by thermal insulating material for temperatures below -1°C (30.2°F).
- Workers should wear gloves where fine manual dexterity is not required and the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, and -7°C (19.4°F) for moderate work.
- To prevent contact frostbite, workers should wear insulated gloves when surfaces within reach (especially metallic surfaces) are colder than -7°C (19.4°F). Warn workers to avoid skin contact with these surfaces.
- Tools and machine controls to be used in cold conditions should be designed for operation by gloved hands.

Shelter

For work performed continuously in the cold, allow rest and warm-up breaks (see Table 1). Heated shelters such as trailers should be available nearby. Encourage workers to use these shelters at regular intervals depending on the wind-chill factor.

Workers showing signs of shivering, frostbite, fatigue, drowsiness, irritability, or euphoria should immediately return to the shelter.

Workers entering the shelter should remove their outer layer of clothing and loosen other clothing to let sweat evaporate. In some cases, a change of clothing may be necessary.

Training

Before working in extreme cold, workers should be instructed in safety and health procedures.

Training should cover

- proper clothing and equipment
- safe work practices
- guidelines for eating and drinking
- risk factors that increase the health effects of cold exposure

- how to recognize signs and symptoms of frostbite
- how to recognize signs and symptoms of hypothermia
- appropriate first aid treatment, including rewarming procedures.



Exposure Limits

Ontario has no legislated exposure limits for work in cold environments. The table below was developed by the Saskatchewan Department of Labour and adopted by the American Conference of Governmental Industrial Hygienists (ACGIH). It indicates Threshold Limit Values for properly clothed personnel working at temperatures below freezing.

Table 1: Work/Warm-up Schedule for a Four-Hour Shift

Air temperature (sunny sky)		No noticeable wind		8 km/h wind (5 mph)		16km/h wind (10 mph)		24 km/h wind (15mph)		32 km/h wind (20 mph)	
°C (approx.)	°F (approx.)	Max work period	No. of breaks	Max work period	No. of breaks	Max work period	No. of breaks	Max work period	No. of breaks	Max work period	No. of breaks
-26° to -28°	-15° to -19°	Normal breaks	1	Normal breaks	1	75 minutes	2	55 minutes	3	40 minutes	4
-29° to -31°	-20° to -24°	Normal breaks	1	75 minutes	2	55 minutes	3	40 minutes	4	30 minutes	5
-32° to -34°	-25° to -29°	75 minutes	2	55 minutes	3	40 minutes	4	30 minutes	5	**Non-emergency work should stop**	
-35° to -37°	-30° to -34°	55 minutes	3	40 minutes	4	30 minutes	5	**Non-emergency work should stop**			
-38° to -39°	-35° to -39°	40 minutes	4	30 minutes	5	**Non-emergency work should stop**					
-40° to -42°	-40° to -44°	30 minutes	5	**Non-emergency work should stop**							
-43° and below	-45° and below	**Non-emergency work should stop**									

Source: Occupational Health and Safety Division, Saskatchewan Department of Labour

Notes

a) This table applies to any 4-hour work period of moderate-to-heavy work with warm-up periods of ten minutes in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate work (limited physical movement) apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (row 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (row 5).

b) Here is a rough guideline for using the chart if only the wind-chill cooling rate is available: 1) initiate special warm-up breaks at a wind chill cooling rate of about 1750 W/m^2; 2) cease all non-emergency work at or before a wind chill of 2250 W/m^2. In general, the warm-up schedule slightly undercompensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly overcompensates for the actual temperatures in the colder ranges because windy conditions rarely prevail at extremely low temperatures.

c) The chart applies only to workers in dry clothing.

9 MOULDS

More and more firms are involved in removing toxic moulds from contaminated buildings. This section explains

- what moulds are
- where they are found
- why they are of concern
- what health effects they may cause
- how they can be identified
- how they can be safely removed.

This section also covers the obligations of employers and others under Ontario's *Occupational Health and Safety Act.*

What are moulds?

Moulds are microorganisms that produce thousands of tiny particles called spores as part of their reproductive cycle. Mould colonies are usually visible as colourful, woolly growths. They can be virtually any colour – red, blue, brown, green, white, or black. When disturbed by air movement or handling, moulds release their spores into the air. Given the right environmental conditions, these spores can go on to form other mould colonies.

Where are moulds found?

Moulds can be found almost anywhere outdoors and indoors. Indoor moulds usually originate from outside sources such as soil and vegetation. Moulds love dark, moist environments and can grow at room temperature on various construction materials including wallpaper, particleboard, ceiling tiles, drywall, and plywood.

Workers can be exposed to toxic spores when working on buildings with some sort of water damage from flooding, plumbing leaks, or leaks in the structure itself.

Why are moulds of concern?

In buildings with water damage or ongoing moisture problems, certain types of "water-loving" moulds may reproduce to higher than normal levels and potentially cause adverse health effects. *Stachybotrys chartarum* (formerly known as *Stachybotrys atra*) is of particular concern because it can be found in large colonies and can cause adverse health effects.

Stachybotrys has gained special attention because it has been discovered in portable classrooms with ongoing moisture problems. It appears as small black patches and grows well on water-soaked cellulose material such as wallpaper, ceiling tiles, drywall, and insulation containing paper.

In addition to *Stachybotrys*, personnel working in water-damaged buildings may be exposed to other types of toxic moulds such as *Fusarium, Aspergillus,* and *Penicillium*.

What health effects can moulds cause?

Air movement and the handling of contaminated material can release toxic spores into the atmosphere. These spores cause adverse health effects by producing toxic substances known as mycotoxins. Once released, toxic spores must come into contact with the skin or be inhaled before symptoms can develop. Not all exposed workers will develop symptoms.

- Exposure to toxic moulds may irritate skin, eyes, nose, and throat, resulting in allergy-like symptoms such as difficulty in breathing, runny nose, and watery eyes.
- Other symptoms such as fatigue and headache have also been reported.
- Workers who are allergic to moulds could experience asthmatic attacks.
- Workers exposed to *Stachybotrys* have also experienced burning in the nose, nose bleeds, severe coughing, and impairment of the immune system. *Stachybotrys* does not cause infection and is not spread from person to person.
- People with weakened immune systems are particularly susceptible to mould-related illness and should not work in mould-contaminated areas.

How are moulds identified?

Owners of buildings that may be mould-contaminated should conduct, at their own expense, an assessment to determine whether or not the buildings are indeed contaminated. The assessment should include building inspection and analysis of bulk samples.

Mould on visible surfaces may be just the tip of the iceberg. Since they thrive in dark, moist environments, moulds may be hidden from view. Thorough inspections of water-damaged areas must be conducted. This involves looking into wall cavities, behind drywall, under carpets, and above ceiling tiles.

Not all mounds are toxic. The type of mould identified and the extent of the contamination will determine the precautions to be taken.

Bulk sampling and laboratory analysis are used to document the type of mould growing on surfaces. The procedure involves scraping surface material into a sealable plastic bag and sending it by overnight delivery to an accredited laboratory.

An accredited laboratory is one that participates in the American Industrial Hygiene Association's Environmental Microbiology Proficiency Analytical Testing Program. The chosen laboratory should have a competent mycologist (a person that studies moulds) who can analyze the sample and determine whether the mould is likely to pose a health risk.

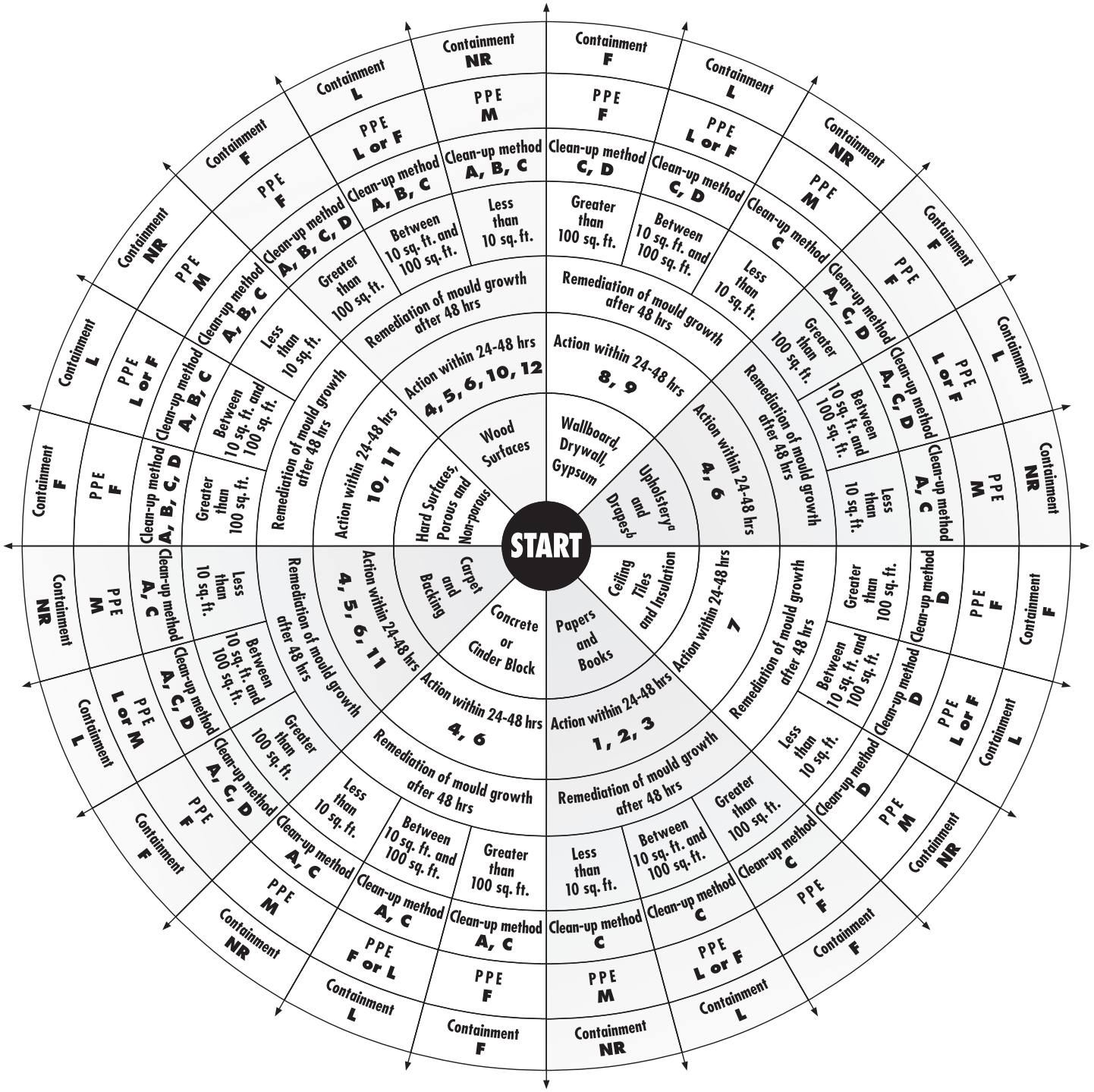
Based on the presence of visible mould, evidence of water damage, and symptoms that are consistent with allergic or toxic response to mould, it may be justified to skip bulk sampling and go straight to remediation (removal).

The person taking bulk samples or performing inspections must be suitably protected for Level 1 work (see chart on the next page) and must be careful not to unduly disturb the mould.

How can moulds be safely removed?

Toxic moulds must be removed. However, special control measures must first be implemented to prevent worker exposure and the spread of moulds from the construction area to adjacent areas. This is especially true for *Stachybotrys* because of its potentially severe health effects.

Mould Remediation Chart



The extent of contamination governs what remediation measures need to be taken in order to prevent the spread of toxic moulds.

Note: The cause of moisture problems should be corrected before any mould remediation takes place.

A follow-up inspection should be conducted 3–6 months after remediation to ensure that the mould has not returned.

Obligations under the Act

Although there are no Ontario regulations specifically addressing moulds, an employer must, under the *Occupational Health and Safety Act,* take every precaution reasonable in the circumtances for the protection of a worker. Work practices set out by Health Canada in *Fungal Contamination of Public Buildings: A Guide to Recognition and Management* provide a reasonable standard.

Employers have a duty to instruct workers in the safe removal and handling of mould-contaminated material. Workers in turn have the duty to follow these instructions. Building owners must ensure that trade contractors follow proper remediation procedures.

Mould Remediation Chart

The chart on the opposite page summarizes mould control procedures recommended by the Environmental Protection Agency in the United States.

For various kinds of material, the chart indicates how mould growth can be prevented within 24–48 hours of water damage and also provides general advice on remediation. This information is intended only as a summary of basic procedures and is not intended, nor should it be used, as a detailed guide to mould remediation.

Although the chart may look complicated, it becomes clear and useful when taken one step, or one ring, at a time.

1) Start at the centre.
2) In the first ring, identify the material you are concerned about.
3) In the next ring, find out what actions to take within the first 24-48 hours of CLEAN water damage. Actions are numbered 1, 2, 3, 4 and so on. Each is spelled out under the **Action within 24–48 hrs** column at right.
4) Proceed to the next ring if mould growth is apparent and more than 48 hours have elapsed since water damage. Determine whether the contaminated area is less than 10 square feet, between 10 and 100 square feet, or greater than 100 square feet.
5) Proceed to the next ring and follow the clean-up method indicated for the size of the contaminated area. Methods are lettered A, B, C, and D. Each is spelled out under the **Clean-up Methods** column.
6) In the next ring, determine the level of personal protective equipment required. This is indicated by M, L, or F under the **PPE** column.
7) Finally, in the outermost ring, determine whether containment is necessary and, if so, whether it must be L (limited) or F (full). These requirements are explained in the **Containment** column.

Action within 24–48 hrs

Actions are for damage caused by clean water. If you know or suspect that water is contaminated by sewage or chemical or biological pollutants, consult a professional. Do not use fans unless the water is clean or sanitary. If mould has grown or materials have been wet for more than 48 hours, consult **Clean-up Method** in the chart.

1. Discard non-valuable items.
2. Photocopy valuable items, then discard.
3. Freeze (in frost-free freezer or meat locker) or freeze-dry.
4. Remove water with water-extraction vacuum.
5. Reduce humidity levels with dehumidifiers.
6. Accelerate drying process with fans and/or heaters.
   - Don't use heat to dry carpet.
   - Use caution applying heat to hardwood floors.
7. Discard and replace.
8. May be dried in place, if there is no swelling and the seams are intact. If not, then discard and replace.
9. Ventilate wall cavity.
10. For all treated or finished woods, porous (linoleum, ceramic tile, vinyl) and non-porous (metal, plastic) hard surfaces, vacuum or damp-wipe with water or water and mild detergent and allow to dry; scrub if necessary.
11. For porous flooring and carpets, make sure that subfloor is dry. If necessary clean and dry subfloor material according to chart.
12. Wet paneling should be pried away from walls for drying.

Clean-up Methods

Methods are for damage caused by clean water. If you know or suspect that water is contaminated by sewage or chemical or biological pollutants, consult a professional. These are guidelines only. Other cleaning methods may be preferred by some professionals. Consult **Action within 24–48 hrs** in the chart if materials have been wet for less than 48 hours and mould growth is not apparent. If mould growth is not addressed promptly, some items may be damaged beyond repair. If necessary, consult a restoration specialist.

A. Wet-vacuum the material. (In porous material, some mould spores/fragments will remain but will not grow if material is completely dried.) Steam cleaning may be an alternative for carpets and some upholstered furniture.
B. Damp-wipe surfaces with water or with water and detergent solution (except wood – use wood floor cleaner); scrub as needed.
C. Use a high-efficiency particulate air (HEPA) vacuum once the material has been thoroughly dried. Dispose of HEPA-vacuum contents in well-sealed plastic bags.
D. Remove water-damaged materials and seal in plastic bags inside containment area, if there is one. Dispose of as normal waste. HEPA-vacuum area once it is dried.

PPE (Personal Protective Equipment)

Use professional judgment to determine PPE for each situation, particularly as the size of the remediation site and the potential for exposure and health effects increase. Be prepared to raise PPE requirements if contamination is more extensive than expected.

M Minimum – Gloves, N-95 respirator, goggles/eye protection.
L Limited – Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection.
F Full – Gloves, disposable full-body clothing, head gear, foot coverings, full-face respirator with HEPA filter.

Containment

Use professional judgment to determine containment for each situation, particularly as the size of the remediation site, and the potential for exposure and health effects, increase.

NR None Required
L Limited – From floor to ceiling, enclose affected area in polyethylene sheeting with slit entry and covering flap. Maintain area under negative pressure with HEPA-filtered fan. Block supply and return air vents in containment area.
F Full – Use two layers of fire-retardant polyethylene sheeting with one airlock chamber. Maintain area under negative pressure with HEPA-filtered fan exhausted outside of building. Block supply and return air vents in containment area.

Endnotes

a) Upholstery may be difficult to dry within 48 hours. For items with monetary or sentimental value, consult a restoration specialist.
b) Follow manufacturer's laundering instructions.

34 ASBESTOS

This chapter provides some brief information about asbestos in construction. If you encounter asbestos on the job, you will need more information. Here are the two main sources of further information on asbestos in Ontario construction:

The legal requirements for handling, working with, removing, and disposing of asbestos and asbestos-containing products are described in ***Designated Substance—Asbestos on Construction Projects and in Buildings and Repair Operations*** **(Ontario Regulation 278/05)**. Read the regulation to get a full description of your legal duties. You can get a copy from the Infrastructure Health & Safety Association (IHSA), or read it on www.ihsa.org.

In addition, IHSA publishes ***Asbestos: Controls for Construction, Renovation, and Demolition*** (DS037). It contains more information than what's in this chapter, and it tells you how to protect yourself. It can also help you understand the asbestos regulation. You can order a copy from IHSA or download it from www.ihsa.ca.

What is Asbestos?

Asbestos is a naturally occurring material once used widely in the construction industry. Its strength, ability to withstand high temperatures, and resistance to many chemicals made it useful in hundreds of applications.

But asbestos can also kill. When inhaled, asbestos has been shown to cause the following diseases

- asbestosis
- lung cancer
- mesothelioma (cancer of the lining of the chest and/or abdomen).

The early widespread use of asbestos has left a potentially dangerous legacy. The improper handling of asbestos-containing products can release harmful amounts of fibre.

You need to protect yourself, your coworkers, your family, and others from asbestos. Read the following pages and the respirator chart at the end of the chapter.

Where is it?

Most structures built between 1930 and 1975 will contain products having substantial amounts of asbestos. (See Table 1 and Figures 1, 2, and 3.)

Table 1

ASBESTOS PRODUCTS IN CONSTRUCTION			
Product	**Residential**	**Commercial/ Institutional**	**Industrial**
Sprayed-On Fireproofing		XX*	
Pipe and Boiler Insulation	X	X	XX
Loose Fill Insulation	X**		X
Asbestos Cement Products	X	X	X
Acoustical Plaster	X	X	
Acoustical Tiles	X	XX	
Vinyl Asbestos	X	X	
Gaskets		X	XX
Roofing Felts	X	X	X
Asphalt/Asbestos Limpet Spray			X
Drywall Joint-Filling Compound	X	X	
Coatings and Mastics	X	X	X

*Denotes extensive use. **Vermiculite insulation.
xx – May contain vermiculite.

If you have any concerns about material that you believe may be asbestos, have it checked **before** work is started. Otherwise, treat the material as if it is asbestos.

Workers in the carpentry, drywall, resilient flooring, and acoustic and interior systems trades may encounter asbestos in

– light fixtures
– light troughs
– soffits
– transite tile over stairways
– soffits of plazas
– ceiling tile
– 2' x 2' porous tile
– exterior cladding
– insulation
– pre-1980 drywall joint compound
– caulking materials
– gaskets and packings.

Sanding creates fine airborne dust which may stay airborne for 24 hours or longer. Air movements created by heating and air-conditioning systems will spread these airborne fibre particles throughout the building unless the work area and ductwork is sealed off.



Figure 1

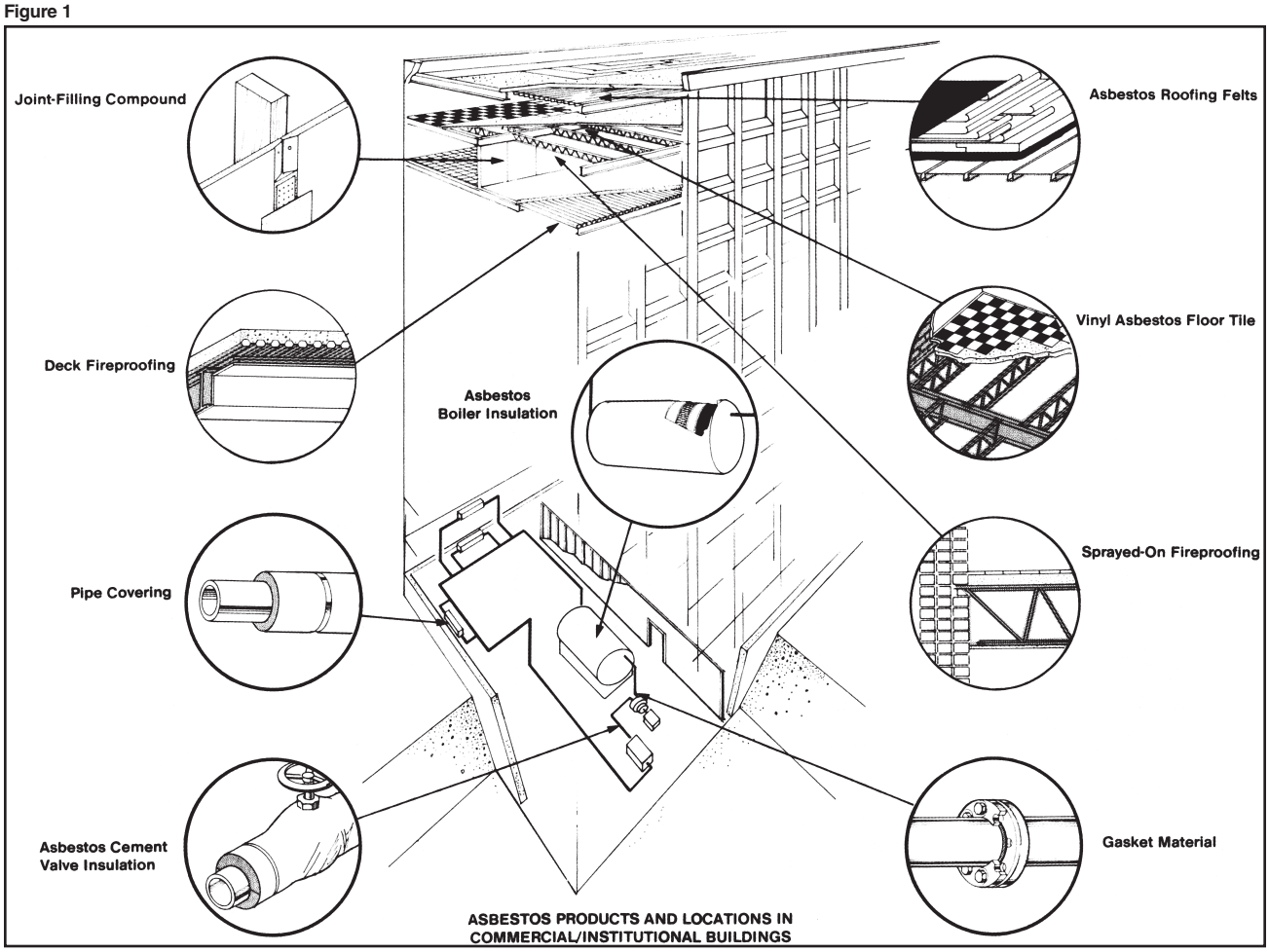


Figure 2

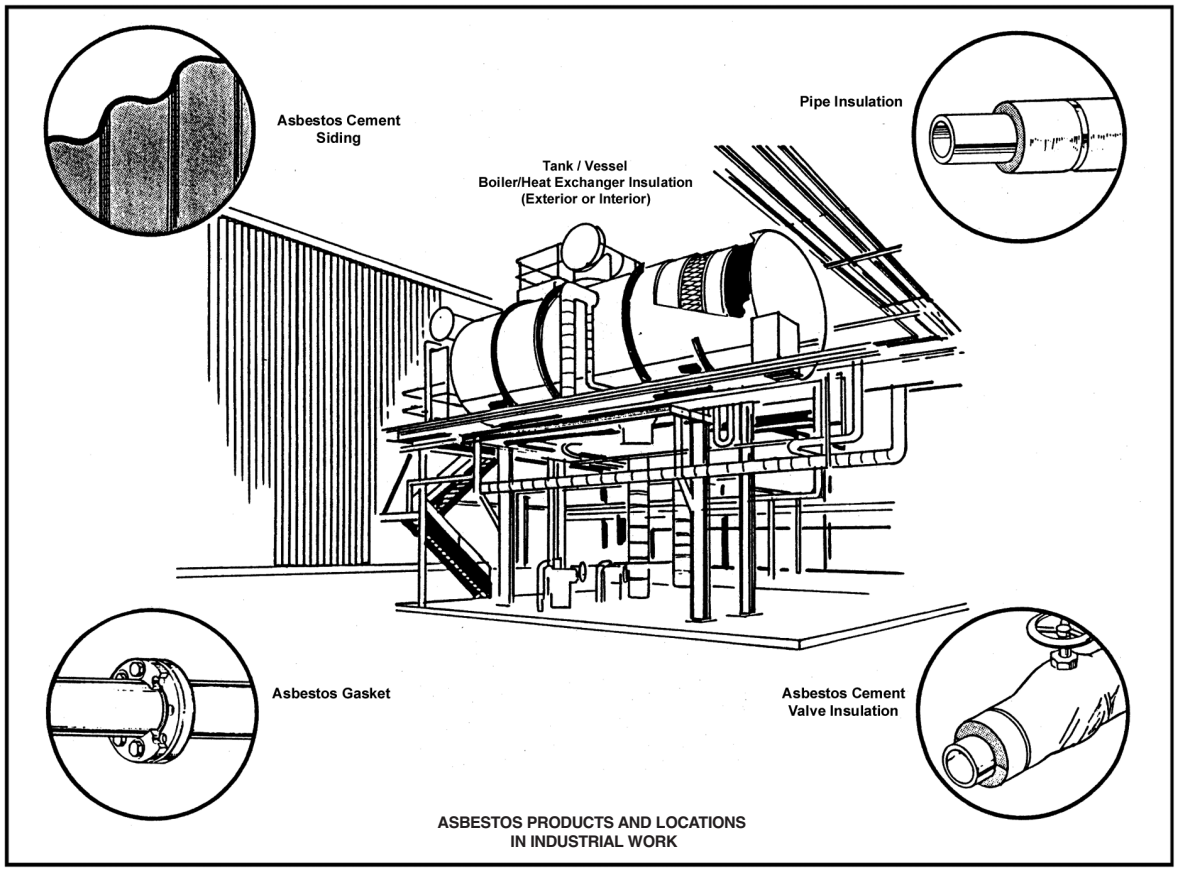
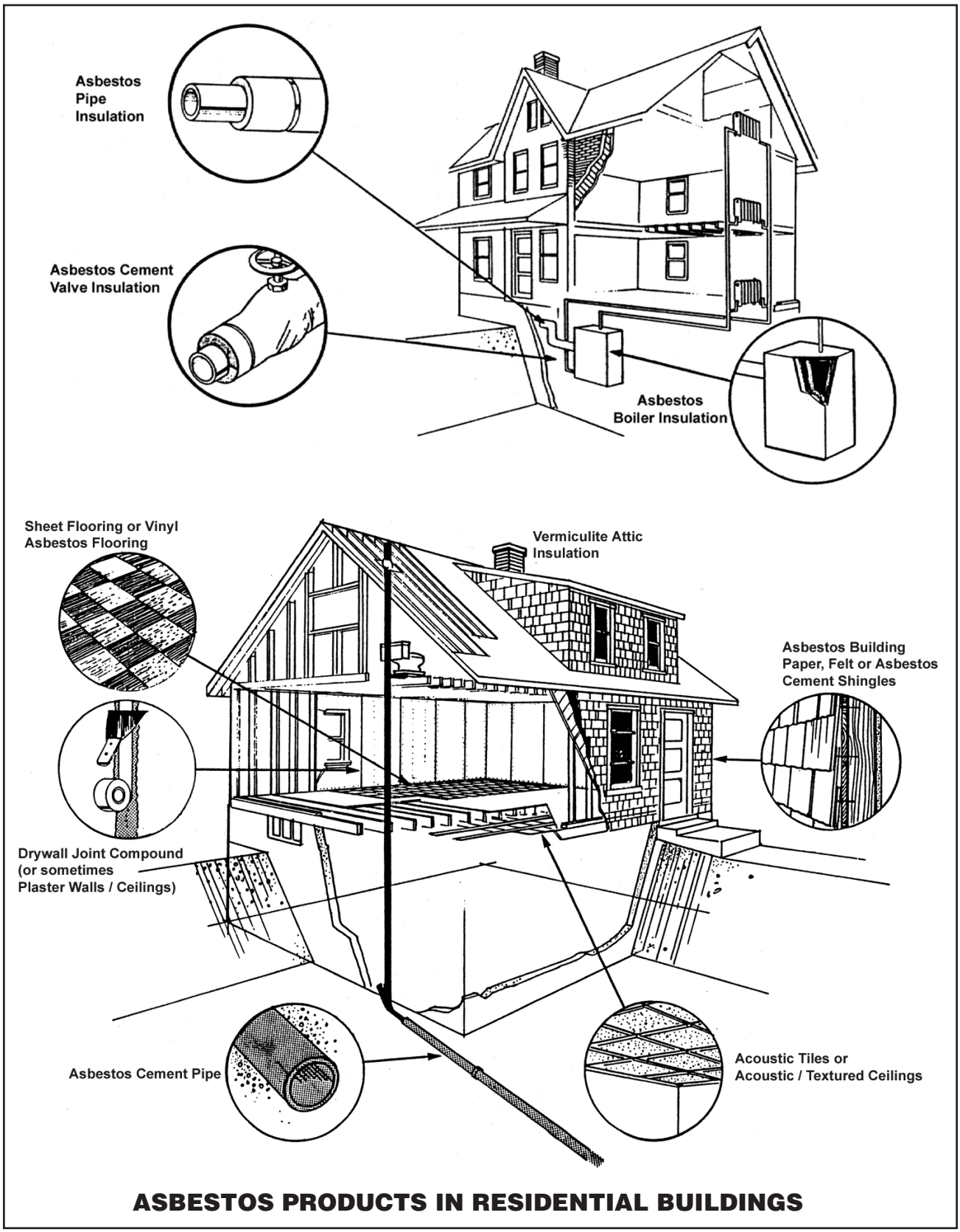


Figure 3



ASBESTOS PRODUCTS IN RESIDENTIAL BUILDINGS

Friable and Non-Friable

Two classes of asbestos products were widely used in the past. The first includes materials easily crumbled or loose in composition. These are referred to as “friable.”

The second type includes materials much more durable because they are held together by a binder such as cement, vinyl, or asphalt. These products are termed “non-friable.”

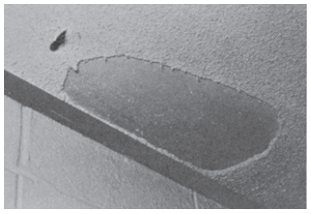
Friable material was widely used to fireproof steel structures. It can be found on beams, columns, trusses, hoists, and steel pan floors. Sprayed material was also used as a decorative finish and as acoustical insulation on ceilings.

The material can be loose, fluffy, and lumpy in texture or, if more gypsum was used, it may be quite hard and durable.

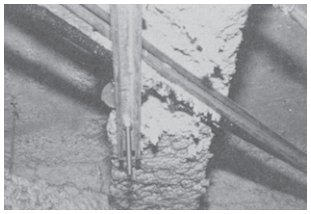
Friable Materials



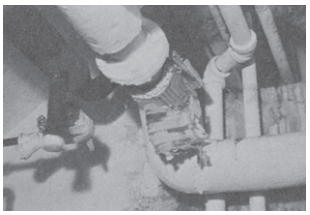
Approved Fireproofing

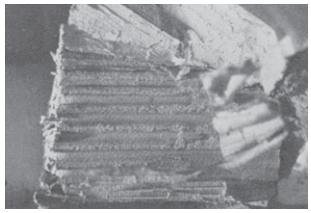


Acoustical Coating



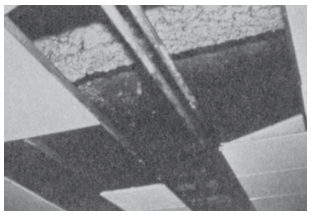
Sprayed Fireproofing

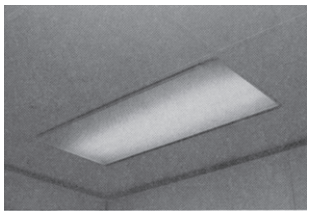




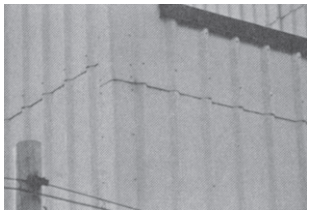
Air-Cell Pipe Insulation

Non-Friable Materials





Suspended Ceiling Concealing Fireproofing



Asbestos-Cement Siding



Vinyl Asbestos Floor Tile

Certification and Training

Certification: Type 3 operations

All workers who perform Type 3 asbestos operations—and the supervisors of these workers—must be certified to do their work. (Type 3 operations are discussed later in this chapter.) This certification requirement is contained in Ontario Regulation 278/05. There are two certification programs: one for workers and one for supervisors. Supervisors must complete both the worker program and the supervisor program. The certification programs must comply with the Ministry of Training, Colleges, and Universities’ training standards for the programs. Contact IHSA for details (1-800-263-5024).

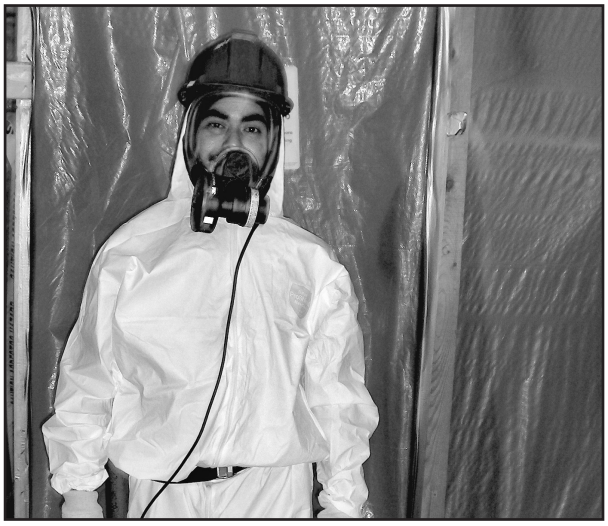
Training for any “Type” of asbestos operation

Whenever work is planned at a location where asbestos is present, constructors and employers must inform workers about

- ❑ the location of asbestos-containing materials or materials assumed to contain asbestos
- ❑ whether the material is friable or non-friable, and
- ❑ the type of asbestos (e.g., chrysotile, amosite, tremolite, etc.) if the material is sprayed.

Constructors and employers must then ensure that workers are trained on asbestos hazards and controls as detailed on the next page.

Employers performing regular service or maintenance work on behalf of owners have these same training requirements. Such employers should develop safe work practices. They should also become familiar with the owner's asbestos procedures and communicate them to their employees.



Content of training

All workers who perform a Type 3 asbestos operation, and the supervisors of the operation, must be certified to do their work. See the section on "Certification: Type 3 operations" on the previous page.

Workers in **any "Type"** of asbestos operation—as well as other workers who could be exposed to asbestos—must be trained by a competent person on the following:

- ❑ the hazards of asbestos exposure
- ❑ the purpose, inspection, maintenance, use, fitting, cleaning, disinfecting, and limitations of respirators
- ❑ personal hygiene and correct procedures for work with asbestos
- ❑ how to use, clean, and dispose of protective clothing.

Note: The above applies to facility owners and tenants whose staff undertake work involving the removal or disturbance of asbestos-containing material or who contract with other employees to do so.

Training should also include

- ❑ methods of recognizing asbestos, including identification of building materials that contain asbestos
- ❑ the relationship between smoking, asbestos, and lung cancer
- ❑ the kinds of operations that could result in exposure to asbestos
- ❑ classification of Type 1, Type 2, and Type 3 operations
- ❑ required work procedures and controls to minimize exposure, including engineering controls, work practices, respirators, housekeeping procedures, hygiene facilities, protective clothing, decontamination procedures, emergency procedures, and waste disposal procedures
- ❑ the requirements of the medical-surveillance program
- ❑ the requirements for signs and labels.

The joint health and safety committee or the health and safety representative must be informed about when and where the training will take place.

Encapsulation or Removal

In dealing with asbestos that may be encountered in applications such as fireproofing and cement, the decision whether to encapsulate the material, remove it, or leave it in place rests with the client/owner.

Many owners of asbestos-containing buildings have decided to reduce the risk of exposure to asbestos. The procedure is normally either removal or encapsulation. Encapsulation means spraying an approved sealant onto or into the material to prevent the release of fibres into the air in the building.

Encapsulation is permitted only if the asbestos will not be damaged further in the process.

Removal of asbestos is a more permanent solution to the problem. Most removal projects employ the **wet removal** method. Water and a wetting agent are sprayed onto the asbestos. This effectively reduces the quantity of fibres released when the material is removed.

Dry removal is normally done only when wet removal is unsafe or impractical—for instance in computer rooms or other areas where there is a chance of water damage to delicate equipment. Dry removal causes excessively high concentrations of asbestos fibres (in excess of 100 fibres per cubic centimetre) and may contaminate other previously "clean" areas.

During dry removal projects, use an extensive filtered exhaust system to create a slight negative air pressure in the work area. This will reduce the chance of spreading asbestos fibres. The requirements for negative air pressure are specified in the asbestos regulation.

Another solution is to enclose the asbestos with a physical barrier such as drywall. This is normally done where the area is not going to be entered frequently or altered later.

The asbestos regulation specifies what precautions must be taken during removal, encapsulation, or enclosure.



Spraying Asbestos Ceiling Material with Amended Water Before Wet Removal

Types

Under Ontario law, asbestos operations are classified as Type 1, Type 2, or Type 3.

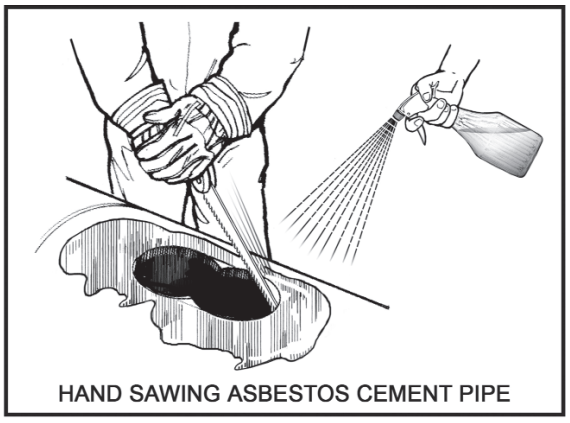
Type 1 – generally presents little hazard to workers or bystanders (for example, hand removal of vinyl asbestos tile).

Type 2 – may create exposure exceeding acceptable limits (e.g., removing six square inches of asbestos fireproofing to attach a new pipe hanger).

Type 3 – major exposures—exceeding acceptable limits—involving frequent or prolonged exposure, and posing serious risks to both workers and to bystanders (e.g., full-scale removal of sprayed asbestos fireproofing in an occupied building).

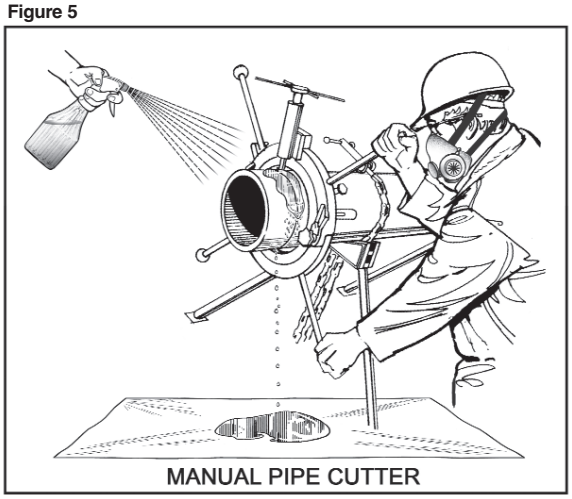
Ontario Regulation 278/05 *(Designated Substance—Asbestos on Construction Projects and in Buildings and Repair Operations)* outlines safe work procedures and respiratory protection for workers who may encounter asbestos in the course of their work. IHSA produces a manual called *Asbestos: Controls for Construction, Renovation, and Demolition* (DS037). It shows how workers can protect themselves and describes correct procedures for asbestos operations. It also helps employers and constructors understand their legal responsibilities.

Figure 4



HAND SAWING ASBESTOS CEMENT PIPE

Figure 5



MANUAL PIPE CUTTER

Type 1 Operations

Type 1 operations include the following:

1) Installing or removing less than 7.5 square metres of ceiling tile containing asbestos (81 square feet, or ten 4-foot x 2-foot ceiling tiles) without it being broken, cut, drilled, abraded, ground, sanded, or vibrated.
2) Installing or removing non-friable asbestos-containing material, other than ceiling tiles, without it being broken, cut, drilled, abraded, ground, sanded, or vibrated.
3) Breaking, cutting, drilling, abrading, grinding, sanding, or vibrating non-friable asbestos-containing material if
   a) you wet the material, and
   b) you use only non-powered hand-held tools.
4) Removing less than one square metre of drywall where asbestos joint-filling compound was used.

If these operations are done properly, it is unlikely that exposure will exceed acceptable limits.

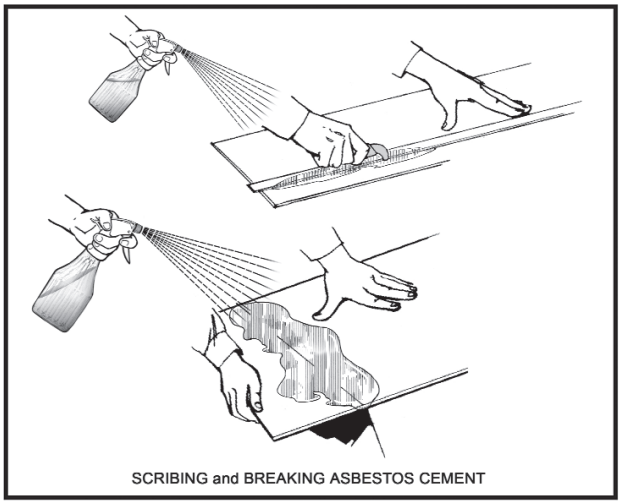
See the respirator selection chart at the end of the chapter to determine the respirator you require. You must also follow the control procedures described in Regulation 278/05. See IHSA's asbestos manual (DS037) for details.

Wetting agent

Water alone is not sufficient to control dust and fibres. You must add a "wetting agent" to reduce the water's surface tension. This increases the water's ability to penetrate material and get into nooks and crannies.

To make this "amended water," you can use ordinary dishwashing detergent: 1 cup detergent for every 20 litres of water.

Figure 6



SCRIBING and BREAKING ASBESTOS CEMENT

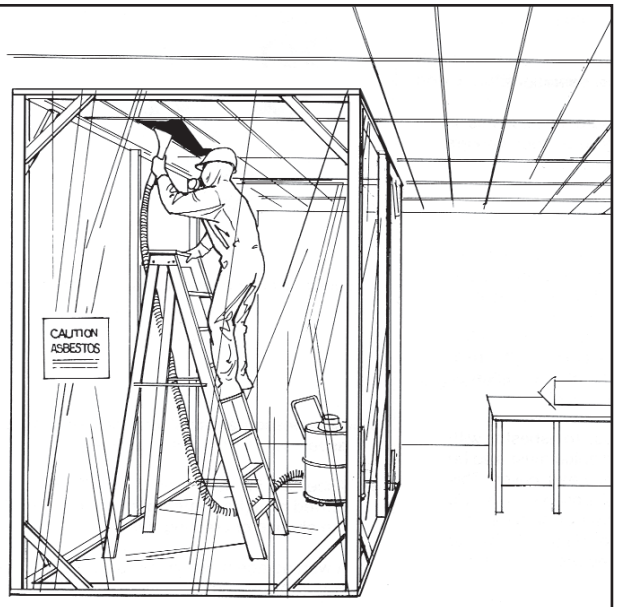
Type 2 Operations

Exposure to asbestos is likely in Type 2 operations. You need controls to protect workers and others nearby.

Type 2 operations include the following:

1) Removing all or part of a false ceiling in buildings containing sprayed asbestos fireproofing if it is likely that asbestos dust is resting on top of the ceiling (Figure 7). This is likely when fireproofing is deteriorating or damaged.

Figure 7



For details on enclosure, refer to Ontario Regulation 278/05: *Designated Substance—Asbestos on Construction Projects and in Buildings and Repair Operations*.

2) Removing or disturbing less than 1 square metre of friable asbestos materials—for example, repairing an insulated pipe joint or removing some fireproofing to fasten a new pipe hanger.

3) Enclosing friable asbestos insulation to prevent further damage or deterioration.

4) Applying tape, sealant, or other covering (by means other than spraying) to pipe or boiler insulation.

5) Installing or removing more than 7.5 square metres of ceiling tile containing asbestos, without it being broken, cut, drilled, abraded, ground, sanded, or vibrated.

6) Breaking, cutting, drilling, abrading, grinding, sanding, or vibrating non-friable asbestos-containing material if the material is not wetted and the work is done only with non-powered hand-held tools.

7) Removing one square metre or more of drywall where the joint-filling compound contains asbestos.

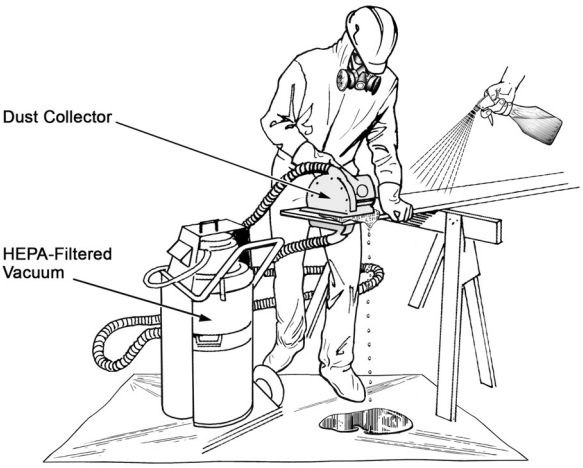
Drywall joint-filling compound

Early drywall joint-filling compounds contained significant amounts of asbestos fibre. This particular use was specifically prohibited in 1980. Still, it may be found in buildings constructed several years afterwards.

8) Working on non-friable asbestos with power tools that are attached to dust-collecting devices equipped with HEPA filters (Figure 8). If you need to power-grind or to machine the asbestos product and your tools are not equipped with HEPA-filtered dust collectors, refer to IHSA's *Asbestos: Controls for Construction, Renovation, Demolition*, Section 12.9.

To prevent electric shock, any power tools used around water must be equipped with a ground fault circuit interrupter (GFCI) and be maintained properly.

Figure 8



POWER SAW EQUIPPED WITH DUST COLLECTOR AND HEPA-FILTERED VACUUM

9) Using a glove bag to remove asbestos-containing materials from pipes, ducts, or similar structures.

10) Cleaning or removing filters used in air-handling equipment in a building with sprayed asbestos fireproofing.

11) An operation that is not Type 1 or Type 3.

See the respirator selection chart at the end of the chapter to determine the respirator you require. You must also follow the control procedures described in Regulation 278/05. See IHSA's asbestos manual (DS037) for details.

Type 3 Operations

These operations require the most precautions because they can release substantial amounts of asbestos dust.

Every worker and supervisor involved in a Type 3 operation must be certified to do their work. See the section on “Certification and Training” earlier in this chapter.

Type 3 operations include the following:

1) Removing or disturbing more than 1 square metre of friable asbestos-containing material.
2) Spraying a sealant onto friable asbestos material.
3) Cleaning or removing air-handling equipment in buildings with sprayed asbestos fireproofing.
4) Repair, alteration, or demolition of kilns, metallurgical furnaces, and other installations with asbestos refractory materials.
5) Disturbing non-friable asbestos material in any way with power tools not equipped with dust collectors and HEPA vacuums.
6) Repair, alteration, or demolition of buildings which are or were used to manufacture asbestos products unless the asbestos was cleaned up and removed before March 16, 1986.

See the respirator selection chart at the end of the chapter to determine the respirator you require. You must also follow the control procedures described in Regulation 278/05. See IHSA’s asbestos manual (DS037) for details.

Asbestos Waste Management

The off-site handling and disposal of asbestos waste is governed by the *Environmental Protection Act.* Regulations regarding the transportation of dangerous goods under either Transport Canada (federal) or the Ontario Ministry of Transportation may also apply.

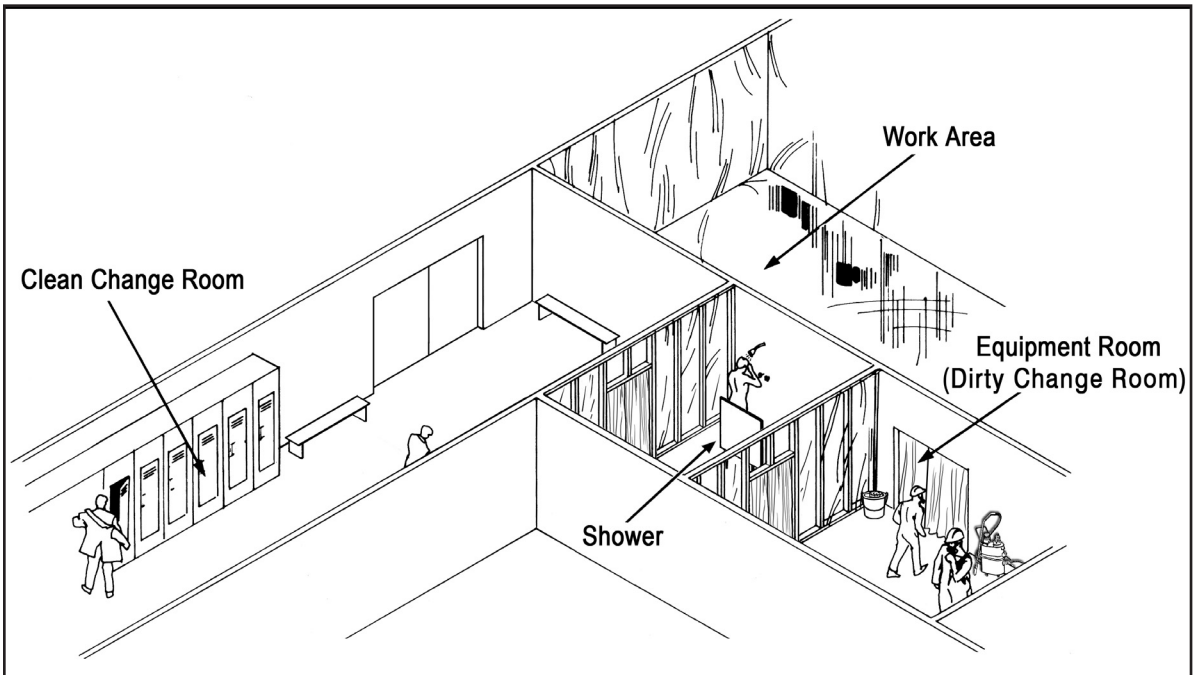
Some municipalities may not accept asbestos waste at landfill operations. Contractors are urged to check with local authorities for the nearest disposal site and with the district office of the Ministry of the Environment.

Equivalent Measures and Procedures

A contractor may use measures and procedures other than those described in this chapter if the proposed measures and procedures offer the same or better protection for workers.

A written notice of this variance must be given in advance to the joint health and safety committee or the health and safety representative for the workplace.

Figure 9



A typical entry/decontamination layout for a Type 3 operation

RESPIRATOR CHART FOR ASBESTOS WORK

"ACM" means asbestos-containing material.

Description of work		Required respirator
Type 1 operations		
All Type 1 operations		If worker asks employer to provide a respirator: **A**
Type 2 operations		
Removing all or part of a false ceiling to obtain access to a work area, if ACM is likely to be lying on the surface of the false ceiling.		**B**
Breaking, cutting, drilling, abrading, grinding, sanding, or vibrating non-friable ACM if the work is done by means of power tools that are attached to dust-collecting devices equipped with HEPA filters.	Material is not wetted	**B**
	Material is wetted to control fibres	**A**
All other Type 2 operations*		**A**
Type 3 operations		
Breaking, cutting, drilling, abrading, grinding, sanding, or vibrating non-friable ACM using power tools, if the tool is not attached to a dust-collecting device equipped with a HEPA filter.	Material is not wetted	**C**
	Material is wetted to control fibres	**B**
➤ Removing or disturbing more than one square metre of friable ACM during the repair, alteration, maintenance, or demolition of all or part of a building, aircraft, ship, locomotive, railway car or vehicle, or any machinery or equipment. ➤ Spraying sealant on friable ACM.	Material is not wetted	**D**
	Friable ACM other than chrysotile was applied or installed by spraying, and is wetted to control fibres	**C**
➤ Cleaning or removing air-handling equipment, including rigid ducting but not including filters, in a building where sprayed fireproofing is ACM. ➤ Repairing, altering, or demolishing all or part of a kiln, metallurgical furnace, or similar structure that is made in part of refractory ACM.	Friable chrysotile ACM was applied or installed by spraying, and is wetted to control fibres	**B**
➤ Repairing, altering, or demolishing all or part of any building in which asbestos is or was used in the manufacture of products, unless the asbestos was cleaned up and removed before 16 March 1986.	Friable ACM was not applied or installed by spraying, and is wetted to control fibres	**B**

* **Warning:** For any **Type 2** operation in which wetting is required but would cause a greater hazard or damage, then dry work is permitted. Dry work, however, usually results in more airborne fibres. IHSA recommends that you select a category B respirator (see below).

KEY TO RESPIRATOR CHART

A	B	C	D
Air-purifying half-mask respirator with N-100, R-100, or P-100 particulate filter. If the worker requests the respirator from the employer, then the worker must wear it.	Choose any of the following: ➤ Air-purifying full-facepiece respirator with N-100, R-100, or P-100 particulate filter. ➤ Powered air-purifying respirator with a tight-fitting facepiece (either full or half facepiece) and a high-efficiency filter. ➤ Negative-pressure (demand) supplied-air respirator with a full facepiece. ➤ Continuous-flow supplied-air respirator with a tight-fitting facepiece (full or half facepiece).	Pressure-demand supplied-air respirator with a half facepiece.	Pressure-demand supplied-air respirator with a full facepiece.

Disposable respirators or dust masks are not recommended for avoiding exposure to asbestos fibres because it's difficult to perform negative-pressure and positive-pressure seal checks.

26 ELECTRICAL HAZARDS

CONTENTS

- Introduction
- Electrical injuries
- Safeguards
- Working on energized systems
- Portable tools and extension cords
- Temporary wiring and power
- Other electrical issues
- Reporting electrical accidents/incidents

INTRODUCTION

An **electrical hazard** can be defined as

- a dangerous condition where a worker could make electrical contact with energized equipment or a conductor, and from which the person may sustain an injury from shock; and/or,
- there is potential for the worker to receive an arc flash burn, thermal burn, or blast injury.

Note: An electrical hazard is considered to be removed when protective measures are put in place at the source (remove hazard or de-energize), or along the path (place electrical insulation/barrier between the worker and the electrical hazard). Where PPE is relied upon for worker protection, an electrical hazard is considered to remain and it is still necessary to address safety requirements for other workers in the area.

Injuries resulting from a worker making electrical contact represent a relatively small portion (7.7%) of the lost-time injuries electricians experience, according to 1997–1999 statistics. It is reasonable to assume that the situation is similar today. Other mechanical trades that do some electrical work can probably expect even fewer electrical injuries.

Nevertheless, working on or near electrical hazards is dangerous and can be fatal. Any work on or near energized equipment must be done only when measures are in place to provide protection from electric shock and burn. With adequate safety measures in place, every electrical injury and fatality can be prevented.

The law requires safe work practices. Under the *Occupational Health and Safety Act and Regulations for Construction Projects*, employers, supervisors, and workers each have legal responsibilities to ensure that work is being carried out in a safe manner.

There are also restrictions in the Construction Regulation (Ontario Regulation 213/91 Section 182) on who can work on electrical equipment:

> *(1) No worker shall connect, maintain, or modify electrical equipment or installations unless,*
>
> *(a) the worker is an electrician certified under the Trades Qualification and Apprenticeship Act; or*
>
> *(b) the worker is otherwise permitted to connect, maintain or modify electrical equipment or installations under the Trades Qualification and Apprenticeship Act, the Apprenticeship and Certification Act, 1998 or the Technical Standards and Safety Act, 2000.*
>
> *(2) A worker who does not meet the requirements of clause (1) (a) or (b) may insert an attachment plug cap on the cord of electrical equipment or an electrical tool into, or remove it from, a convenience receptacle.*

Guidelines for working on or near electrical equipment and conductors are found in several documents:

- Construction Regulation (O. Reg. 213/91)
- *Ontario Electrical Safety Code*

- Operating manuals for different tools and equipment.
- **NFPA 70E** *Standard for Electrical Safety in the Workplace*
- **CSA Z462** *Workplace Electrical Safety.*

An important aspect of electrical work involves isolating electrical energy. A reference for detailed information on lockout and control of hazardous energy is the Canadian standard **CSA Z460-05**, *Control of Hazardous Energy—Lockout and Other Methods.*

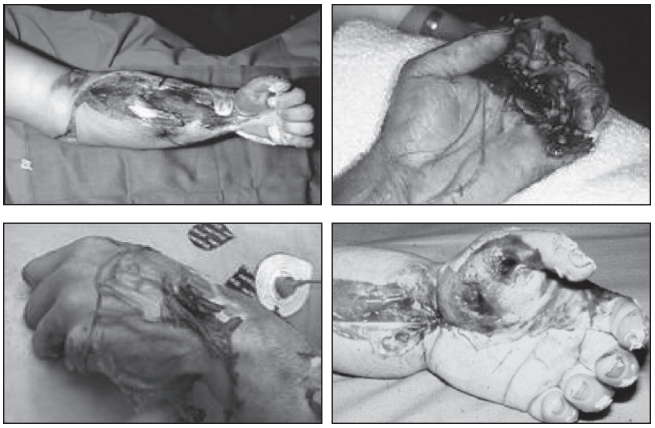
ELECTRICAL INJURIES

There are basically two ways to be injured by electricity. One is by electric shock and the other is by arc flash.

Electric shock is the passing of electric current through the body. Electrical contact can cause involuntary physical movements. The electrical current may

- prevent you from releasing your grip from a live conductor
- throw you into contact with a higher voltage conductor
- cause you to lose your balance and fall
- cause severe internal and external burns
- kill you.

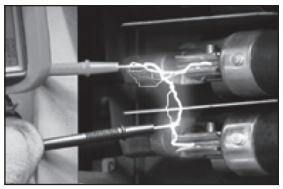
A household 125-volt circuit can deliver 15 amps. Current as low as 30/1000 of 1 amp (30 mA) can cause breathing to stop. A 15-Amp circuit contains many times the current needed to cause death.



A major cause of accidents involving electricity comes from the failure to identify the hazards associated with live electrical equipment and wiring.



An **arc flash** is a release of energy caused by an electric arc. The flash causes an explosive expansion of air and metal. The blast produces



Electric arc

- a dangerous pressure wave
- a dangerous sound wave
- shrapnel
- extreme heat
- extreme light.



These dangers can result in blast injuries, lung injuries, ruptured eardrums, shrapnel wounds, severe burns, and blindness. Arc flash injuries can also result in death.



Arc flash

SAFEGUARDS

Protective tools and equipment

Workers exposed to an electrical hazard must use mats, gloves, shields, flame resistant clothing, and any other protective equipment required to protect themselves from electric shock and burn. As part of everyday work, electrical workers should always

- remove watches, rings, neck chains, or other current-conducting apparel
- wear electric-shock-resistant footwear
- wear a CSA-approved Class E hard hat or equivalent
- wear safety glasses with side shields, and
- wear under and outer clothing that has flame-resistance properties.

Tools, devices, and equipment — including personal protective equipment — used for live work must be designed, tested, maintained, and used so as to provide adequate protection for workers.

Where there is the potential for an arc flash, **all** PPE should be chosen with consideration for the kinds of hazards that can result from an arc flash. (See "Flash hazard arc flash protection" below.)

The following information provides guidelines on appropriate and required personal protective equipment. Check the reference documents identified at the beginning of this chapter to determine your job-specific needs. See also the chapters on personal protective equipment in this manual. As well, see the chapters on personal protective equipment in the Equipment section of this manual.

Clothing

Whether or not the day's planned work involves working near an electrical hazard, workers that do electrical work should choose everyday clothing that offers some flame-resistance properties. When work must be done in the presence of an electrical hazard, ensure that all clothing is chosen to provide adequate protection from the potential hazards. (See "Flash hazard arc flash protection" below.)

Head protection

The following hardhats comply with the Construction Regulation:

- CSA Z94.1-05 Class E, Type 1 or 2 (Canadian)
- ANSI Z89.1-2009 Type II, Class E (US)
- ANSI Z89.1-2009 Type I, Class E. (US)

Note that under the latest ANSI standard, there are two types of Class E hardhats: Type I and Type II. Type I hats are similar to the old CSA Class B hard hats which provide limited lateral impact protection. The Type II hats have enhanced lateral protection like the CSA Class E. ANSI Type II Class E hard hats are clearly labelled "Type II." If your hardhat just says "ANSI Class E," assume it's a Type I.

Foot protection

Construction workers require Grade 1 toe protection with sole protection in accordance with the Canadian Standards Association standard (CSA) Z195-02. Protective footwear compliant with the intent of the Construction Regulation is identified by a green triangular patch on the tongue or the ankle of the footwear.

Mechanical tradespeople exposed to electrical hazards should also wear electric-shock-resistant footwear identified by a white rectangular label bearing the CSA logo and the Greek letter omega in orange.



CSA logo



omega

Eye protection

The Canadian Standards Association (CSA) standard CAN/CSA Z94.3-99 *Industrial Eye and Face Protectors* can assist you in classifying hazards and recommending protectors. Appropriate protection chosen according to this standard meets with the intent of the Construction Regulation regarding eye protection worn on the job.

In any case, eye protection should be of industrial quality eye protection in the form of safety glasses incorporating side-shields or a wrap-around style. Arc flash protection requires a face shield that is rated for arc flash, with safety glasses underneath.

> Regular plastic face shields do not to provide arc flash protection. They can burn and melt in an arc flash incident. Use a face shield that is designed and rated for arc flash protection.

Hearing protection

Hearing protection is important at work since continuous exposure to excessive noise can lead to hearing loss and tinnitus. Hearing protection is required for some arc flash hazards. Hearing protection is available in three general types:

1. Disposable ear plugs made of pliable material. One size fits all, but they should only be used once.
2. Reusable custom-fit ear plugs are available to provide protection for specific frequencies of noise. These provide a good seal and can be washed and reused.
3. Earmuffs. They need to be fitted to provide maximum protection.

Shock protection

The passage of electricity through the body is called shock. Effects can range from a tingling sensation to death. A shock that may not be enough to cause injury can nonetheless startle a worker, causing an involuntary reaction that can result in serious injuries or death.

A household 125-volt circuit can deliver 15 amps. Current as low as 30/1000 of 1 amp (30 mA) can cause breathing to stop. A 15-amp circuit has many times the current needed to cause death.

Rubber gloves and leather protectors are the most common personal protective equipment used for shock protection. These must be adequate to protect the worker from electrical shock or burn. The rubber gloves must have been tested and certified.

Class 0 and Class 00 gloves must be air-tested and visually inspected for damage and adequacy immediately before each use. *Class 0 and Class 00 are exempt from regular re-certification unless work is carried out under the Electrical Utility Safety Rules.* Rubber gloves rated for use with voltages above 5,000 volts AC must be regularly tested and certified to ensure that they can withstand the voltages for which they are rated,

- at least once every three months if they are in service, or
- once every six months, if they are not in service.

Workers must be trained in the proper use, care, and storage of rubber gloves and leather protectors.

Rubber mats and shields can also be used with standard personal protective equipment to protect the worker from electric shock or burn. The rubber mat must have been tested and certified.

The best shock protection is afforded by turning off or isolating the electrical power from the worker. The Construction Regulation requires all work to be done with the system de-energized unless certain specified conditions are met. (See "Working on Energized Systems" in this chapter.)

Flash hazard (arc flash) protection

A **flash hazard** is defined as a dangerous condition associated with the release of energy caused by an electric arc (NFPA 70E 2004). The

release of energy is often referred to as an arc flash.

An arc flash produces thermal energy which is measured in calories/cm^2. Adhering to arc flash protection calculations can still expose a worker to second degree burns, or 1.2 calories/cm^2.

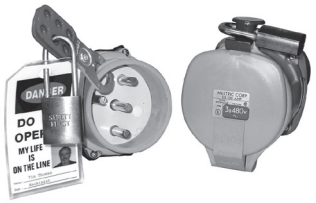
> One calorie is the amount of heat needed to raise the temperature of one gram of water by 1°C.
>
> Second degree burn results from exposure to 1.2 cal/cm^2 for more than 0.1 second.
>
> 1.2 calories/cm^2 is equivalent to holding your finger in the blue part of a butane lighter flame for one second.

These conditions can lead to arc flash:

- accidental contact between two conductors
- wiring errors
- insulation deterioration or failure
- corrosion of equipment
- contamination of the equipment (e.g., dust, moisture)
- animals, tools, or fallen parts that short-circuit the equipment
- poor maintenance
- workers using improper or non-rated tools.

If a worker is close to energized electrical equipment, the worker may be exposed to a flash hazard, even if the source of the arc flash is not being worked on. Employers and supervisors need to ensure these workers are protected from flash hazards, and should educate workers on flash hazard recognition.

It may be possible to eliminate the electrical hazard with equipment designed to offer flash protection. The plug in the picture at right and below is designed for flash protection and can be used as a disconnect switch.



Flash protection is designed into this disconnect switch/plug



Mechanical workers that are potentially exposed to arc flash should always wear clothing that provides for some level of arc-flash protection. Clothing made of synthetic fibres can be readily ignited by arc flash and melt to the workers' skin. Cotton or wool fabrics are more flame-retardant and are therefore recommended as outer-wear and inner-wear for work clothes. Clothing that is arc-flash rated to provide protection up to a specified hazard category must be worn when there is a flash hazard.

Protection from an arc flash is afforded by protective clothing and equipment such as

- wearing arc-rated clothing
- flame-resistant eye protection (arc-rated face shield is often required as well)
- hand protection
- hearing protection.

There are a number of levels of flame-resistant (FR) clothing, ranging from cotton clothes to the arc-rated suits and face shields shown in the accompanying image. The level of protection necessary is determined by a calculation using tables or a computer program.



A flash suit and face shield are required for the more powerful flash hazards.

A hypothetical example:

For voltage testing on an energized part, 240 volts or less, a worker may require

- arc-rated pants and shirt (each rated to withstand 4 calories/cm^2)
- arc-rated face shield and safety goggles
- 500-volt-rated class 00 gloves (class 0 gloves protect up to 1000 volts)
- 1000-volt-rated tools
- approved hard hat
- hearing protection.

Actual calculations for this task may yield different results.

Workers that encounter a flash hazard can take additional precautions to reduce exposure.

- Standing as far away as possible from the hazard lowers the calorie intensity of an arc flash.
- Standing to the side when opening electrical-box doors can reduce exposure to the full force of a blast.

Information is available to assist with arc-flash energy calculations. Here are some sources:

- The (US) National Fire Protection Association's *Standard for Electrical Safety in the Workplace* (NFPA 70E). Contact the NFPA: 1-800-344-3555, www.nfpa.org.
- The Institute of Electrical and Electronics Engineers' standard 1584, Guide for Performing Arc-Flash Hazard Calculations. Contact the IEEE: 1-800-678- 4333, www.ieee.org.
- CSA standard Z462 *Workplace Electrical Safety*. Contact the CSA: 1-800-463-6727, www.csagroup.org

WORKING ON ENERGIZED SYSTEMS

What if there's an electrical hazard but work must be done on or near enough to the hazard to make electrical contact, or near enough to be exposed to injury from an arc flash? In such cases, working while the system is energized is permitted only if specific conditions are met.

Work on energized equipment is permitted only if

- it is not reasonably possible to disconnect the equipment, installation, or conductor from the power supply,
- the equipment is rated at a nominal voltage of 600 volts or less, and disconnecting the equipment would create a greater hazard to workers than proceeding without disconnecting it, or
- the work consists only of diagnostic testing.

Note: Testing with a meter **is** working on energized equipment, and requires appropriate protection including personal protective equipment.

Unless the work consists only of diagnostic testing or involves a nominal voltage under 300 volts, an adequately equipped competent worker who can perform rescue operations, including cardiopulmonary resuscitation (CPR), must be stationed where he or she can see the workers performing the live work.

Work on energized equipment nominally rated greater than 400 amperes and greater than 200 volts, or greater than 200 amperes and greater

than 300 volts, can only be done if

1) the owner of the equipment provides the employer and the constructor with a record showing that it has been maintained according to the manufacturer's specifications
2) a copy of the maintenance record is readily available at the project
3) the employer has determined from the maintenance record that work on the equipment can be performed safely without disconnecting it, and
4) before beginning live work, the worker has verified that requirements 1), 2), and 3) have been met.

Repair or permanently disconnect defective equipment.

Section 2-300 of the *Ontario Electrical Safety Code* requires operating electrical equipment to be kept in safe and proper working condition.

The constructor must ensure that written procedures for work on or near live equipment are produced and implemented to protect workers from electrical shock and burn. The constructor must have copies of the procedures available for employers on the project.

The employer must provide and explain the written procedures to workers before they start work on or near live equipment. The constructor and the employer both have a general duty to ensure that the health and safety of workers are protected.

Operating equipment near energized powerlines

Incidental powerline contact happens too often, especially considering the potential severity of the consequences. The Ministry of Labour reported 108 powerline contacts in 1998. That number rose to 196 in 2005. See Table 1.

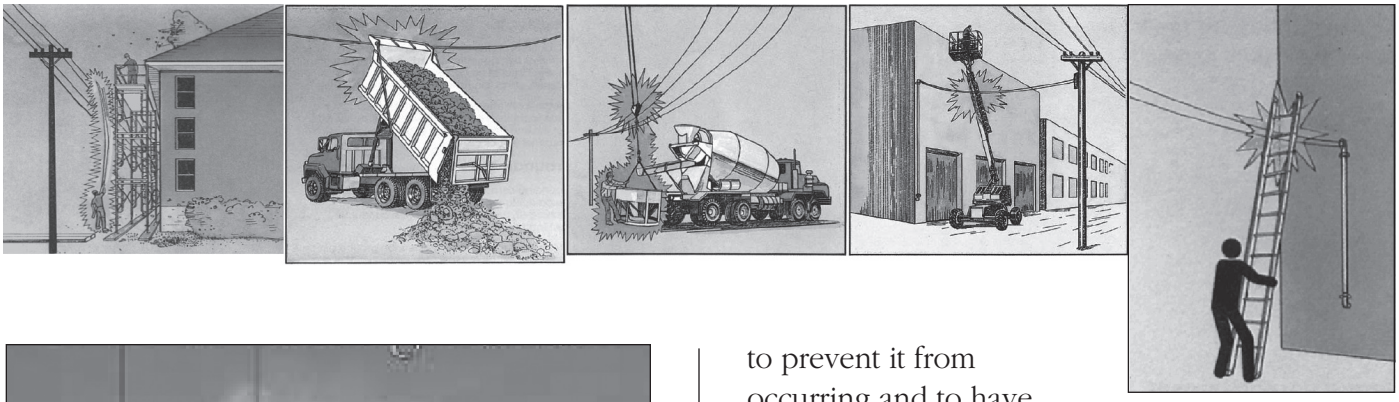
Constructors must be aware of electrical hazards when equipment such as a crane, dump truck, or other vehicle is going to be operated near an energized overhead electrical conductor, or when excavating equipment such as a backhoe will be operated near underground powerlines.

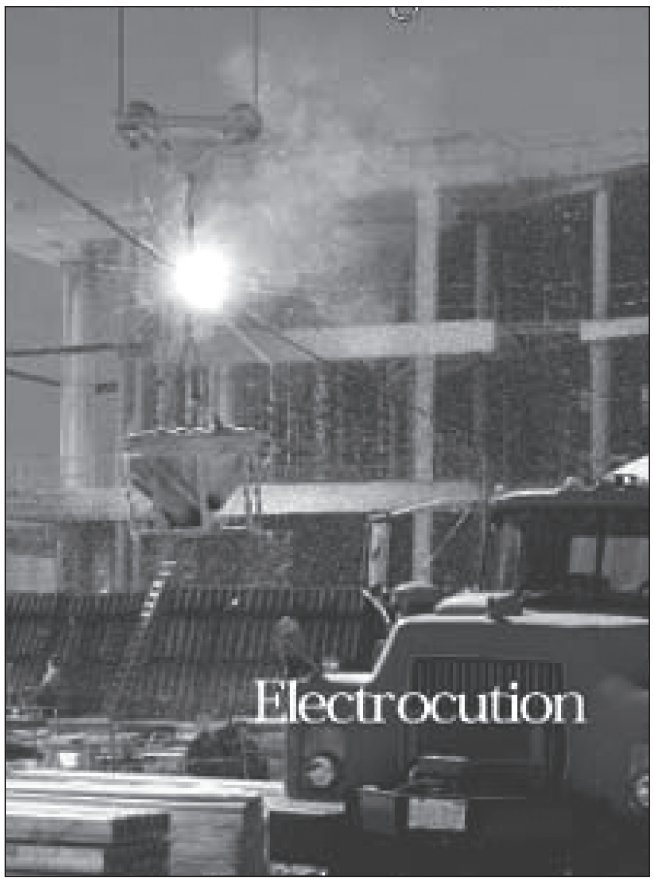
When equipment operates within reach of, and could therefore encroach on, the minimum

Table 1: Summary of Powerline Contacts

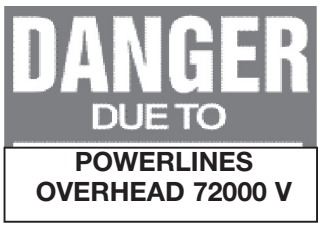
	Overhead Lines				Buried Cables		
Year	**Crane**	**Dump truck**	**Tree felling**	**Other**	**Digging**	**Other**	**Total**
2005	19	21	9	87	45	15	196
2004	11	16	5	57	53	9	151
2003	16	19	9	63	35	6	148
2002	16	20	4	50	36	6	132
2001	16	22	5	43	27	7	120
2000	15	10	3	59	32	3	122
1999	11	26	2	48	27	1	115
1998	10	17	8	39	27	7	108
TOTALS	**114**	**151**	**46**	**446**	**282**	**54**	

(Source: Ontario Ministry of Labour)





permitted distances from live overhead powerlines (as listed in Table 2), the constructor is required to have written procedures in place to prevent it from occurring and to have copies of the procedure available for every employer on the project.



Overhead powerlines are most frequently hit by dump trucks and cranes; however, elevating work platforms and low-tech equipment such as ladders and rolling scaffolds are also involved. Keep in mind that many powerline contacts involve low-voltage service and buried cable.

Safety measures

Written measures and procedures required by the Construction Regulation include the following:

- Place enough warning devices in the area of the hazard so at least one is always visible to the operator. The warning devices must be visible to the operator under any conditions in which the equipment may be operating (night, rain, fog, etc.), and must be specific about the hazard. Provide a sign meeting the requirements of the Construction

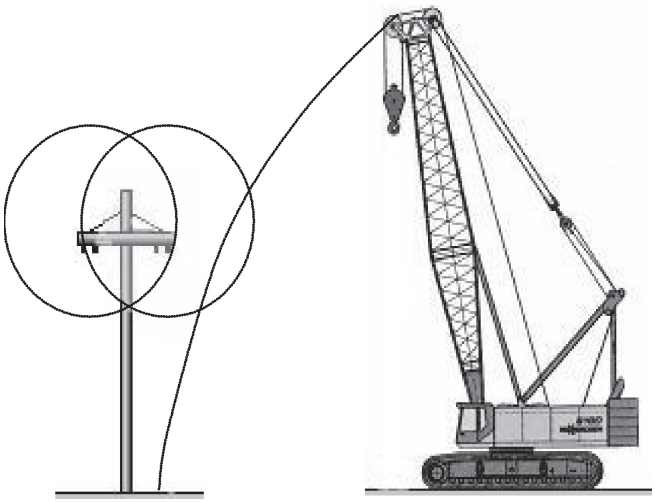
Table 2

Normal phase-to-phase voltage rating	Minimum distance
750 or more volts, but no more than 150,000 volts	3 metres
More than 150,000 volts, but no more than 250,000 volts	4.5 metres
More than 250,000 volts	6 metres
The wind can blow powerlines, hoist lines, or your load. This can cause them to cross the minimum distance.	

Regulation's section 44, stating, for example, "Danger! Electrical powerlines overhead." We recommend that you include the voltage.

- Ensure the equipment operator has been provided with written notification of the electrical hazard before beginning the work.
- Ensure there is a sign warning of the hazard that is visible to the operator at the operator's station. This may come as a sticker with the machine. Check to ensure the sticker is still legible.
- Before the operator starts work, ensure that the employer of the equipment operator provides and explains the procedures to the equipment operator.
- A competent worker must be designated as a signaller to warn the operator when any part of the equipment, load, or hoist line may approach the minimum distance. The signaller must then be in full view of the operator and have a clear view of the equipment and the conductor. Section 106 of the Construction Regulation also applies with respect to the designated signaller.

An exemption to these measures is only allowed if, under the authority of the owner of the electrical conductor (typically the local utility), protective devices and equipment are installed, and written procedures are implemented (e.g., using the *Electrical Utilities Safety Rules*) that are adequate to protect the equipment operator from electrical shock and burn.



Inside the limit of approach to the powerline.

Prevention

Ensure that contractors and workers understand that work should be planned to avoid powerlines. Prepare for work that must be done in close proximity to energized powerlines by developing written procedures ahead of time. Have overhead powerlines moved, insulated, or de-energized where possible. Insulating or "rubberizing" powerlines offers some protection against brush contact in some circumstances. The local utility may provide this service.



Identify the voltage of the service by checking markings on the utility pole and calling the utility. If material must be stored under powerlines, hang warning flags and signs to inform workers about the hazard and the need to obtain written procedures if hoisting.

Provide instruction as part of site orientation.

- Tell operators of large equipment where overhead and buried powerlines are and where overhead powerlines may be lower than expected.
- Remind workers not to let a ladder, scaffold, or elevated work platform lean or drift toward overhead powerlines. Always maintain minimum allowable clearances.
- Inform all workers how powerline hazards are identified on site and that written procedures are required prior to operating near them.

- Review an appropriate emergency response for equipment operators and workers assisting operators, in case contact should occur.

In the event of contact between equipment and overhead powerlines:

1. **Stay on equipment**. Don't touch equipment and the ground at the same time. Touching anything in contact with the ground can be fatal. Stay on the equipment unless forced off because of a life-threatening hazard such as fire.
2. **Keep others away**. Warn everyone not to touch the equipment or its load. That includes buckets, outriggers, load lines, and any other part of the machine. Beware of time-delayed relays. After line damage trips a breaker, relays may still try to restore power. They may reset automatically two or three times.
3. **Break contact**. If possible, break contact by moving the equipment clear of the wires. This may not be feasible where contact has welded conductors to equipment, the hoist line, or the load.
4. **Call the local utility**. Get someone to call the local electrical utility for help. Stay on the equipment until the utility shuts down the line and *confirms* that power is off. Report incidents of powerline contact so that the utility can check for damage that could cause the line to fail later.
5. **Jump clear**. If forced to leave the equipment, jump carefully *off* the equipment onto the ground landing only on your feet, with your feet together. **Touching the equipment and the ground at the same time can be fatal.** Touching the ground at different points can also be fatal. Shuffle slowly away from the equipment using very small steps to minimize the contact area with the ground.
6. **Report the contact.** See "Reporting Electrical Incidents" in this chapter.

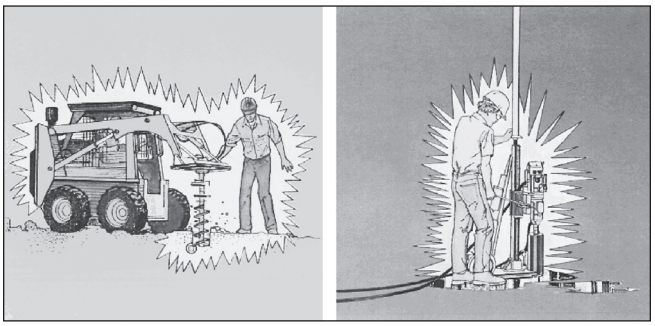
Hidden power supplies

Digging into buried cable resulted in 282 powerline contacts between 1998 and 2005 (see Table 1). A great many of these resulted from excavating prior to getting a locate on the service. If the electrical power cannot be shut off during excavation, the owner (of the service) must be present to supervise the uncovering of the powerline.

The following are some prevention measures for hidden powerlines.

For underground powerlines:

- Before excavating, request that the owner of the service locate and mark underground powerlines.
- Contact the utility through Ontario One Call to locate all underground services.
- Locate and mark underground lines on drawings that will be used for excavating.
- Post warning signs along the route of underground powerlines.
- When operators of excavation equipment arrive on site, tell them where underground services are located and how they are identified.



For powerlines embedded in concrete:

- Ensure various trades provide sleeving when concrete is poured to reduce the need to drill.
- Try to have powerlines laid along dedicated sections of flooring and walls.
- Mark powerline location on drawings that will be referenced for drilling.
- Use a location service to x-ray the concrete and locate embedded powerlines.

MULTIMETERS

In the process of troubleshooting, electrical workers face the risk of injury from improper multimeter selection or use. Multimeters that are designed to meet the International Electro-technical Commission (IEC) 1010 and overvoltage category standards, when properly used, offer the electrician an acceptable level of protection that is recognized by the electrical industry. The use of fused leads provides additional protection for the worker.

Why use overvoltage category rated multimeters?

Momentary high-voltage transients or spikes can travel through a multimeter at any time and without warning. Motors, capacitors, lightning, and power conversion equipment such as variable speed drives are all possible sources of spikes.



A failed multimeter

The IEC 1010 standard defines categories I through IV that are abbreviated as CAT I, CAT II, CAT III, etc. The higher-numbered categories represent an electrical environment that is susceptible to higher-energy spikes. For example, multimeters that are designed to the CAT IV standard provide the worker more protection from high transient voltage spikes than do CAT III, CAT II, or CAT I designs. See the diagram on the next page and Table 3 below for an explanation of each category.

Be sure that the multimeter model has been tested. Simply being designed to the CAT III standard, for example, does not mean the multimeter was also *tested* to that standard. **Look for proof of independent testing by an organization accredited by the Standards Council of Canada, such as the CSA (Canadian Standards Association) International logo, along with the appropriate category *rating* on the equipment.** Test leads should also be rated at the same or greater voltage than the multimeter.

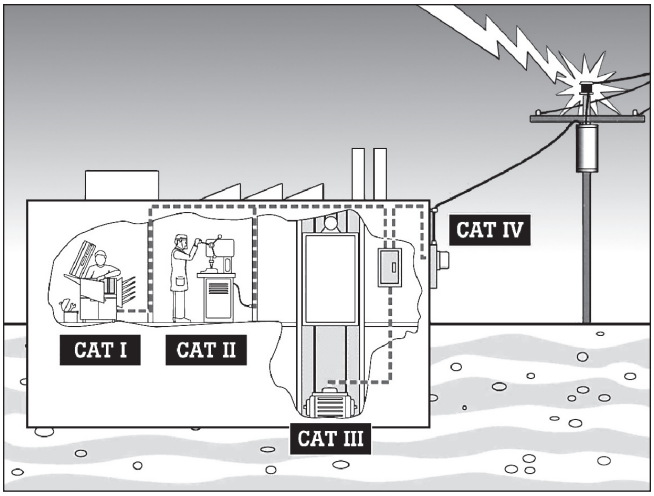
Table 3

OVERVOLTAGE CATEGORY	IN BRIEF	EXAMPLES
CAT IV	Three-phase at utility connection, any outdoors conductors	• Refers to the "origin of installation" (i.e., where low-voltage) connection is made to utility power. • Electricity meters, primary overcurrent protection equipment. • Outside and service entrance, service drop from pole to building, run between meter and panel. • Overhead line to detached building, underground line to well pump.
CAT III	Three-phase distribution, including single-phase commercial lighting	• Equipment in fixed installations, such as switchgear and polyphase motors. • Bus and feeder in industrial plants. • Feeders and short branch circuits, distribution panel devices. • Lighting systems in larger buildings. • Appliance outlets with short connections to service entrance.
CAT II	Single-phase receptacle connected loads	• Appliance, portable tools, and other household and similar loads. • Outlet and long branch circuits. • Outlets at more than 10 meters (30 feet) from CAT III source. • Outlets at more that 20 meters (60 feet) from CAT IV source.
CAT I	Electronic	• Protected electronic equipment. • Equipment connected to (source) circuits in which measures are taken to limit transient overvoltages to an appropriately low level. • Any high-voltage, low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.

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Understanding overvoltage installation categories

The division of a power distribution system into catagories is based on the fact that a dangerous high-energy transient such as a lightning strike will be attenuated or dampened as it travels through the impedance (AC resistance) of the system. A higher CAT number refers to an electrical environment with higher power available and higher-energy transients. Therefore, a multimeter designed to the CAT III standard is resistant to much higher-energy transients than one designed to the CAT II standard. *Categories I through IV apply to low voltage (less than 1000 V) test equipment.*



Safe use of multimeters

- Use only multimeters that display **both** the CSA logo (or equivalent) **and** the CAT (I, II, III, or IV) designation. *Categories I through IV apply to low voltage (less than 1000 V) test equipment.*
- Check to ensure that the meter's voltage rating is appropriate for the work being done. *Be aware of multimeters with maximum voltage ratings typical of other countries (550 V for example).*
- Use personal protective equipment such as arc flash fire-resistant clothing; eye and face protection; long-sleeved shirts; dielectric safety boots; rubber gloves with leather protectors; and mats, blankets, or shields as required. **Do not wear synthetic inner or outer clothing that can melt if an arc flash occurs.**
- Check the manufacturer's manual for special cautions. Moisture and cold may affect the performance of your meter.
- Wipe the multimeter and test leads clean to remove any surface contamination prior to use.
- Use fused test leads. Ensure fused leads and internal probe fuses are rated as high as or higher than the equipment you are going to work on. A minimum of 30 kA is recommended (200 kA is desirable).
- Ensure that test leads are in the correct input jacks.
- When the values to be measured are uncertain, start testing with high ranges of the multimeter, then move to the lower ranges.
- Connect to the ground first, and disconnect from ground last.
- Test the multimeter on a known power source to verify that the meter is functioning properly before and after testing the suspect circuit, using the same power function for all three tests.

Using a meter to confirm zero energy for a lockout

Set the meter to the power function to be used for validating the zero energy. Test to ensure the meter is functioning correctly by testing on a known power source, then test the locked out circuit to verify the power has been effectively isolated, and finally re-test on the same known power supply to verify the meter's fuse has not blown and the meter is still functioning correctly on that power setting.

PORTABLE TOOLS AND EXTENSION CORDS

1. Unless they are double-insulated, tools must have:

   a) the casing grounded

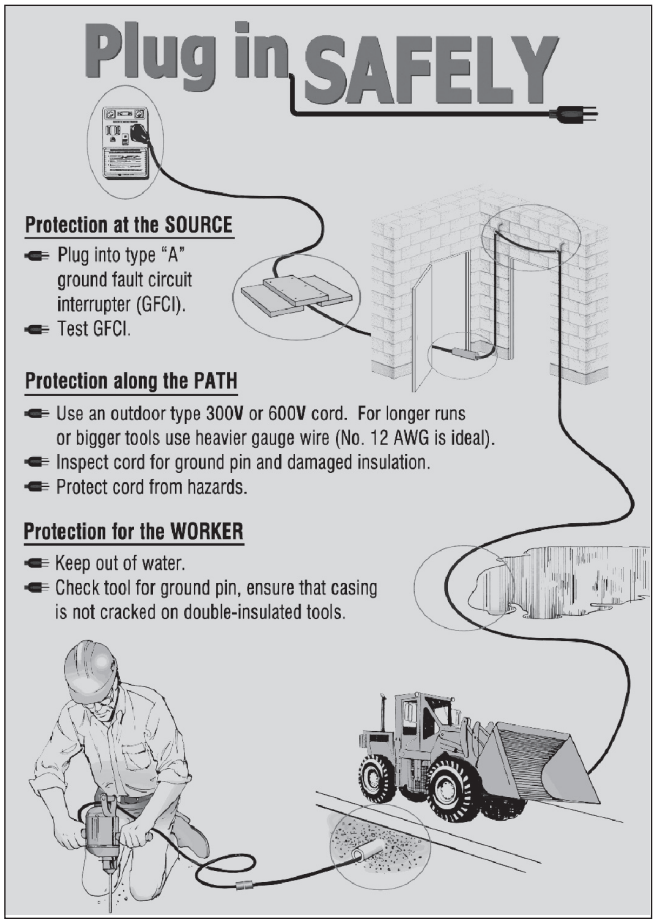
   b) a polarized plug connection.

2. Extension cords must be of the outdoor type, rated for 300 volts, and have an insulated grounding conductor.

3. Defective cords must not be used. They should be either destroyed or tagged and removed from the jobsite until they are repaired.

4. Extension cords should be protected during use to prevent damage.

5. Extension cords should be plugged into Class A ground fault circuit inturruptors (GFCIs). When built-in GFCI receptacles are not available, protection can be attained with an in-line GFCI plugged directly into the supply receptacle. **Electric tools used outdoors or in wet locations must be protected by a Class A GFCI.**





In-line Class A GFCI.

TEMPORARY WIRING AND POWER

1. **Temporary wiring** for construction or demolition projects must be installed in accordance with the Ontario Electrical Safety Code 23rd Edition/2002 (as amended by O. Reg. 62/07). Copies are available from Orderline by phoning 1-888-361-0003 or visting www.orderline.com.

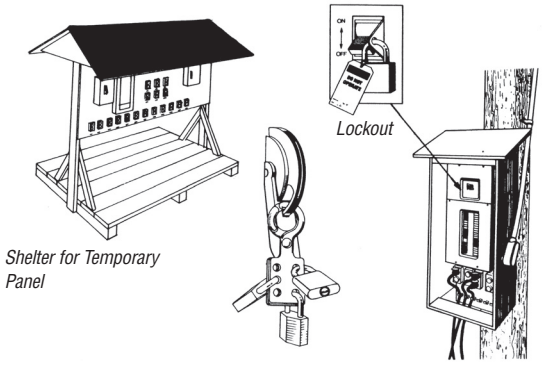
2. **A switch and panel board**

   a) must be securely mounted on a soundly constructed vertical surface

   b) must have a cover over uninsulated parts carrying current

   c) must be located

   - in an area where water will not accumulate; **and**



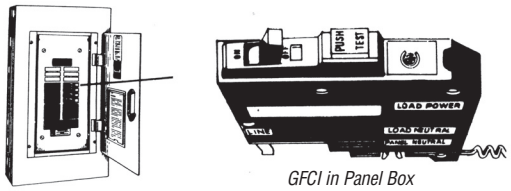
- within easy reach of workers and readily accessible to them

d) must be kept clear of obstructions in the area in front of the panel board

e) that controls a service entrance, service feeder, or branch circuit providing temporary power

- must not be locked in the energized position; **and**
- must be housed in an enclosure that can be locked and is provided with a locking device.

f) When supplying power to tools that will be used outdoors or in wet locations, the receptacle must be protected by a class A GFCI.



GFCI in Panel Box

3. **Portable generators** for use as a stand-alone supply for portable electrical devices must be labelled "**Neutral Bonded To Frame.**"

"Portable Generators for portable electrical devices shall be a generator with the neutral bonded to the case to facilitate the operation of the overcurrent protection device(s)." Labelling on newer portable generators must indicate the status of the neutral conductor and shall be marked on each machine as follows: NEUTRAL BONDED TO FRAME or NEUTRAL FLOATING.

Source: Electrical Safety Authority Flash notice 03-03-FL



Labelled "Neutral Floating"

Portable generators with no connection between the neutral and the case cannot be used for a stand-alone electrical supply for the operation of portable electrical equipment. Generators with no connection between the neutral and the case are intended to be connected to a distribution system through a transfer switch. An example of this is a standby backup system in a residential home which kicks in upon failure of the utility supply. These generators will be labelled **"Neutral Floating"**.

OTHER ELECTRICAL ISSUES

Electromagnetic induction

Electromagnetic induction can create an electric current in a dead circuit. The condition occurs when a magnetic field from another wire, circuit, or device cuts across a wire in its path and produces a charge in that wire. Temporary grounding will prevent electromagnetic induction. The temporary grounding cable must be the same size conductor as the one found within the circuit.

Grounding

A ground conductor provides a direct physical connection to the mass of the earth.

A grounding conductor limits the voltage or current to the ground during normal operation, and also prevents excessive voltages due to lightning strikes.

A temporary ground provides a direct physical connection to the mass of the earth. Temporary grounding typically involves the use of a wire or cable that has one end connected to a de-energized circuit, and the other end to a known grounded connection. The known grounded connection can be the equipment frame (note that if the equipment is electrically isolated, the frame may not provide an effective grounded connection), a metal water pipe, a ground electrode, or other acceptable grounding medium.

Ground all phases. Attach a temporary ground

cable to the system and keep it in place until work is completed.

Connecting and disconnecting conductors

Any disconnect devices used to isolate electrical equipment must be certified by CSA International or another certification body accredited by the Standards Council of Canada. It is important that the device has the appropriate rating for the available current and load it is serving. Never assume a circuit has been de-energized when the disconnect is in the open position. Check for power in all conductors, then follow prescribed lockout and tagging procedures before beginning work.

Capacitors

Isolate the capacitor by opening the circuit breaker or the isolation device connecting it to the circuit. Drain off the accumulated charge for five to ten minutes with the system device. Short circuit and ground the capacitor using a hot stick and required personal protective equipment.

Electrical fires

Never put water on fires in live electrical equipment or wiring. Water is a conductor and increases the risk of arc flash and electrocution. An electrical fire in a confined space can rapidly deplete oxygen and may release toxic fumes. If possible, switch off power. Avoid inhaling fumes and vacate the area at once. If necessary, breathe through a damp cloth and stay close to the floor. Use a Class C fire extinguisher. Intended for electrical fires, Class C extinguishers employ a non-conductive extinguishing agent. An ABC fire extinguisher may also be used on an electrical fire. Every worker who may be required to use a fire extinguisher must be trained in its use. Report fires immediately. Wiring or equipment involved in a fire must be inspected by the electrical utility inspector before being reactivated.

REPORTING ELECTRICAL INCIDENTS

All incidents, regardless of severity, must be reported promptly to management and the immediate supervisor, and a record should be kept at the jobsite. When a serious or fatal injury involves a union member, the union office and steward must be notified immediately. Labour and management should cooperate fully in conducting an investigation.

Part VII of the *Occupational Health and Safety Act* specifies the requirements for notification in the event of fatalities, injuries, and incidents. In the event of an incident that requires reporting and investigation, care should be taken not to disturb the incident scene, nor should equipment or tools involved in the incident be removed.

Contact with an overhead powerline

Contact with an overhead powerline must be reported to multiple parties.

If accidental contact occurs with an energized powerline carrying 750 V or more, report the contact to the inspection department of the Electrical Safety Authority (ESA), and provide written notice to the Ministry of Labour, joint health and safety committee or health and safety representative, and trade union.

Fatality or critical injury

A written report is required under subsection 51 (1) of the Act, respecting an occurrence in which a person is killed or critically injured. (See box on next page.)

Section 53 of the Act: Where a notice or report is not required under section 51 or 52, and an

- accident
- premature or unexpected explosion, fire, flood or inrush of water
- failure of any equipment, machine, device, article, or thing
- cave-in, subsidence, rockburst
- or other *incident as prescribed* (see box below)

occurs at a project site, mine, or mining plant, notice in writing of the occurrence shall be given to a director, the joint health and safety committee

or health and safety representative, and trade union, if any, by the constructor of the project or the owner of the mine or mining plant within two days of the occurrence containing such information and particulars as are prescribed.

For the purpose of the Act, the Regulations, and the Ontario Electrical Safety Code, "critically injured" means an injury of a serious nature that,

- places life in jeopardy;
- produces unconsciousness;
- results in substantial loss of blood;
- involves the fracture of a leg or arm but not a finger or toe;
- involves the amputation of a leg, arm, hand, or foot but not a finger or toe;
- consists of burns to a major portion of the body; or,
- causes the loss of sight in an eye.

Note: *O. Reg. 834* and *Ontario Electrical Safety Code* (OESC) (twenty third edition 2002) use virtually identical wording for the definition of "critically injured."

For the purpose of section 53 of the Act, a "prescribed incident" includes:

- accidental contact by a worker or by a worker's tool or equipment with energized electrical equipment, installations or conductors. (s.11 O. Reg. 213/91)
- Accidental contact by a crane, similar hoisting device, backhoe, power shovel or other vehicle or equipment or its load with an energized electrical conductor rated at more than 750 volts. (s.11 O. Reg. 213/91)

Reporting serious electrical incidents to the ESA

An owner, contractor, or operator of a facility must report any serious electrical incident to the Inspection Department of the ESA within 48 hours after the occurrence.

"Serious electrical incident" means,

a) Any electrical contact which causes death or critical* injury to a person, or

b) Any fire or any explosion or any condition suspected of being electrical in origin which might have caused a fire, explosion, loss of life, critical* injury to a person, or damage to property, or

c) Any electrical contact with electrical equipment operating at over 750 volts, or

d) Any explosion or fire of electrical equipment operating at over 750 volts.

OESC 2002

* see definition of "critically injured" under "Fatality or critical injury" above.

Notice of accident, explosion or fire causing injury

If a person is disabled from performing his or her usual work or requires medical attention because of an accident, explosion, or fire at a workplace, but no person dies or is critically injured because of that occurrence, the employer shall, within four days of the occurrence, give written notice of the occurrence containing the prescribed information and particulars to the following:

1. The joint health and safety committee or the health and safety representative, and the trade union, if any
2. The Director, if an inspector requires notification of the Director.

32 PROPANE

INTRODUCTION

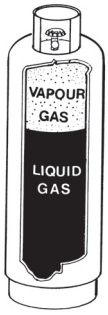
Packaged under pressure, propane gas presents three hazards if misused:

1. high flammability and explosive potential
2. displacement of breathable air in confined spaces (also, being heavier than air, propane will collect in low areas)
3. contact injury from accidental exposure to a substance under high pressure.

We will not cover the use of propane in the roofing industry.

Physical Characteristics

Propane or liquefied petroleum gas (LPG) is a by-product of petroleum or natural gas refining which is packaged under pressure in cylinders. In its stored state it is a liquid but is released from the cylinder or tank in a gaseous form. The boiling point of propane, the point at which the liquid converts to a gas, is -42.2°C (-44°F). If the surrounding air temperature is above this, gas will form in the upper part of the cylinder (Figure 1).



Cutaway view of vapour withdrawal propane cylinder
Figure 1

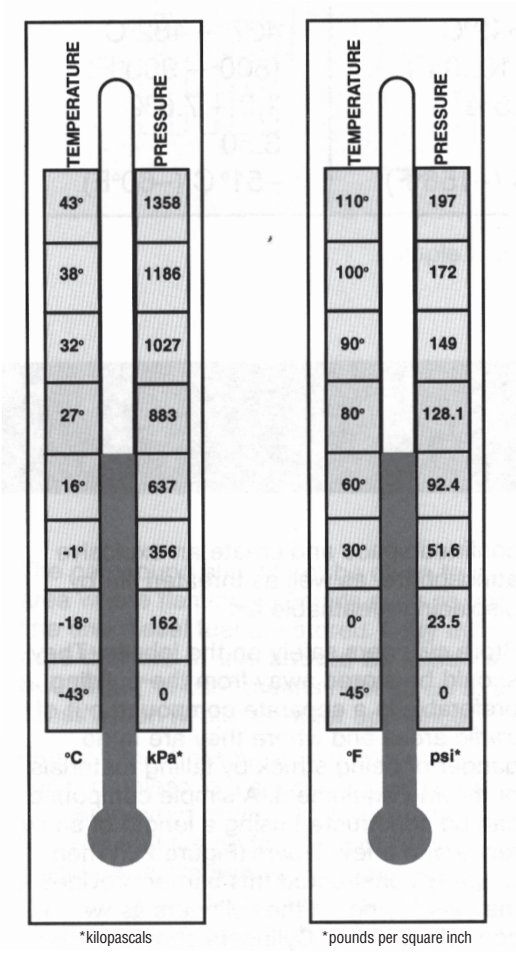
The pressure within the container is variable depending on the temperature to which the container is exposed (Table 1). The pressure increases as the temperature rises, causing expansion of the liquid. For this reason containers are never fully charged with liquid, but have a vapour space at the top of the tank to allow for normal expansion.

Should the temperature rise above safe limits, a relief valve will open to allow release of the gas in a measured amount. This release is generally over in seconds. The valve reseals and remains closed until the pressure builds up again. Cylinder relief valves are set at 2585.5 kPa (375 lb per square inch).

Propane is packaged in a number of cylinder types and sizes to meet a variety of applications:

- 100-lb cylinders for construction heaters, roofing kettles, and other appliances that consume large amounts of fuel. They are called 100-lb cylinders because they are charged with 100-lb of liquid at the propane plant.
- 20-lb cylinders for oxypropane welding set-ups. (This is a familiar size that will be used on such appliances as household gas barbecues.)
- 10 and 20-lb cylinders for soldering work.
- 14-oz. throwaway containers for various hand-held torch applications.

Propane can be easily compressed from a gaseous to a liquid state in small cylinders, making it very portable. When the liquid converts back to a gas, it expands 270 times in volume. Compared to natural gas, propane has a heating value that is 2.5 times greater. One cubic foot of propane converts to 2,500 BTUs, while one cubic foot of natural gas converts to only 1,000 BTUs. This explains why so much energy (BTUs) can be contained in a small cylinder, making it a very convenient fuel for the contractor.



Temperature/Pressure Variables (values taken from CSA Standard B149.2-M80)
Table 1

But the high-energy value of propane also makes it very dangerous to handle. It only takes a tiny leak to form an explosive gas/air mixture.

The high flammability of propane can be seen by comparing its ignition characteristics with those of gasoline (Table 2).

	Propane	Gasoline
Minimum ignition temperature range	493° – 549°C (920° – 1020°F)	427° – 482°C (800° – 900°F)
Flammability limits in air	2.4 – 9.5%	1.3 – 7.5%
Vapour density (air=1)	1.52	3.50
Minimum flash point	-104°C (-156°F)	-51°C (-60°F)

Table 2

When you consider that the heat from a lighted cigarette ranges between 1000°F and 1600°F, and that a lighted match produces 2000°F, all that is necessary for combustion is a sufficient quantity of propane gas mixed with air. This is why safety procedures must be followed—so that a very efficient energy source does not become a hazard to workers.

Safe Handling of Cylinders

In construction, most propane applications dispense the fuel in a vapour form. For this reason, it is essential that portable cylinders be transported, stored, and used in an upright position. Propane liquid must never come in contact with the cylinder relief valve. If liquid escapes through the valve, large volumes of gas will be released.

The simplest way to avoid the problem is to fasten cylinders in an upright position with rope, wire, or other means. When transporting by truck, take extra care to keep cylinders upright and stationary. Cylinders should not be transported in an automobile trunk or in a closed van. Escaping gas can collect in a confined space and create an explosive atmosphere, as well as threaten life by displacing breathable air.

Store cylinders safely on the jobsite. They should be stored in a separate compound out of traffic areas and where they are in no danger of being struck by falling materials or moving equipment. A simple compound can be constructed using a length of snow fence and a few T-bars (Figure 2). When properly constructed, this barrier provides a means of tying up the cylinders as well as controlling stock. Empty cylinders should be stored on one side, full on the other. Don't mix the cylinders.

The compound should not be close to an area where flammable liquids such as gasoline and diesel fuel are stored. **Only cylinders that are in use should be inside a building.** ("In use" means hooked up to a construction heater or other appliance.)

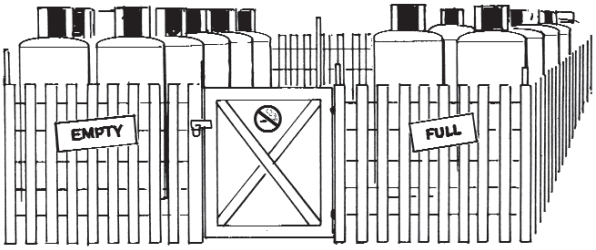


Figure 2: Simple but secure on-site storage

Do not locate cylinders in stairwells and hallways. Leaking gas or the outbreak of fire can block exits and prevent escape.

When moving cylinders of gas around the jobsite, remember the following precautions.

- Keep cylinders upright. Use a hand cart (Figure 3). Never roll cylinders.
- Use a hoisting cradle to move cylinders from one level to another (Figure 4).

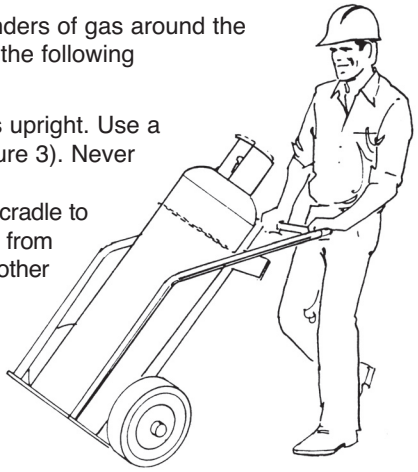


Figure 3

- Never use a sling. This practice is prohibited by the Construction Regulation under the *Occupational Health and Safety Act*.
- Never hook onto the protective collar around the valve.
- Keep cylinders away from heat sources.

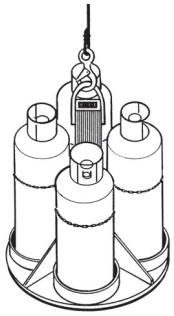


Figure 4

Heaters

You must have a record of training (ROT) recognized by the Technical Standards and Safety Authority (TSSA) before you can hook up and light a propane-fired heater.

When working near construction heaters, note the following precautions.

- All connections must be made by a competent worker holding a valid ROT who can inspect the burner, controls, regulator, and hose for defects. Repair or replace any damaged parts. **Gas-burning equipment should only be repaired by licensed service personnel.**
- Make sure all hose and valve connections are clean.
- Use fitting wrenches to make connections. Don't use adjustable pipe wrenches.

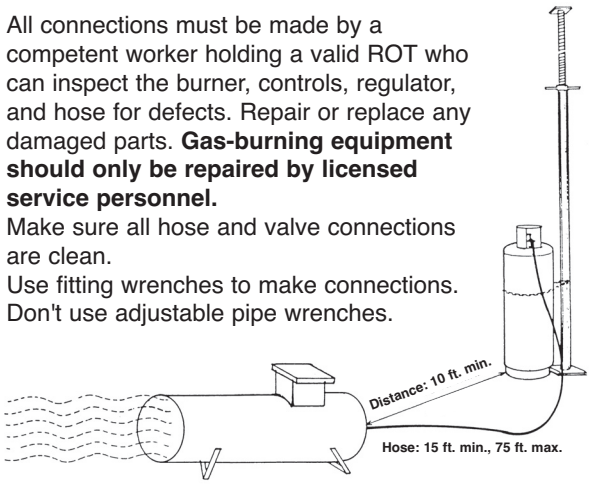


Figure 5
Secure the cylinder and keep it at least 10 feet away from the heater. Hose length must be between 15 feet and 75 feet.

- Cylinders should be at least 10 feet away from the heaters. The cylinder should be placed well clear of any heat source and never at the flame end of a heater.
- Have a 4A40BC fire extinguisher on hand before lighting the heater.
- Cylinder valves in use must be fully opened and check for leaks with soapy water (Figure 6) or a leak detector. Sometimes you may notice a gas odour or frost appearing on a fitting, but these signs are not always reliable. If a leak is detected, shut off the cylinder valve and make corrections. Fully close valves when not in use.
- Secure the cylinder by tying or wiring it to a column or other upright. Keep cylinders out of traffic areas where they may be knocked over.
- Keep heaters away from flammable materials. The heat from a burner is effective well past the tip.

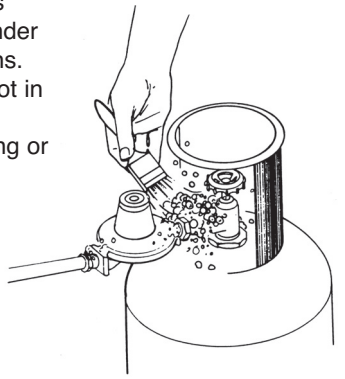


Figure 6: Soap Test for Leaks

- Watch for a drop in pressure or reduced flame efficiency. This indicates that gas is being withdrawn too quickly, and may require additional cylinders to be hooked up in manifold. Never apply heat to the cylinder.
- If cylinders must be manifolded, use no more than three 100-pound cylinders (Figure 7). If other heaters with manifolded cylinders are to be operated in the same area, they must be at least fifty feet away or be separated by a firewall.

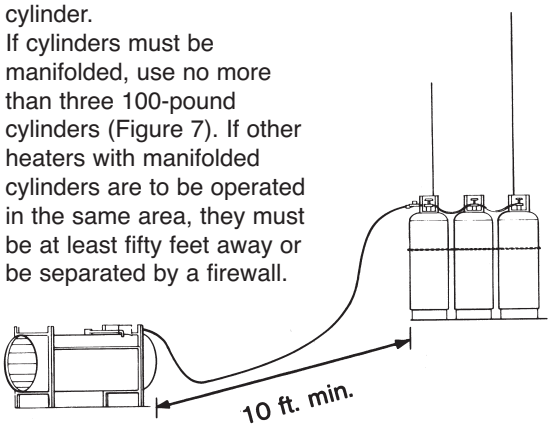
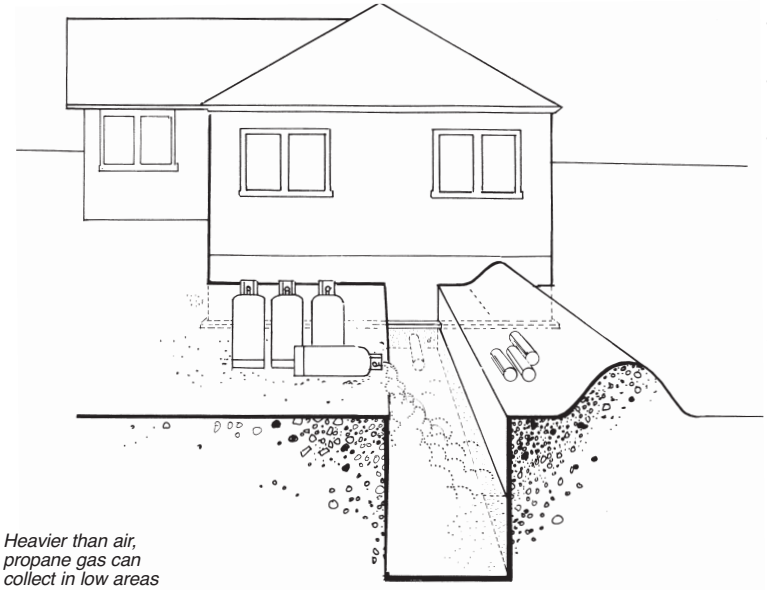


Figure 7: Typical Manifold Set-Up

- Remember that propane is heavier than air and will collect in low areas such as trenches, pits, and basements where it can create a flammable or explosive situation (Figure 8).
- Never attempt to tie down, defeat, or bypass safety devices on a construction heater. If the heater is defective, replace it. If the heater is inadequate, get extra heaters or replace it with a larger one.
- If the flame goes out, act with caution. Shut off the gas supply, then determine whether escaped gas is concentrated in the area. Because of its strong odour, you can usually smell propane. However, in a confined space, test with a gas detection device. If escaped gas is detected or even suspected, ventilate and purge the area thoroughly before relighting the unit.

Warning: If the heater is in a confined or low-lying area, escaped gas can accumulate. Never attempt to relight. Notify your supervisor or certified operator.



Heavier than air, propane gas can collect in low areas and create the potential for asphyxiation or explosion.

Figure 8

- Never expose any part of your skin to liquid propane. Propane under pressure is extremely cold and can cause frostbite.
- Don't allow propane gas to saturate your clothing. A highly flammable situation can remain for some time after the exposure. Saturated clothing should be removed and aired outside.
- Never operate heaters without adequate ventilation. Do not block or restrict openings meant to ventilate emission gasses.

Bulk Tanks

Propane construction heaters that operate from a central bulk storage tank are common on large construction projects. This type of installation takes planning and close consultation between contractor and gas supplier to select a safe, convenient tank storage area that will not interfere with onsite traffic and materials handling, nor infringe on property line clearance requirements. The bulk tank and feed lines are installed by licensed service personnel, but hooking up the heaters is generally left to the construction heater operator. The feed lines are usually well provided with hook-up points called station valves. They consist of a shut-off and a connection point for a flexible hose. Similar safety precautions also apply here.

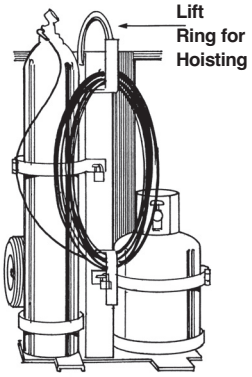
- Check for leaks at the hook-up point after installing a flexible heater line.
- Flexible hose lengths should never exceed 75 feet between heater and station valve.

Welding and Cutting

In recent years, propane has become a popular energy source in open flame welding and cutting. Combined with oxygen in a manner similar to oxyacetylene welding, it provides a gas mix that is considered much more stable by many users.

While welding cylinders are generally smaller than cylinders used for construction heaters, they should be treated with the same care.

- Fittings should be clean and free of grease before hooking up.
- Fitting wrenches should be used to avoid damage to parts.
- Cylinders should be in an upright position at all times, kept in a suitable cradle when in use, and preferably tied upright to prevent tipping over (Figure 9).
- A fire extinguisher (4A40BC minimum) should be kept close when using any torch.
- Regulators should be removed and stored in a protective case when not in use, along with hoses and torches.



Oxypropane Welding Cart

Figure 9

- Consult manufacturer's handbook for oxypropane regulator settings. They are very different from oxyacetylene settings. For more information, refer to “Welding and Cutting”.



Summary

The safe use of propane depends on twelve basic rules:

1) Don't store cylinders inside a building.
2) Always use a certified ROT holder to connect, disconnect and operate propane cylinders.
3) Keep heat sources and flammables away from cylinders.
4) Always secure cylinders to prevent upset.
5) Never transport cylinders in an enclosed vehicle or trunk.
6) Always use proper gear for hoisting or moving cylinders around the worksite.
7) Keep heaters in good condition. Repairs and maintenance should be done only by licensed service personnel.
8) Always have a fire extinguisher handy (4A40BC minimum).
9) Protect stored cylinders or bulk tanks from onsite traffic.
10) Don't tamper with controls or safety devices.
11) Never enter an area where leaking gas is suspected.
12) Don't block or restrict openings meant for ventilation of heater exhaust emissions.

25 HOUSEKEEPING AND FIRE SAFETY

Many injuries result from poor housekeeping, improper storage of materials, and cluttered work areas. To maintain a clean, hazard-free workplace, all groups – management, supervision, and workers – must cooperate.

General

Regulations for safe housekeeping require

- daily jobsite cleanup program
- disposal of rubbish
- individual cleanup duties for all workers
- materials piled, stacked, or otherwise stored to prevent tipping and collapsing
- materials stored away from overhead powerlines
- work and travel areas kept tidy, well-lit, and ventilated (Figure 8)
- signs posted to warn workers of hazardous areas.

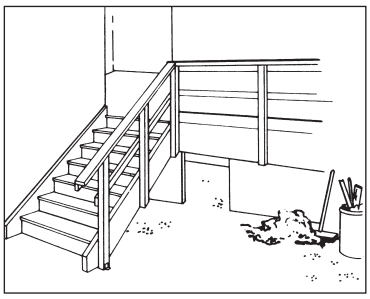


Figure 8
Keep stairs and landings clear and well-lit.

The basics of good housekeeping are shown in Figure 9.

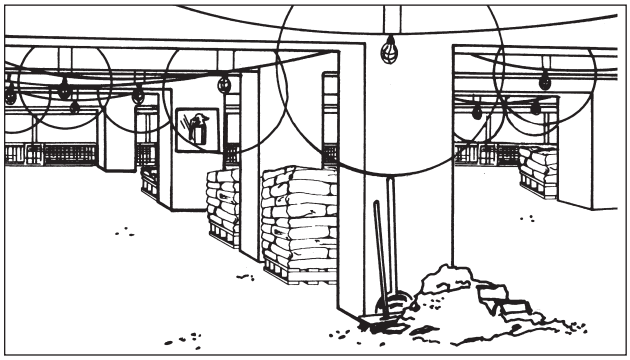


Figure 9
Good housekeeping means clear traffic and work areas, out-of-the-way storage, adequate illumination, and cleanup of debris.

Specific

- Gather up and remove debris as often as required to keep work and travel areas orderly.
- Keep equipment and the areas around equipment clear of scrap and waste.
- Keep stairways, passageways, and gangways free of material, supplies, and obstructions at all times.
- Secure loose or light materials stored on roof or on open floors to prevent them being blown by the wind.
- Pick up, store, or dispose of tools, material, or debris that may cause tripping or other hazards.
- Before handling used lumber, remove or bend over protruding nails and chip away hardened concrete.
- Wear eye protection when there is any risk of eye injury.
- Do not permit rubbish to fall freely from any level of the project. Lower it by means of a chute or other approved device (Figure 10).
- Do not throw materials or tools from one level to another.
- Do not lower or raise any tool or equipment by its own cord or supply hose.
- When guardrails must be removed to land, unload, or handle material, wear fall-arrest equipment (Figure 11). The area must also be roped off with warning signs posted.

In shops, it is relatively easy to maintain a clean work area. Barriers and warning lines can also be set up to isolate table saws and other equipment.

On construction sites, arrangements are more difficult. Equipment often sits in basements, on decks, or in corners with insufficient working space and sometimes it's open to the weather. The footing may simply consist of a piece of plywood.

Around table saws and similar equipment, keep the immediate area clear of scrap to avoid tripping hazards and provide sound footing.

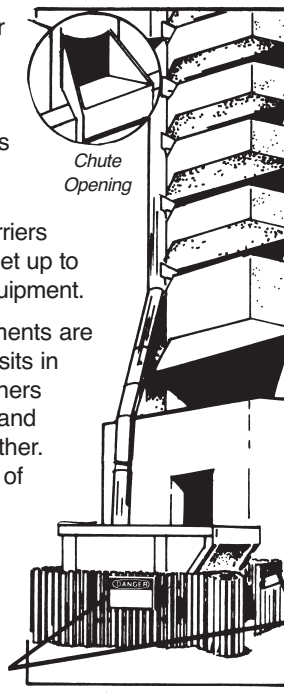


Figure 10

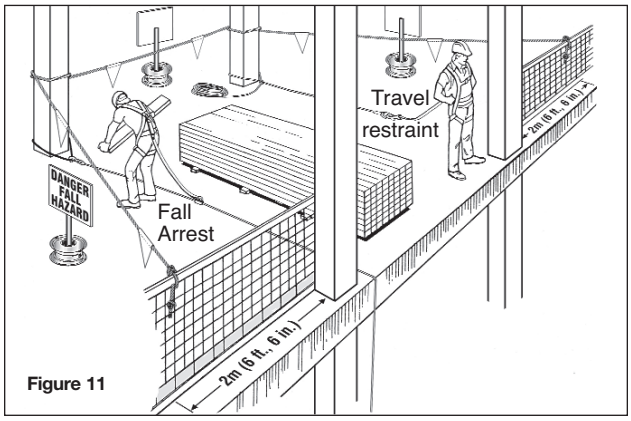


Figure 11

Airborne wood dust can be a respiratory hazard, causing problems ranging from simple irritation of the eyes, nose, and throat to more serious health effects. Dust collectors should be installed in shops to remove sawdust from air and equipment. Wood dust is also very flammable.

In construction, saws and other tools are often operated in the open air where dust presents no hazard. However, dust masks or respirators should be worn whenever ventilation is inadequate.

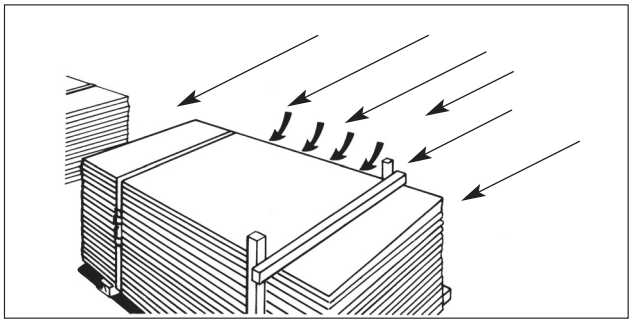


Figure 12
Secure material against the wind.
After removing material, resecure pile.

Storage

Storage areas should be at least 1.8 metres (6 feet) from roof or floor openings, excavations, or any open edges where material may fall off (Figure 12).

Near openings, arrange material so that it cannot roll or slide in the direction of the opening.

Flammable Materials

- Use copper grounding straps to keep static electricity from building up in containers, racks, flooring, and other surfaces (Figure 13).
- Store fuel only in containers approved by the Canadian Standards Association (CSA) or Underwriters' Laboratories of Canada (ULC).
- Ensure that electric fixtures and switches are explosion-proof where flammable materials are stored.
- See Figure 14 for pointers on safe storage.

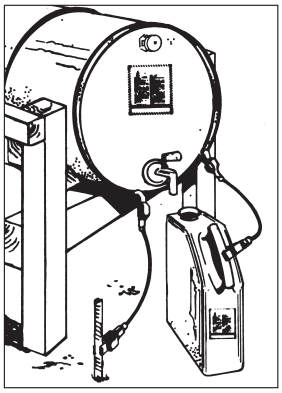


Figure 13
Dispensing and receiving containers should both be grounded.

Hazardous Chemicals

- Refer to the material safety data sheet (MSDS) for specific information on each product.
- Follow manufacturer's recommendations for storage.
- Observe all restrictions concerning heat, moisture, vibration, impact, sparks, and safe working distance.
- Post warning signs where required.
- Have equipment ready to clean up spills quickly.
- To keep them separate for special handling and disposal later, store empty chemical containers in secure area away from full containers.

Bags and Sacks

- Do not pile bagged material more than 10 bags high unless the face of the pile is supported by the walls of a storage bin or enclosure.
- Do not move piles more than 10 bags high unless fully banded or wrapped.
- Cross-pile bags and sacks for added stability. Pile only to a safe and convenient height for loading and unloading.

Compressed Gas Cylinders

- Store and move cylinders in the upright position. Secure cylinders upright with chains or rope.
- Lock up cylinders to prevent vandalism and theft.
- Wherever possible, store cylinders in a secure area outdoors.
- Keep full cylinders apart from empty cylinders.
- Store cylinders of different gases separately.
- Keep cylinders away from heat sources.
- When heating with propane, keep 45-kilogram (100 lb.) cylinders at least 3 metres (10 feet) away from heaters; keep larger tanks at least 7.6 metres (25 feet) away.

Lumber

- Stack on level sills.
- Stack reusable lumber according to size and length. Remove nails during stacking.
- Support lumber at every 1.2-metre (4-foot) span.
- Cross-pile or cross-strip when the pile will be more than 1.2 metres (4 feet) high.

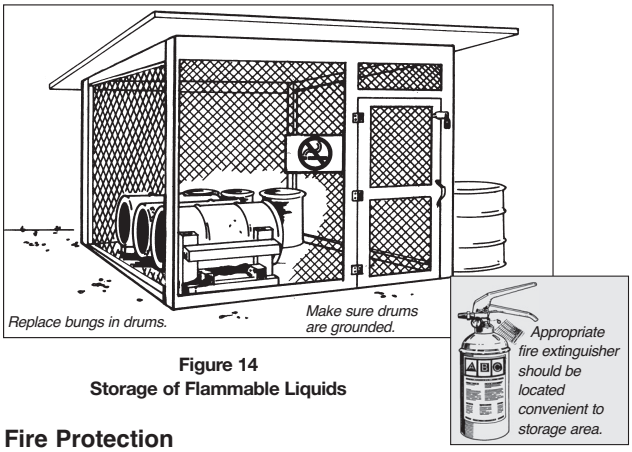


Figure 14
Storage of Flammable Liquids

Fire Protection

Housekeeping includes fire prevention and fire protection. Workers must be trained to use fire extinguishers properly.

Fire extinguishers must be

- accessible
- regularly inspected
- promptly refilled after use.

Extinguishers must be provided

- where flammable materials are stored, handled, or used
- where temporary oil- or gas-fired equipment is being used
- where welding or open-flame cutting is being done
- on each storey of an enclosed building being constructed or renovated
- in workshops, for at least every 300 square metres of floor area.

Fire extinguishers are classified according to their capacity to fight specific types of fires (Figure 15).

Workers must be trained to use fire extinguishers properly.

For most operations, a 4A40BC extinguisher is adequate.

Extinguishers have a very short duration of discharge – usually less than 60 seconds. Be sure to aim at the base of the fire.





Class "A" Extinguishers

For fires in ordinary combustible materials such as wood, paper, and textiles where a quenching, cooling effect is required.



Class "B" Extinguishers

For flammable liquid and gas fires, such as oil, gasoline, paint and grease where oxygen exclusion or flame interruption is essential.



Class "C" Extinguishers

For fires involving electrical wiring and equipment where the non-conductivity of the extinguishing agent is crucial.

This type of extinguisher should be present wherever functional testing and system energizing take place.



Class "D" Extinguishers

For fires in combustible metals such as sodium, magnesium, and potassium.

How to Use the Extinguisher

Aim the extinguisher at the base of the fire to extinguish the flames at their source.

Figure 15

30 MOUNTING AND DISMOUNTING

Each year, workers are hurt while getting on or off trucks, backhoes, and other construction equipment. Learn the safe way to mount and dismount.

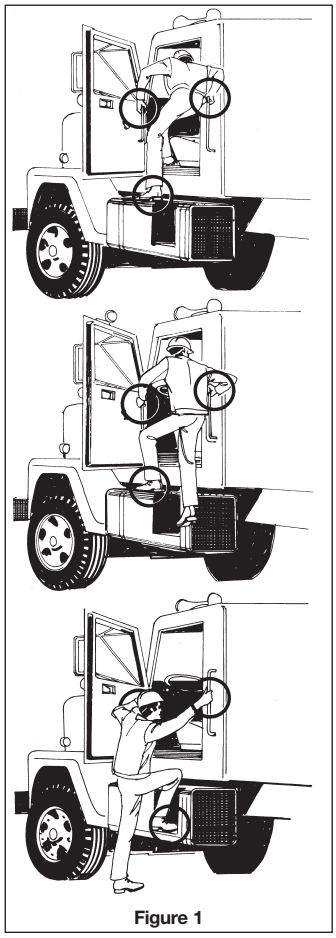


Figure 1

Three-point contact

When getting on or off equipment, you need three points of constant contact with the machine. That means one hand and two feet, or two hands and one foot—**at all times.**

Anything less, and you're risking a fall.

Three-point contact forms a triangle of anchor points which changes in form while you mount or dismount (Figure 1). You have the most stability when the centre of this triangle is close to your centre of gravity. Your weight should be evenly distributed among the three contact points. This means that you should avoid sideways movement because it can put you off balance.

Remember

- ✓ always face in towards the machine or ladder
- ✓ mount and dismount only when the equipment is standing still
- ✓ break three-point contact only when you reach the ground, the cab of the vehicle, or a stable platform
- ✓ take your time
- ✓ take extra care in wet, snowy, icy, or other dangerous weather conditions
- ✓ avoid wearing loose or torn clothing that can catch on the equipment
- ✓ get on or off at the safest access position (normally designed by the manufacturer)
- ✓ where necessary, retrofit equipment to provide safe access.

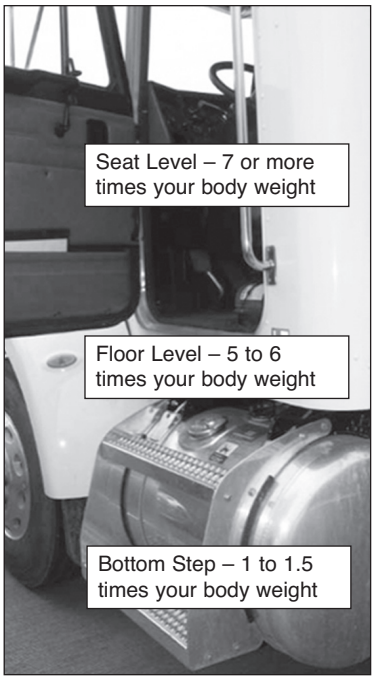
The Construction Regulation states that construction equipment must have a means of access to the operator's station that will not endanger the operator, and must have skid-resistant walking, climbing, and work surfaces.

Ensure that your equipment complies with the law. And keep runningboards, treads, steps, footholds, and platforms clear of mud, ice, snow, grease, debris, and other hazards. Housekeeping keeps you and your co-workers safe!

Don't Jump Down

Jumping down is the quickest and easiest way to exit tractors, trailers, trucks and other heavy equipment. But the fastest way is not always the safest way. When jumping between two points, the body has to absorb the impact force on landing. This impact force can change significantly depending on the height of the jump and the characteristics of the landing area.

Figure 2: Impact force varies with the height of the jump[1]

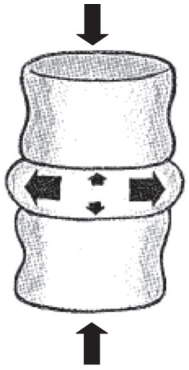


As demonstrated in Figure 2, the impact force of jumping from the bottom step of a truck compared with jumping from the floor level or seat level can increase from 1 – 1.5 times your body weight to 5 – 7 times your body weight. The impact force will also increase if the landing area contains a hard surface or is in a tight space compared to if it contains soft soil, mats or foams that allow the impact force to dissipate.

Spine and joint injuries

The high impact force of jumping down increases the risk of a serious injury to the lower back and lower limbs. The force of landing on the ground intensifies the shock or impact load on the spinal column, which can lead to increased bone-on-bone compression forces (see Figure 3).

Figure 3: The greater the impact force, the higher the bone-on-bone compression force



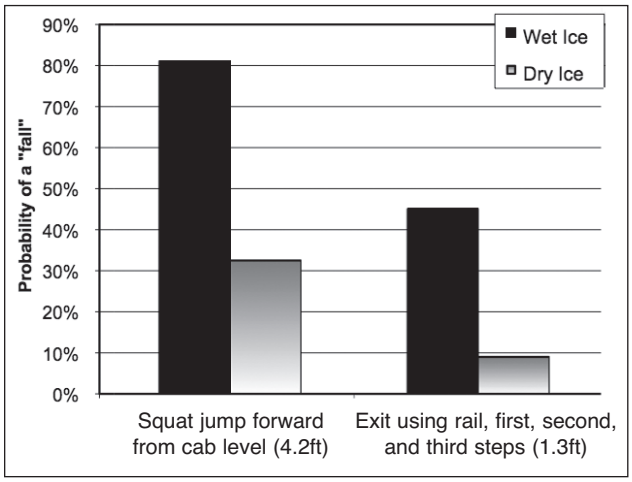
Research has shown that repetitive bone-on-bone impact is a direct cause of spinal disc degeneration and other soft-tissue back injuries. The force of landing can also cause a similar bone-on-bone effect in your joints, such as the knees and ankles.

Slip and fall injuries

Another risk from jumping off a trailer or from a truck cab is a slip and fall injury after the landing. Landing force is a function of the height of the jump, so the higher the jump distance, the higher the landing force. In order to maintain balance and prevent a slip or a fall, the contact friction between safety boots and the ground must be high upon landing. If the friction is low, a slip or a fall can occur.[2]

The risk of a slip and fall injury can also increase if you land on a slippery surface such as ice, mud, or waste materials on the ground (see Figure 4). Landing awkwardly on an uneven surface can result in ankle and knee injuries from torn muscles and tendons.

Figure 4: Probability of a fall is a function of the jump distance and slippery surfaces.[3]



Prevention

Musculoskeletal disorders (MSDs), slips, and falls are among the leading causes of injuries in Ontario. To help prevent these injuries, make the following solutions part of your workplace health and safety program.

1. Take the time to take the few extra steps. Climb down from the vehicle rather than jump.
2. Provide proper ramps or ladders so workers can safely enter and exit trucks, trailers, and other heavy equipment.
3. Install slip-resistant steps and grab rails to help workers mount and dismount equipment safely (see Figure 5).
4. When getting off or on equipment, always face the equipment and maintain three-point contact—keep either two hands and one foot or two feet and one hand on the equipment at all times (see Figure 6).
5. If you can't avoid jumping down, get as close to the ground as possible. Sitting on the edge and jumping from a seated position will lessen the impact on your body (see Figure 7).



Figure 5: Use a ladder whenever possible, to access different work locations



Figure 6: Always use three-point contact when mounting and dismounting from vehicle.



Figure 7: Impact force on your body can be reduced by sitting on the back of a trailer or the side of an open trailer before the jump.

[1] Fathallah and Cotnam (2000), "Maximum force sustained during various methods of exiting commercial tractors, trailers, and trucks. *Applied Ergonomics*, 31: 25-33.

[2] For the technical reader – the typical coefficient of friction (COF) from a jumping distance of 0.4 m is 0.15 and increases to 0.3 from a jumping distance of 1.25 m. Therefore "slip-resistant" safety boots should have a minimum COF of 0.3 (Fathallah et al, 2000).

[3] Fathallah et al. (2000), "Estimated slip potential on icy surfaces during various methods of exiting commercial tractors, trailers, and trucks". *Safety Science*, 36: 69-81.

33 CONFINED SPACES

As of July 1, 2011, confined spaces on construction projects are regulated under Regulation 632–*Confined Spaces*.

Before letting a worker enter a confined space, the employer must develop a written confined space program meeting the requirements of Regulation 632–*Confined Spaces*. The employer must maintain the program.

Confined Space Program

Among the first requirements for employers developing a confined space program is the need to assess which workers will be entering the confined space and therefore which workers will need a copy of the confined space program.

Employers must provide a copy of the program to the constructor of a project. In turn, the constructor must provide a copy of the program to the project's joint health and safety committee or health and safety representative, if any. A copy must also be available to other employers to which the program relates and every worker if there is no project joint health and safety committee or health and safety representative.

If workers from more than one employer will be entering the confined space, the constructor must prepare a **confined space coordination program**. A copy of the confined space coordination document must be provided to each employer who is performing work in the confined space and to the project's joint health and safety committee or the health and safety representative.

The confined space program can apply to one or more confined spaces.

Program elements must include

- ❑ a method for recognizing each confined space
- ❑ a method for assessing the hazards to which workers may be exposed
- ❑ a method for developing plans to control the hazards
- ❑ a method for training workers
- ❑ an entry permit system setting out measures and procedures to be followed when working in a confined space.

Coordination

When workers of more than one employer perform work in the same confined space, the constructor must prepare a coordination document to ensure that the various employers perform their duties in a way that protects the health and safety of all workers. A copy of the coordination document must be provided to

- ❑ each employer of workers who perform work in the same confined space
- ❑ the project's joint health and safety committee or health and safety representative.

Recognizing a Confined Space

A confined space is defined as a place

a) that is **partially or fully enclosed**

b) that is not both designed and constructed for **continuous human occupancy**, and

c) where **atmospheric hazards** may occur because of its construction, location, or contents, or because of work that is done in it.

All three criteria have to be met before a space is defined as a confined space. Here is more information on each of the criteria.

Partially or fully enclosed

Because air cannot move freely in and out of a partially or fully enclosed space, there is a potential for a hazardous atmosphere to be generated inside. This is especially true for spaces such as vaults, tanks, pits, trenches, or manholes.

Not designed and constructed for continuous human occupancy

Confined spaces are not designed or constructed for people to work in them on an ongoing basis. They are usually designed and constructed to store material, transport products, or enclose a process. But occasionally, some work must be done inside the space.

Atmospheric hazards

A hazardous atmosphere is one that contains any of the following:

- ➤ an accumulation of flammable, combustible, or explosive agents
- ➤ less than 19.5% or more than 23% oxygen, or
- ➤ an accumulation of atmospheric contaminants that could result in ***acute*** (short-term) health effects which
  - a) pose an immediate threat to life, or
  - b) interfere with a person's ability to escape unaided from a confined space.

Hazard Assessment

Before each time that a worker enters a confined space, a person with adequate knowledge, training and experience must perform a written hazard assessment. The name of the competent worker must appear on the assessment and the employer must keep a record of the competent worker's qualifications.

The hazard assessment must take into account

a) the hazards that may exist in the confined space

b) the hazards that may develop while work is performed inside the confined space

c) general safety hazards in the confined space.

The person with adequate knowledge, training and experience must sign and date the assessment and give it to the employer.

If requested, the employer must give copies of the assessment and the qualifications of the person with adequate knowledge, training and experience to

- ❑ the project's joint health and safety committee, or
- ❑ the health and safety representative, or
- ❑ every worker involved in the confined space entry if the project has no joint health and safety committee or health and safety representative.

The employer must review the assessment as often as necessary to make sure that the plans remain adequate. For example, if the potential chemical hazard changes due to a change in process or equipment use, then the assessment must be changed.

An assessment is generally required for each confined space. But if there are two or more similar confined spaces containing the same hazards, then you need only a single assessment document.

To perform a hazard assessment, you need to anticipate potential hazards. Often, the hazards of working in confined spaces are not recognized until it's too late.

For example:

- ➤ A mixing tank was inadvertently started while a worker was inside.
- ➤ A worker was killed by carbon monoxide gas from a gasoline-powered pump used to drain a pit.

Because construction projects are not limited to new buildings, confined spaces may be encountered in a variety of places. The following table describes typical confined spaces and the most common hazards found there.

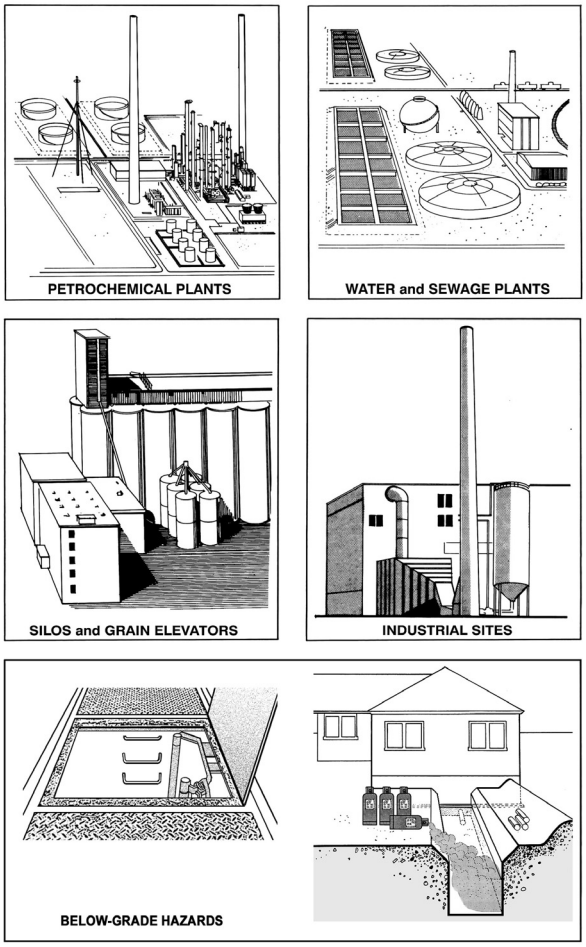
Hazards in confined spaces can be divided into two distinct categories: physical hazards and atmospheric hazards.

If control measures (such as continuous mechanical ventilation) are used to ensure that the concentrations of an atmospheric hazard are **controlled** or maintained at an appropriate level (but not eliminated), then the space would still be considered a confined space. If, however, measures are implemented to **eliminate** the possibility that any atmospheric hazards may occur in a space, then the confined space provisions no longer need to apply. Eliminating the possibility that an atmospheric hazard will occur is different from controlling the hazard. If workers must enter the confined space to eliminate the hazards (by steam-cleaning or vacuuming, for example), then the confined spaces provisions apply.

EVERY CONFINED SPACE MUST BE THOROUGHLY ASSESSED AND EVALUATED BY A PERSON WITH ADEQUATE KNOWLEDGE, TRAINING AND EXPERIENCE TO DETERMINE WHETHER IT IS POSSIBLE TO ELIMINATE THE ATMOSPHERIC HAZARD COMPLETELY.

Even if a space is not defined as a confined space under the regulations, the employer must take every precaution reasonable in the circumstances to protect workers entering the space.

Figure 1
TYPICAL LOCATIONS OF CONFINED SPACES



Physical Hazards

Physical hazards often present a greater danger inside an enclosed space than they do outside.

Examples:

➤ **Noise and vibration**

An enclosed environment can amplify noise. Excessive noise can damage hearing and prevent communication. It can affect workers' ability to hear alarms, warning shouts, or orders to evacuate.

➤ **Temperature extremes**

Ask plant personnel if workers could encounter dangerous temperatures. For example, heat stress can be a hazard when working around boilers, hot pipes or tanks, or structures heated by the sun. Protective clothing can also add to heat stress.

➤ **Cramped work spaces**

Cramped work spaces restrict movement and can make using tools and equipment difficult and dangerous.

➤ **Poor access or exit**

Confined space openings are generally small and not well-located. This can make entry and exit difficult and can interfere with rescue.

➤ **Rotating or moving equipment**

Before entry, identify any moving or rotating equipment (such as conveyors, mixers, augers, etc.) which could become activated by stored pressure, accidental contact,

Examples of confined spaces	Common hazards
Chemical and petrochemical projects Tanks, vessels, storage tanks, underground tanks, pipes, sumps, pits, any area where a worker cannot readily escape from a toxic or explosive atmosphere; any area where toxic, explosive, or oxygen deficient atmospheres may be encountered.	Toxic and explosive gases, vapours and fumes; physical hazards of cramped entry and exit, narrow passages, and chemical spills.
Sewage-handling systems Settling tanks, sewers, manholes, pumping areas, septic tanks, digesters.	Toxic and/or explosive atmospheres such as hydrogen sulphide and methane; oxygen deficiencies.
Water treatment plants Settling tanks, holding tanks, equipment and wells below floor level.	Oxygen deficiency, chlorine gases, ozone; also possibly methane and hydrogen sulphide produced by decaying debris removed from lake and river water.
Heavy industrial projects Sumps, pits, roasters, digesters, mixers, bins, flues, ducts, conveyors, elevators, bag houses.	The hazards will depend on processes and materials involved but may include methane, hydrogen sulphide, oxygen deficiency, flammable agents, electrical hazards, moving parts, and engulfment due to free-flowing materials.
General construction Vaults, caissons.	Toxic materials such as carbon monoxide from temporary heaters in low-lying areas; refrigerants; high-voltage transmission equipment; physical hazards involving poor lighting and cramped working conditions.

or gravity. Check with plant personnel on lockout and tagging procedures, and review drawings, plans, and specifications.

➤ **Electrical hazards**

Any exposed conductors or energized equipment should be identified before entry. The presence of water in confined spaces may pose an additional electrocution hazard where electrical circuits, equipment, and tools are used.

➤ **Engulfment due to uncontrolled movement of liquids and solids**

Liquids, sludge, fine solids, and other material may not be completely removed from confined spaces and may present an engulfment or drowning hazard. Use inspection ports and dipsticks, and check with plant personnel to evaluate such hazards.

➤ **Slick or wet surfaces**

You can be severely injured from a slip or fall on icy, oily, wet, or moist surfaces.

➤ **Lighting**

Confined spaces generally have poor lighting. You often need temporary lighting. In potentially explosive atmospheres, use lighting designed for such situations.

Atmospheric Hazards

Confined spaces can present three kinds of atmospheric hazards:

➤ flammable, combustible, or explosive atmosphere

➤ oxygen-enriched or oxygen-deficient atmosphere

➤ atmospheric contaminants.

The hazardous atmosphere may be due to existing conditions (e.g., residue in a tank,) or it may be created by the work being done inside the confined space (e.g., welding or using solvents). In some cases, removing sludge or scale can release trapped pockets of gas or vapour and create a hazardous atmosphere. Moreover, dangerous atmospheres often exist together. For instance, flammable, combustible or explosive atmospheres may also be toxic or cause an oxygen deficiency.

Flammable, Combustible, or Explosive Atmospheres

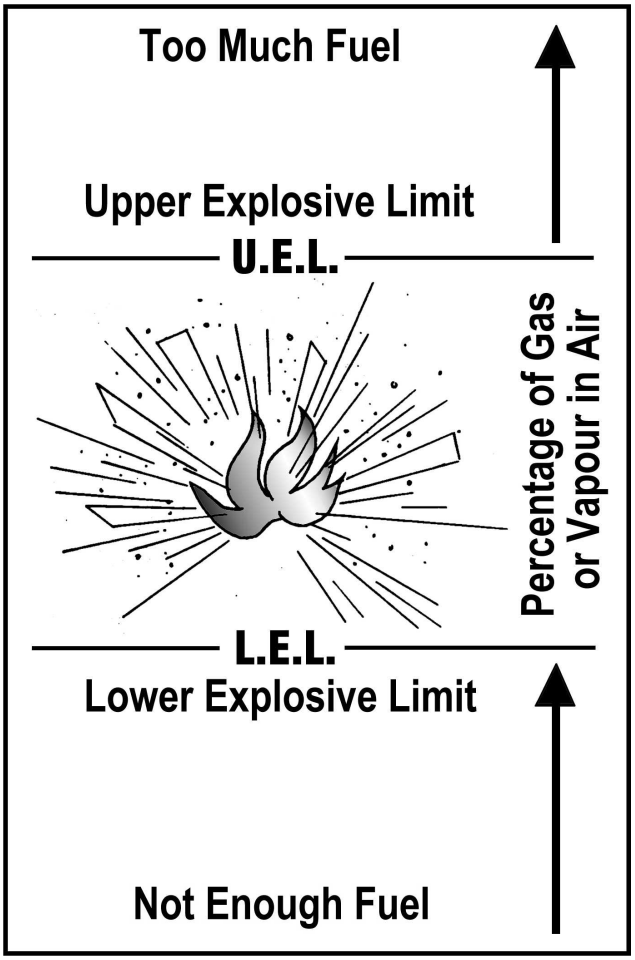
Flammable atmospheres are generally caused by

➤ evaporation of flammable liquids (e.g., gasoline)

➤ by-products of chemical reactions (e.g., decomposition of organic matter to form methane).

Explosive atmospheres are those in which a flammable gas or vapour is present in quantities between the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL). These limits define the “Explosive Range” which varies from one substance to another. (Refer to the section “Fire and Explosion Hazard” of a material’s MSDS for fire- and explosion-related information.)

Figure 2



The LEL is the lowest, and the UEL is the highest concentration of gas or vapour that will support combustion. For example, gasoline has an LEL of 1.4% and a UEL of 7.6%. Below 1.4% there is not enough fuel to burn, while above 7.6% there is too much fuel and not enough oxygen to burn. (See Figure 2.)

The most common explosive gas likely to be encountered in sewers and other underground structures is methane or “natural gas” produced by decaying garbage and sewage.

Other explosive gases and vapours may be present in confined spaces depending on previous contents or accidental spills and leaks (e.g., leaking fuel-storage tanks near service stations).

Explosive ranges for common gases and vapours are listed in Table 1. These values must be considered when selecting and operating gas-testing equipment.

Combustible atmospheres can arise in grain elevators, feed mills, and some industrial settings such as bag houses, because of the large quantities of dust generated. The most common combustible dust is grain or flour dust—there have been several explosions in grain elevators. You need to address this issue whenever you're working in these settings.

Table 1
Explosive Range for common gases and vapours

Gas/vapour	Lower Explosive Limit (%)	Upper Explosive Limit (%)
Acetone	2.6	12.8
Ammonia	16.0	25.0
Benzene	1.3	7.1
Ethyl Alcohol	3.3	19.0
Gasoline	1.4	7.6
Hexane	1.1	7.5
Hydrogen Sulphide	4.0	44.0
Methane	5.0	15.0
Methyl Alcohol	7.3	36.0
Propane	2.4	9.5
Toluene	1.2	7.1
Xylene	1.1	7.0

Oxygen-Enriched and Oxygen Deficient Atmospheres

Normal outside air contains about 21% oxygen. If the concentration of oxygen exceeds 23%, it is considered "enriched". The primary concern with oxygen-enriched atmospheres is the increased flammability of materials. Things that would only smoulder in normal air will burn vigorously in oxygen-enriched atmospheres.

Oxygen-enriched atmospheres are fairly rare in construction. They are usually associated with pure oxygen escaping from leaking or ruptured oxyacetylene hoses or—on projects in industrial plants—from an oxygen line in an industrial or manufacturing process.

Oxygen-deficient atmospheres, on the other hand, are fairly common. They may result from work being done (such as welding), bacterial action (which consumes oxygen), or from chemical reactions (such as rusting). Oxygen may also be displaced by another gas or vapour (e.g., carbon dioxide or nitrogen used to purge tanks, pipe, and vessels). Table 2 lists the effects of oxygen deficiency.

Table 2
Effects of oxygen deficiency

Oxygen concentration	Effect
19.5%	Minimum for safe entry
Less than 18%	Loss of judgment and coordination
Less than 15%	Loss of consciousness
Less than 12%	Sudden collapse and loss of consciousness

Never use pure oxygen to ventilate a confined space. Use clean air.

Atmospheric Contaminants

Because confined spaces are poorly ventilated, atmospheric contaminants can build up to hazardous levels very quickly. For construction in an industrial setting, the type of airborne hazard that may be encountered depends on

- products stored in the confined space
- the type of work tasks performed in the confined space
- work or processes being performed near the confined space.

The most common atmospheric contaminants in construction include hydrogen sulphide, carbon monoxide, sulphur dioxide, chlorine, and ammonia.

Hydrogen Sulphide (H_2S) is a gas generated by the decomposition of garbage and sewage. H_2S can be found in sewers, sewage treatment plants, refineries, and pulp mills. It is also found in many oil refineries since most crude oil in Canada has some H_2S dissolved in it. H_2S is very toxic. A single breath at a concentration of about 500–700 ppm (parts per million) can be instantly fatal. At very low concentrations, H_2S has the characteristic odour of rotten eggs. However, at about 100 ppm, it can deaden your sense of smell and create the false impression that no hazard exists.

Carbon Monoxide (CO) is a very common toxic gas. It has no odour or taste and is clear and colourless. Carbon monoxide poisoning can be very subtle and may cause drowsiness and collapse followed by death. A major source of CO in construction is the internal combustion engine used to power saws, scissor lifts, powered trowellers, generators, and forklift trucks. Even these relatively small engines produce high levels of CO.

Heating in confined areas, particularly with propane, presents special hazards and requires special safeguards.

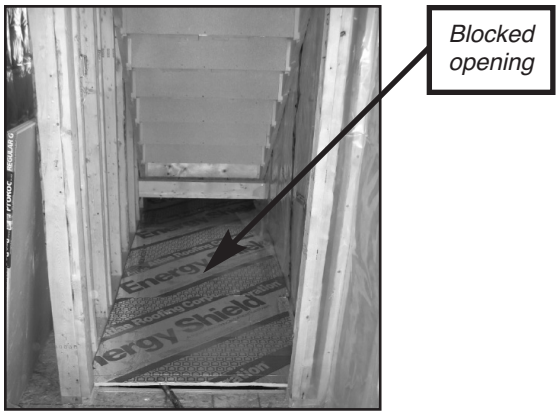
Propane is heavier than air and can collect in low-lying areas such as trenches, basements, and shaft bottoms. Propane can also be absorbed into clothing. Workers must therefore use extreme caution in the event of leakage or flame-out.

Direct-fired heaters release combustion emissions directly into the air where people work. Although carbon monoxide (CO) is the main concern, carbon dioxide (CO_2) and nitrogen oxides may also be a problem.

Traditionally, explosive blasting has been used for demolition or breaking up rock. Blasting in a confined space can produce high levels of carbon monoxide. You must use mechanical ventilation and perform air tests before workers re-enter the blast area to ensure that the carbon monoxide levels are within acceptable levels.

> Adequate ventilation is absolutely essential when you cannot avoid using combustion engines in confined spaces.

CO in atmosphere (parts per million)	Signs and symptoms
10	No symptoms
25	TWA (Time-weighted average): The maximum average amount a worker is allowed to be continuously exposed to for a work day or work week.
70	Blood vessels widen, shortness of breath, tightness across the forehead
100	STEL (Short-term exposure limit): The maximum amount a worker is allowed to be exposed to for a 15-minute period.
120	Shortness of breath, headache with throbbing in temples
220	Headache, irritability, tiredness, impaired judgment, impaired vision, dizziness
350–520	Headache, confusion, fainting, collapse
800–1220	Unconsciousness, spasms, respiratory failure, death if exposure continues
More than 2000	Rapidly fatal



Do not restrict ventilation by blocking openings

Sulphur Dioxide (SO_2) is a very irritating and corrosive gas with a strong sulphur-like odour which can be found in pulp-and-paper mills and oil refineries.

Chlorine (Cl_2) is another irritating and highly corrosive gas with a bleach-like odour used as a disinfectant in water and sewage treatment plants and a wide variety of other industrial settings.

Ammonia (NH_3) is a fairly common chemical used as a refrigerant and in making fertilizer, synthetic fibres, plastics, and dyes.

Hundreds of other toxic materials may be encountered in factories, chemical plants, and similar industrial settings. The best way to obtain information regarding the presence or absence of toxic materials is to discuss the proposed work with the client and ask for the information.

Flammable Products

When using flammable materials in a confined space, take these precautions:

- ✓ Provide adequate ventilation.
- ✓ Control sparks (use non-sparking tools) and control other potential ignition sources.
- ✓ Extinguish all pilot lights.
- ✓ Use specially protected lighting.
- ✓ Have fire extinguishers handy.

Contact cement is an example of a product with fire or explosion potential when used in a small area with poor ventilation. Workers have been killed from explosion and fire when they finished work and switched off the light in a room where solvent vapours from contact cement or adhesives had accumulated.

Accumulation of Contaminants Below Grade

Trenches, manholes, and low-lying areas may become hazardous from leaking gases heavier than air, such as propane, or from gases such as carbon monoxide seeping through the soil and into the confined space.

Case study

A construction crew finished installing a 12-foot-deep manhole without incident. After the crew left the area, 265 pounds of nitroglycerin-based explosive in 20 boreholes, each 18 feet deep, were detonated 40–60 feet from the manhole. A worker who entered the manhole 45 minutes after the explosion collapsed within minutes, and two coworkers descended into the manhole to rescue him. One rescuer retrieved the unconscious worker before collapsing on the surface, and the other rescuer died in the manhole.

An investigation determined that carbon monoxide released from the explosion had migrated through the soil into the manhole. Carbon monoxide concentrations at the bottom of the manhole two days after the incident were 1,905 ppm (parts per million). This concentration was well above 1,200 ppm, the concentration classified as Immediately Dangerous to Life or Health (IDLH). Tests following ventilation of the manhole showed that high levels of carbon monoxide reappeared as a result of continued migration from the surrounding soil. Subsequent monitoring of the manhole showed a decline in carbon monoxide levels over the next 8 days.

Accumulation of Contaminants in Areas Not Classified as Confined Spaces

A variety of spaces can become hazardous because of the products being used or the work being done in them. These areas can be deadly even if they are not classified as confined spaces and even if the Confined Space Regulation does not apply.

Skylights, domes, and ceilings

Work is sometimes required within newly installed skylights where lighter-than-air gases and fumes may accumulate.

Workers should be aware of this hazard. At the first sign of discomfort or disorientation, they should leave the area until it has been ventilated.





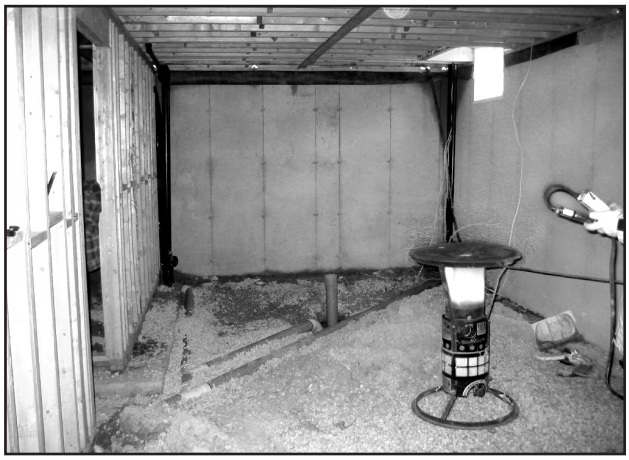
Workers feeling light-headed or experiencing headaches may be inhaling these pollutants. Drowsiness or disorientation can lead to falls. Again, leave the area until it has been ventilated.

Underground mines, tunnels, and shafts

These spaces are intended for people to carry out work in them (this work is covered by specific regulation). These spaces may present physical or atmospheric hazards. Many utilities are routed through tunnels or underground shafts where hazardous atmospheres may collect from containers or operations above, or be created by utility leaks (such as gas and oil).

Work in shafts must be carefully planned. Because the work may be of short duration and require only a temporary platform, these jobs are often not given proper attention.

In addition to the areas already described, beware of apparently harmless areas such as basements, halls, and small rooms that can become dangerous when a lack of ventilation and hazardous materials or operations combine to create atmospheric hazards.



If a worker can be injured by inhaling a hazardous gas, vapour, dust, or fume—or if there is an explosion hazard—then you must provide adequate ventilation by natural or mechanical means. If this is not possible, then you must provide respiratory protection equipment suitable for the hazard.

Plan for Controlling Hazards

Once the hazards have been identified in the assessment, **a person with adequate training, knowledge and experience** must develop a **plan** to eliminate or control the hazards.

A PERSON WITH ADEQUATE TRAINING, KNOWLEDGE AND EXPERIENCE

A person with adequate knowledge, training and experience can include a worker, a supervisor, a consultant, or anyone who has—in addition to the "academic" knowledge of the task at hand—a hands-on knowledge in safety performing the work, a knowledge of the associated hazards, possible controls and legal requirements needed in order to enact the necessary controls to protect the health and safety of the workers in and about the confined space.

The primary objective of the **plan** is to eliminate the hazard before entry. If this is not possible, then controls, measures, and procedures must be put in place to ensure that workers are not in danger.

If confined spaces are of similar construction and present the same hazards, a single plan can be used. Still, the individual confined spaces must be identified in both the hazard assessment and the plan.

The plan is the program element with the most regulatory requirements attached to it. The regulation outlines 11 mandatory requirements that must be contained in the plan:

1) Duties of workers
2) Co-ordination document (prepared by the constructor) if workers of more than one contractor enter the same confined space
3) On-site rescue procedures
4) Rescue equipment and methods of communication
5) Protective clothing and equipment
6) Isolation of energy and control of material movement
7) Attendants
8) Adequate means of entry and exit (access and egress)
9) Atmospheric testing (conducted by a competent worker)
10) Adequate procedures for working in the presence of explosive or flammable substances
11) Ventilation and purging.

We address each of these 11 mandatory requirements below.

1) Duties of Workers

a) Do not enter or re-enter (if the confined space has been left unoccupied and unattended) the confined space unless testing has been performed.

b) Know the hazards that may be faced upon entry. Know the routes of exposure (e.g., inhalation or skin absorption), signs and symptoms, and long-term effects of exposure.

c) Know how to use the equipment (including personal protective equipment and tools) properly.

d) Maintain communication with the attendant so that the attendant can monitor your safety and be able to alert workers to evacuate the confined space.

e) Alert the attendant whenever
- you recognize any warning sign or symptom of exposure
- you see a dangerous condition
- an alarm is activated.

f) Get out of the permit space immediately whenever
- a warning system indicating a ventilation failure is activated
- the attendant gives an evacuation order
- a worker recognizes any signs or symptoms of exposure
- a person inside detects a dangerous condition
- an evacuation alarm is activated.

2) Co-ordination Document

When workers of more than one employer perform work in the same confined space, the constructor must co-ordinate entry operations. The constructor must prepare a co-ordination document to ensure that the various employers perform their duties in a way that protects the health and safety of all workers entering the confined space.

A copy of the co-ordination document must be provided to each employer of workers who perform work in the confined space and the project's joint health and safety committee or health and safety representative.

Each employer is responsible for the health and safety of their own workers and for ensuring compliance with the regulation.

3) Rescue Procedures

The confined space plan must include written procedures for safe onsite rescue that can be implemented immediately in case of an emergency. An adequate number of people must be available to carry out the rescue procedures immediately. They must be **trained** in

a) the onsite rescue procedures

b) first aid and cardio-pulmonary resuscitation (CPR)

c) how to use the rescue equipment necessary to carry out the rescue.

Dialing 911 is not a sufficient rescue response.

4) Rescue Equipment and Communications

The rescue equipment must be readily available, appropriate for the confined space, and inspected by a person with adequate knowledge, training and experience. This person must keep a written record of the inspection. Examples of rescue equipment include harnesses and lifelines, hoist/retrieval systems, respirators, and other personal protective equipment.

NOTE: You must consider the size of the confined space's opening when choosing rescue equipment. There is no point planning for a rescuer to wear a SCBA (self-contained breathing apparatus) unit if it doesn't fit through the opening.

All too often, inadequate or incorrect emergency rescue response results in multiple fatalities. Here are two examples:

- A worker collapsed shortly after entering a degasser tank. His coworker went in after him and collapsed as well.
- A contractor went to test acid-tainted water and was discovered by a worker floating in a well of the above-ground pump house. The worker went to his rescue after calling 911 but was himself overcome. Two paramedics responding to the call were also struck down. All four victims died.

Even with the best planned and executed entry, there is a chance of a sudden change in conditions. The change could be due to factors recognized earlier but for which no "absolute" protection exists, such as the failure of a respirator, the introduction of a new hazard, or collapse from heart attack or illness. In such cases, you need a rescue plan that has been practiced and works.

Remember, rushing into a confined space to help your buddy who is laying on the ground will likely result in your own death. Rescuers are no good to the victim if they also become victims. Many cases of multiple fatalities involve would-be rescuers overcome because of inadequate preparation.



5) Protective Clothing and Equipment

Protective clothing and equipment suitable for one situation may not be suitable for others. For example, polyvinyl chloride (PVC) plastic is resistant to most acids, but it can be softened or penetrated by many common solvents such as benzene, toluene, and xylene.

For this reason, a knowledgeable person should assess the protective clothing and equipment needed (e.g., gloves, boots, chemical suits, fire resistant coveralls—as well as hearing, respiratory, eye, and face protection). Don't forget that if workers need personal protective equipment, they must be trained in its use.

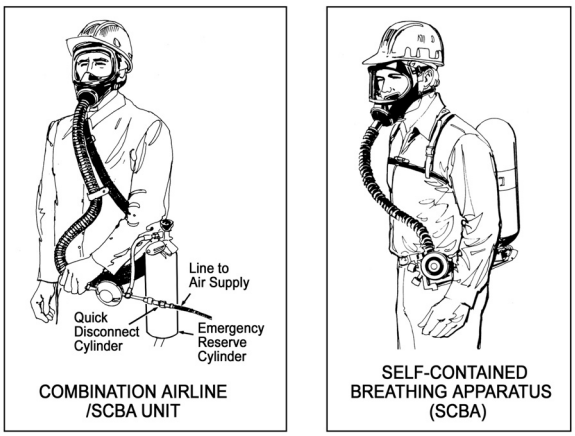
Respiratory protective equipment should be used where ventilation is impractical or inadequate. Certain basic rules apply to the equipment.

First of all, you need to select the proper type of respirator. Oxygen-deficient atmospheres require supplied-air respirators—either airline types with emergency reserves or SCBA (self-contained breathing apparatus). (See Figure 3.)

SCBA note: Because the amount of air supply in standard SCBA cylinders is rated for a specific time period, it is very important to plan your tasks, especially rescue operations, accordingly. Heavy work and stress will increase breathing rates and workers will use up the air in less than the rated time. An alarm sounds when the air supply is low.

In toxic atmospheres, you must use supplied-air respirators if the concentration of the gas or vapour exceeds the level considered to be Immediately Dangerous to Life or Health (IDLH), or if the concentration is unknown.

Figure 3: Supplied-Air Respirations



When the level of toxic gas or vapour is above the exposure limit but below the IDLH level, air-purifying respirators approved by the National Institute of Occupational Safety and Health (NIOSH) may be used, provided the exposure conditions do not exceed the unit's limitations. Someone who is competent in respirator selection must determine the appropriate type of respirator.

Workers required to wear respirators must be instructed how to properly fit and maintain them. (For more information on respiratory protection, refer to the chapter on “Respiratory Protection”, or the Canadian Standards Association’s standard Z94.4-2011, *Selection, Use, and Care of Respirators*.)

Do not use single-strap dust masks and surgical masks—they are not approved by NIOSH. NIOSH is a U.S.-based organization that approves respirators. Workers must be supplied with NIOSH-approved respirators only. All NIOSH-approved respirators have an approval number (always starting with the letters TC) on them.

Make sure your respirator has all the proper parts. Since each manufacturer uses different designs, parts are not interchangeable between brands. Make sure you use the correct parts (cartridges, air cylinders, etc.) for your brand of respirator. Never use cartridges or air cylinders from another manufacturer. They will not fit correctly and will endanger the life of the worker or rescuer.

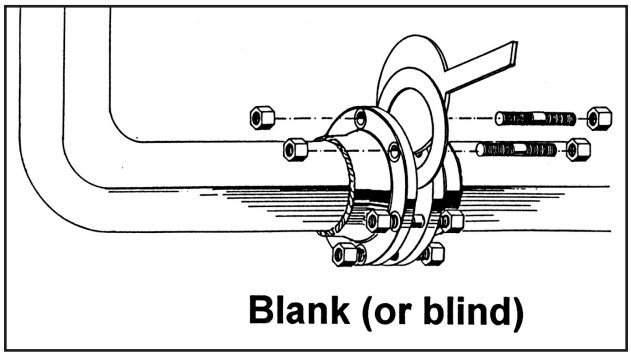
6) Isolation of Energy and Control of Material Movement

Equipment that moves in any way (even rotation) must be isolated by

- ❑ disconnecting the equipment from its power source and de-energizing the equipment, or
- ❑ lockout and tagging. Only workers trained in lockout and tagging should perform such operations. Lockout and tagging should be done even if you use the first option (disconnect and de-energize) to isolate the energy.

For pneumatic or hydraulic equipment, isolate the power source and depressurize the supply lines. Depressurize any components that may still be pressurized after the supply lines have been bled (e.g., hydraulic cylinders). You must disconnect and drain pipes carrying solids or liquids to or from a confined space, or insert blank flanges. (See Figure 4.)

Figure 4

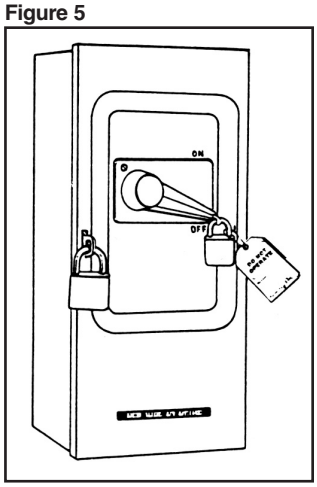


If the pipe cannot be blanked off or disconnected, the valve may be closed, chained, locked and tagged, provided that this type of control—and its importance—have been explained to all workers in the area. **Simply closing valves is not generally acceptable.**



You may need blocking to prevent movement caused by gravity for some equipment (e.g., conveyors).

Figure 5



Electrical equipment in the space should be disconnected, tagged and locked out, and grounded when it's practical to do so (Figure 5).

In the case of live electrical work in a confined space, you need to pay special attention to standard procedures. A minor mistake in a manhole can lead to disaster.

Cramped working conditions can make accidental contact with an energized conductor more likely, so you may need non-conductive equipment.

You may need gloves, mats, and other insulating equipment depending upon the type of work. Capacitors or other components which can store a charge should be discharged and/or grounded.

7) Attendants

An attendant must be present whenever a worker enters a confined space. The attendant is not allowed to enter the confined space, unless he or she is replaced by another attendant in accordance with the plan.

The attendant must

- ✓ remain alert outside and near to the entrance
- ✓ be in constant communication (visual or speech) with all workers in the confined space
- ✓ monitor the safety of workers inside the confined space
- ✓ provide assistance as necessary
- ✓ be provided with a device for summoning help in case of emergency, and
- ✓ initiate an adequate rescue procedure in case of an emergency.

> The attendant is not allowed to enter the confined space to perform a rescue even after help has arrived unless he or she is replaced by another attendant in accordance with the plan.

8) Entry and Exit (Access and Egress)

The means of entry and exit can be evaluated before entry by checking drawings, by prior knowledge, or simply by inspection from outside the space.

Confined space openings are generally small and not well located. These small openings must be considered in the rescue plan since they restrict the movement of workers and equipment in and out of confined spaces.

Entry and exit for top-side openings may require ladders. Ladders must be well secured. Performing an emergency rescue on workers trapped in such areas requires careful planning and practice.



9) Atmospheric Testing

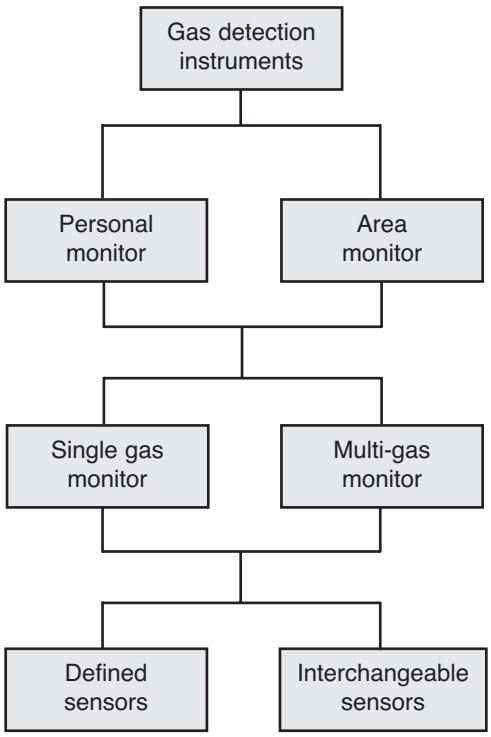
If the hazard assessment determines that there is an atmospheric hazard in the confined space, you must perform atmospheric testing.

1) The employer must appoint a person with adequate training, knowledge and experience to perform adequate tests safely before and during the time a worker is in a confined space to ensure that acceptable atmospheric levels are maintained. The person who will perform the tests must receive training in the operation, calibration, and maintenance of the instruments. Most manufacturers can provide necessary training.
2) If the confined space has been left unoccupied and unattended, you must perform the testing again.
3) The person with adequate training, knowledge and experience performing the tests must use properly calibrated and maintained instruments appropriate for the hazards in the confined space.
4) Results of every sample of a test must be recorded on the entry permit. If continuous monitoring is performed, test results must be recorded at adequate intervals.

Gas detection instruments

Gas detection instruments can take many forms—"personal" or "area," single-gas or multiple-gas detectors, detectors with dedicated sensors, or those with interchangeable sensors.

Figure 6





If a monitor is worn by the worker, it is referred to as "personal monitoring." Personal monitoring gives information about the concentration of hazardous substances surrounding the worker. It is particularly useful when the worker is moving from place to place within the confined space.

Area sampling is done before entry or re-entry. As much of the confined space area as possible should be tested, including the bottom, mid-level, top, and corners.

Single-gas detectors measure only one gas whereas multi-gas monitors are available with several toxic sensor options and have the flexibility of measuring many gases simultaneously. Most multi-gas monitors include an oxygen sensor, a flammable/combustible gas sensor, and one or two sensors for detecting specific toxic gases. Newer single and multi-gas instruments offer the flexibility of interchangeable sensors. You can change the sensors to suit the application in hand. For example, a single-gas detector used to check hydrogen sulphide levels can be used to monitor carbon monoxide concentrations after you change the sensor.



Key steps to follow when you suspect a dangerous atmosphere

Select the appropriate type of calibrated instruments for the hazards identified in the assessment.

You must understand the characteristics of the work area in order to choose the right instruments. Different types of confined spaces present different kinds of toxic gas hazards. There are hundreds of different toxics gases or vapours. You need a familiarity with the characteristics of the confined space in order to narrow down the possibilities and choose equipment.

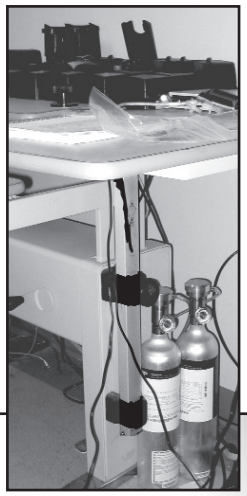
You must use a calibrated monitor that is capable of measuring the hazardous atmosphere found in the confined space. For example, if a propane heater is being used inside a confined space, then you need calibrated monitors capable of measuring oxygen levels, carbon monoxide, and combustible gases.

WARNING: Combustible gas detectors should not be used to assess toxic atmospheres. Most combustible gas detectors do not respond to low concentrations of gases. For example, H_2S is flammable from 4.3% to 44%. But it is Immediately Dangerous to Life or Health (IDLH) at 100 parts per million (0.01%) and would not be detected at this concentration by most combustible gas detectors. Most other toxic gases that are also flammable are dangerous in concentrations well below the LEL.

You must calibrate, maintain, and use the equipment in accordance with the manufacturer's recommendations.

If the meter is not properly calibrated, you cannot rely upon its results. Death can occur if the instrument underestimates the atmospheric conditions.

Most confined-space instrument manufacturers now offer "docking" stations that can automatically calibrate instruments and print a record of calibration. The stations also recharge and store the instruments.





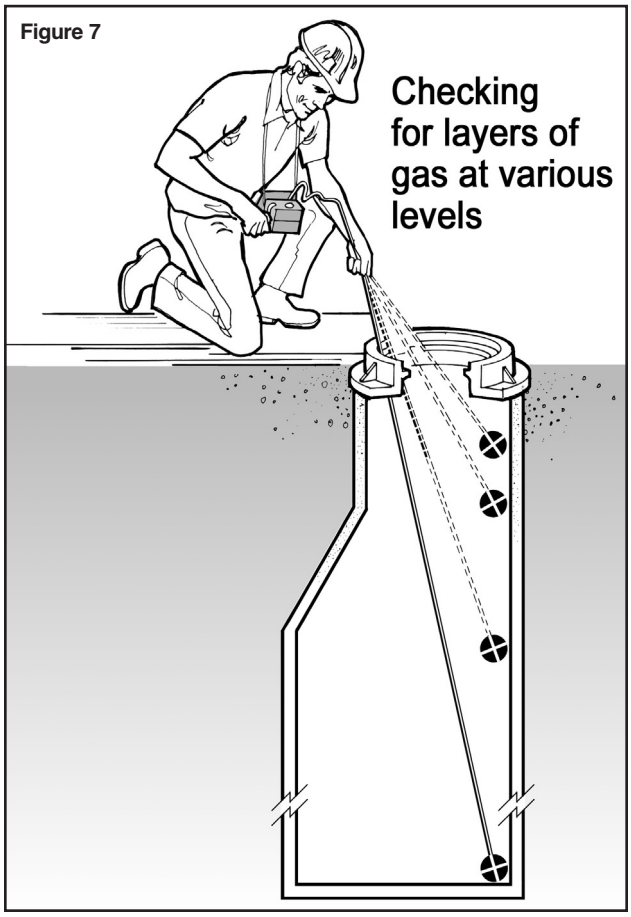
Perform the tests safely.

Entry into a confined space must be prohibited before the appropriate tests are performed. Atmospheres should be evaluated remotely (from outside the confined space) before each entry. If possible, an extendable probe should be inserted through an inspection port or other opening before removing large doors or covers.

Make sure that as much of the space as possible is tested, including the bottom, mid-level, top, and corners, so that you don't miss layers or pockets of bad air. (See Figure 7.)

There are some gases that are lighter or heavier than air. Lighter gases, such as methane, will accumulate at the top, while gases heavier than air will sink to floor level. Gases that are the same weight as air, such as carbon monoxide, will be found throughout a confined space.

Figure 7



Check for oxygen content, combustible or explosive gases and vapours, and toxic gases and vapours in that order if you use more than one meter.

First, check for oxygen content. Checking oxygen first is important because you may need adequate oxygen to get a valid result from other tests.

If the oxygen level is adequate, test for explosive atmospheres. Several different calibration gases are available. Methane is used most frequently since it is a common gas found in many places. But you can get devices calibrated for propane, hexane, heptane, or almost any other combustible gas. These devices give a result expressed as a percentage of the lower explosive limit (LEL) for the calibration gas used.

The next thing to check for is the presence of toxic gases and vapour using a calibrated instrument.

If you're using a multi-gas monitor capable of measuring oxygen, combustibles, and toxic gases simultaneously, then the order of testing is not as critical.

All three types of dangerous atmospheres must be evaluated before entry. Users of gas detectors must be competent workers. They must also receive training in the operation, calibration, and maintenance of the devices. Most manufacturers can provide necessary training.

Always test for the three dangerous atmospheres:

- ❑ too much or too little oxygen
- ❑ combustible or explosive gases or vapours
- ❑ toxic gases or vapours.

You may need to monitor the atmosphere continuously.

Continuous monitoring in a confined space is required while hot work is being performed in a potentially flammable or explosive atmosphere or where the flammable or explosive atmosphere has been rendered inert by adding an inert gas. It should also be considered when conditions in the confined space change rapidly.

If continuous monitoring is performed then test results must be recorded at regular intervals.

Most confined space instruments have data-logging capabilities. Data-logging is useful for compliance and record-keeping purposes. If an accident or unusual event happens, data-logging may be useful for demonstrating due diligence.

Interpret the results.

There may be other gases present in the confined space that interfere with the reading for the gas you are trying to measure. Such gases are referred to as “interfering gases.” They can lead to misinterpretation of the monitoring results.

Know the limitations of your specific equipment. Consult the manufacturer's instructions for proper use.

Temperature, humidity, and interfering gases can all affect the performance of gas monitors.

If the atmosphere meets acceptable exposure limits, the confined space may be entered. If the atmosphere does not meet acceptable limits, you need to implement controls before anyone can enter.

Acceptable atmospheric levels	
Explosive or flammable gas or vapour	**< 25%** of its lower explosive limit: inspection work can be performed. **< 10%** of its lower explosive limit: cold work can be performed. (Cold work is work which does not involve – welding and cutting – the use of tools or equipment which can produce a spark – other sources of ignition.) **< 5%** of its lower explosive limit: hot work can be performed.
Oxygen content	At least 19.5% but not more than 23% by volume.
Exposure to atmospheric contaminants	Exposures to atmospheric contaminants must not exceed what is reasonable in the circumstances. The exposure limits in the regulation on "Control of Exposure to Biological or Chemical Agents" (O. Reg 833) and the "Designated Substance Regulations*" (O. Reg. 490) are generally considered reasonable for protecting workers.

* *This is the case despite the fact that construction projects are, strictly speaking, exempt from Regulation 833 and most of the Designated Substance Regulations. (The Designated Substance Regulation which does apply to construction is O. Reg. 278/05: "Designated Substance–Asbestos on Construction Projects and in Buildings and Repair Operations.")*

If measurements are within acceptable exposure limits but are approaching hazardous levels, the competent worker's decision to proceed should be based on an assessment of the source of the problem, the likelihood of change, and the conditions at the scene. In doubtful cases, it is best to implement the appropriate controls discussed in the following section.

Recording the results.

The test results must be recorded on the work entry permit. The records must be kept by the constructor or employer for at least one year after the project is finished.

- ★ Never trust your senses to determine whether the atmosphere in a confined space is safe.
- ★ You cannot see or smell many toxic gases and vapours.
- ★ You cannot determine by your senses the level of oxygen present.
- ★ Know which gases or vapours may be present in the confined space and test for them.

10) Explosive, or Flammable Substances

No worker is allowed to enter a confined space if airborne **combustible** dust or mist is present in a concentration sufficient for explosion. If an **explosive** or **flammable** atmosphere is detected, you can perform only certain types of work. The conditions for each type of work are specified below the following definitions.

Hot work means activities that could produce a source of ignition such as a spark or open flame. Examples of hot work include welding, cutting, grinding, and using non-explosion-proof electrical equipment.

Cold work means activities that cannot produce a source of ignition.

a) Between 0% and 5% of the LEL, you can perform hot work. The following conditions must also be met:
   - ❑ The oxygen content must be maintained below 23%.
   - ❑ The atmosphere must be continuously monitored.
   - ❑ The entry permit must include adequate provisions for hot work, and it must specify the appropriate measures to be taken.
   - ❑ An alarm and exit procedure must be in place to provide adequate warning and allow safe escape if the atmospheric concentration exceeds 5% of the LEL or if the oxygen content exceeds 23%.

b) Between 0% and 10% of the LEL, you can perform cold work.

c) Between 0% and 25% of the LEL, you can perform inspection work.

Alternatively, work may be carried out in the confined space if the explosive or flammable atmosphere is rendered inert by an inert gas (such as nitrogen, argon, helium, or carbon dioxide).

The atmosphere must be monitored continuously to ensure it remains inert. The worker in the confined space must use adequate respiratory equipment as well as adequate equipment to help people outside the confined space locate and rescue the worker if a problem occurs.

Inerting is the process of replacing the potentially combustible atmosphere in a confined space with a noncombustible gas such as nitrogen, argon, helium, or carbon dioxide.

The inert gas will replace all of the ***oxygen*** as well as the combustible gases in the confined space. Workers entering the confined space should use NIOSH-approved ***air-supplied*** respirators. After work is completed, the confined space must be properly ventilated, and a competent worker must test the confined space to see if it is safe.

11. Ventilation and Purging

This is the most effective method of control. The space can be purged of dangerous atmospheres by blowing enough fresh air in, and/or by removing (or suction-venting) the bad air and allowing clean air in. Studies have shown that the best results are obtained by blowing fresh air into a space close to the bottom. Check the efficiency of ventilation by re-testing the atmosphere with the gas detection equipment before entry.

When ventilation is used to improve the air in a confined space, ensure that the toxic or flammable gases or vapours removed from the space do not pose a risk to other workers. “Exhaust air” should not be discharged into another work area.

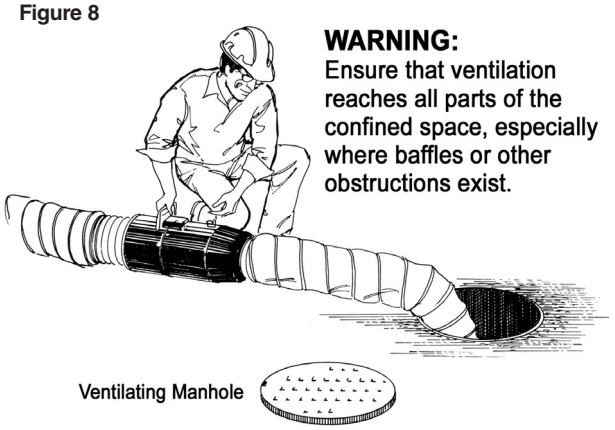
If you use mechanical ventilation to maintain acceptable atmospheric levels by providing a continuous supply of fresh air, you must have a warning system (i.e., an alarm) and exit procedure in case there is a ventilation failure. The alarm should be activated by a pressure switch *at the fan* rather than by electrical failure. This ensures that the alarm is activated if the fan belt fails.

In cases where the concentration of explosive gas or vapour is higher than the UEL, ventilation will bring the concentration down into the “Explosive Range.” This is one reason why you should use only “explosion-proof” fans. These may be specially designed fans powered by electricity or compressed air. Some pneumatic air movers may also be suitable.

For manholes, you can use portable fans. These usually provide around 750-1,000 cubic feet of air per minute.

A typical manhole 10 feet deep and 5 feet wide contains 196 cubic feet. Blowing in 750 cubic feet per minute should provide an air change every 15 seconds and easily dilute or displace most dangerous atmospheres.

Figure 8



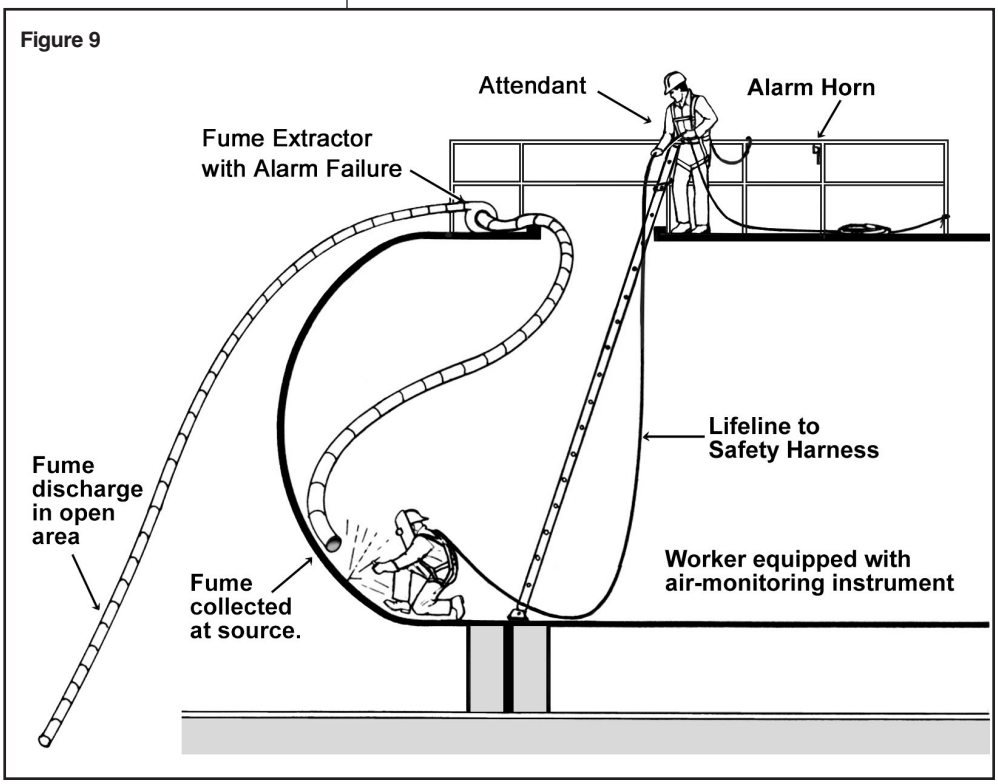
Fans capable of moving 5,000 cubic feet per minute are available for use in larger tanks and vessels.

This type of ventilation may not be adequate in situations where additional toxic or explosive gases or vapours may be generated (e.g., during cleaning and resurfacing tanks or by disturbing sludge and scale).

In the case of welding or other work which generates a localized source of toxic gas, fume, or vapour, an exhaust ventilator can be used to draw out and discharge the hazard in an open area. (See Figure 9.)

Options must be evaluated by someone who understands the risks of the work being done.

Figure 9



Worker Training

Workers must be trained before they enter a confined space. The training must include

- ✓ recognizing the hazards (including potential hazards) in the confined space
- ✓ safe work practices, including the use of all equipment such as ventilation equipment, air monitors, and personal protective equipment.

It is strongly recommended that

- ❑ the employer use an evaluation procedure (a test) to ensure that workers have acquired the knowledge necessary to safely perform their duties
- ❑ inexperienced workers team up with experienced workers.

You must review the content of the training at least annually, and whenever there is a change in circumstances such as a change in an industrial process. If the review indicates that the training is not adequate, you must provide additional training.

You must keep a record of the names of trainers, trainees, as well as the date of training. If the project's joint health and safety committee or health and safety representative wants a copy of the record, you must provide one.

Entry Permits

Permits are valuable tools for planning, evaluating, and controlling confined space entries.



A permit involves a formal system of procedures and is issued by the employer before any worker enters the confined space. A competent person must verify that the permit issued complies with the plan before every shift. The duration of an entry permit must not exceed the time required to complete the task. Entry permits should be understood by everyone involved in the job and must be readily available to every person entering the confined space.

At the very least, the entry permit must include

- ❑ the location and description of the confined space
- ❑ a description of the work
- ❑ a description of the hazards and the corresponding controls
- ❑ the time period for which the entry permit applies
- ❑ the name of the attendant
- ❑ a record of each worker who enters and leaves
- ❑ a list of the equipment required for entry and rescue, and verification that the equipment is in good working order
- ❑ the results of the atmospheric testing
- ❑ additional procedures and control measures if hot work is to be done.

The entry permit may also include

- ❑ a record of the hazard assessment
- ❑ the hazard control plan
- ❑ the training records.

(See Sample Confined Space entry permit.)

Unauthorized entry

The constructor must ensure that each entrance to the confined space is secured against unauthorized entry and/or has adequate barricades or signs warning against unauthorized entry.

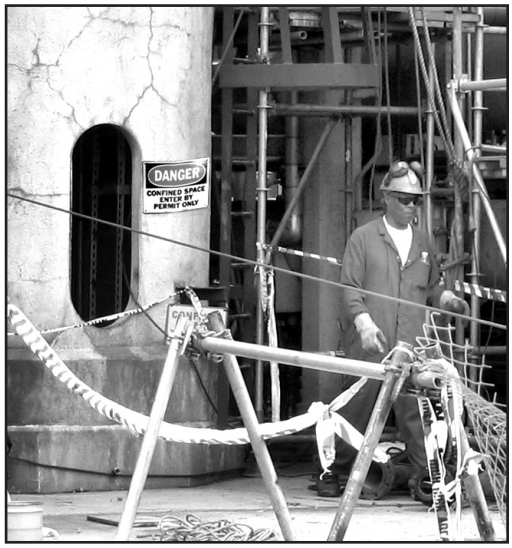


Recordkeeping

The employers must keep records of every

- ✓ plan
- ✓ assessment
- ✓ coordination document
- ✓ training
- ✓ entry permit
- ✓ record of rescue equipment inspection
- ✓ record of tests.

The records must be kept for at least one year after the project is finished, and they must be available for inspection.

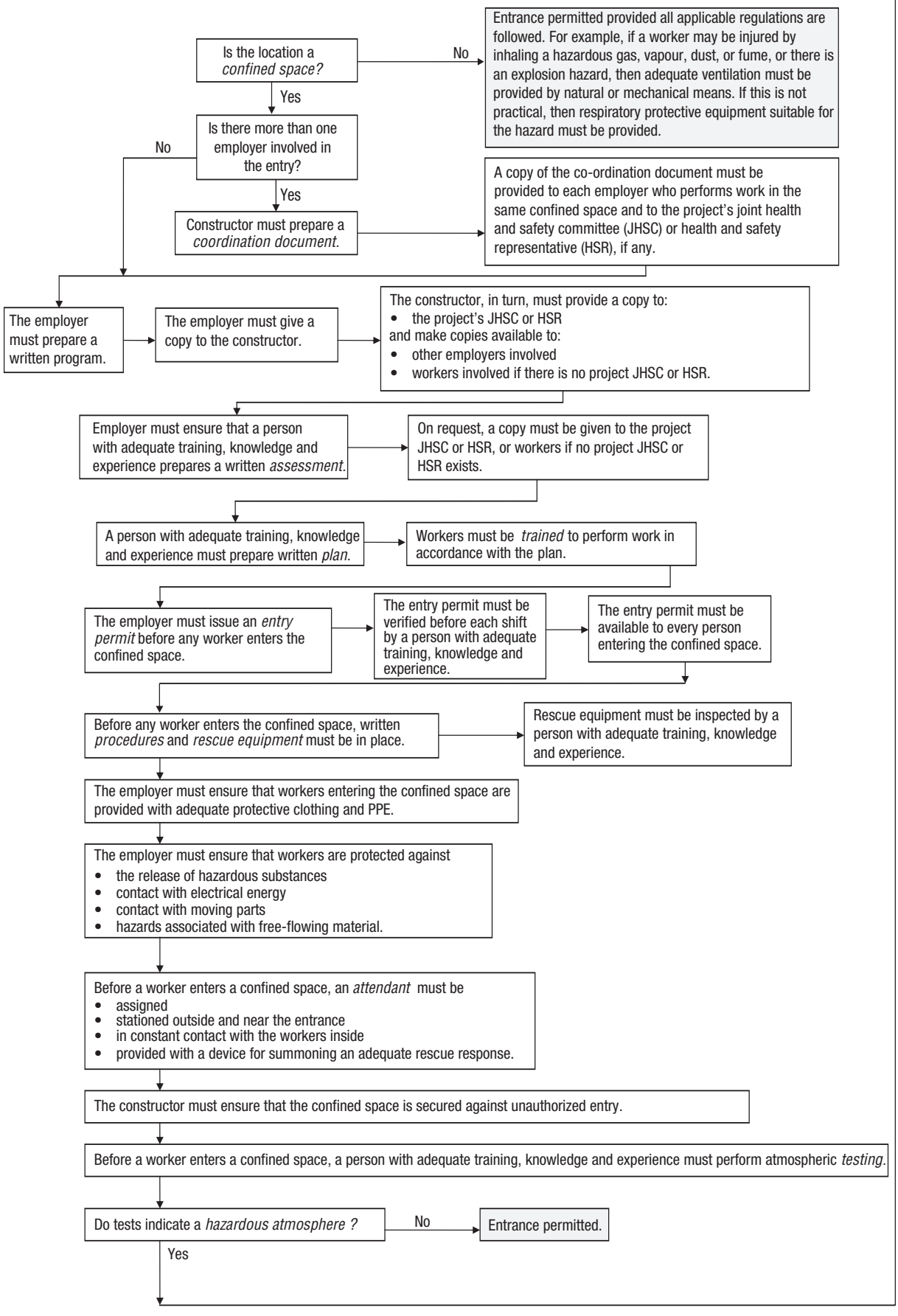


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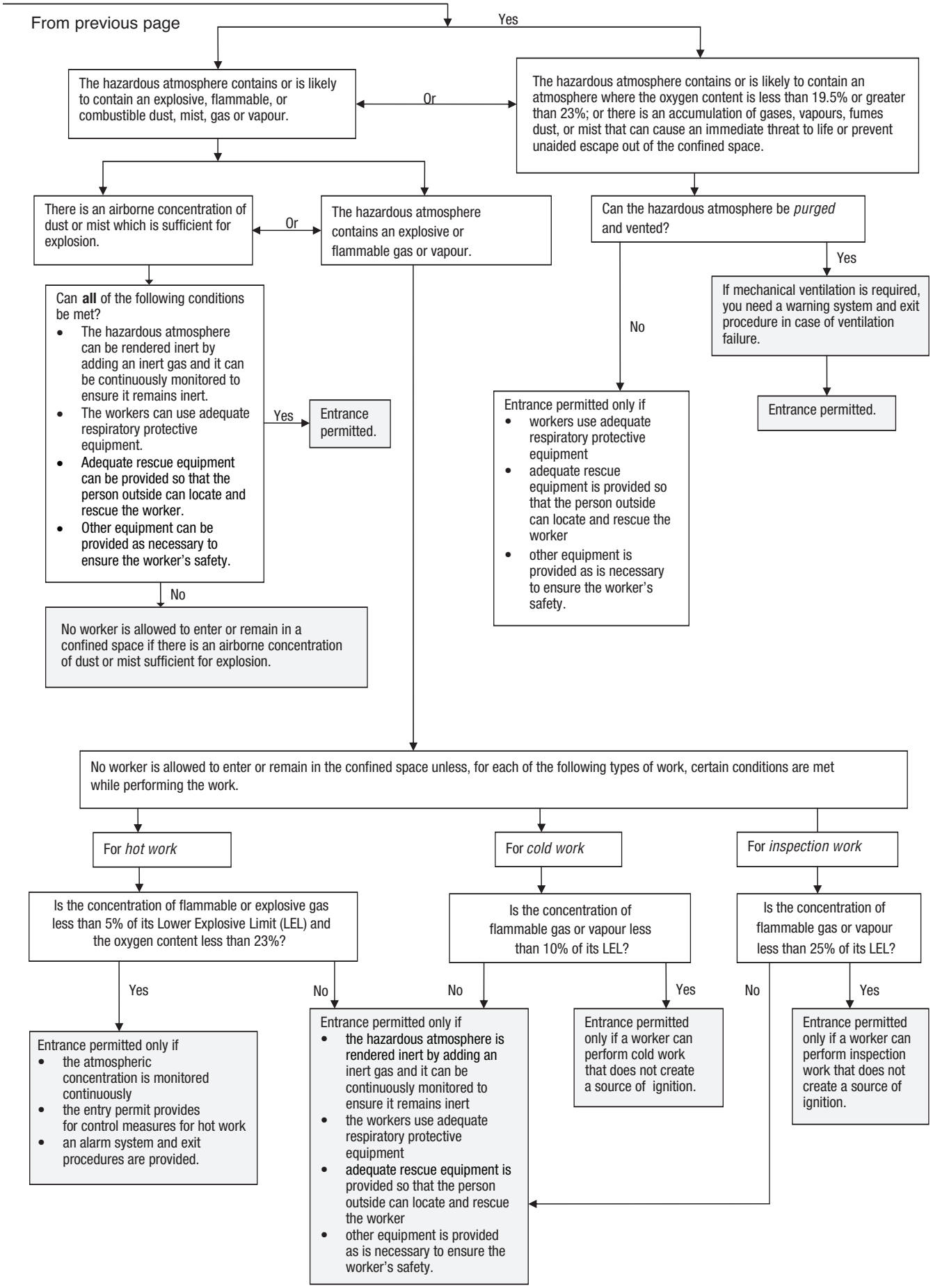
— a decision tree for confined space entry

— a sample confined space entry permit.

DECISION TREE FOR CONFINED SPACES



To next page


From previous page
Yes
The hazardous atmosphere contains or is likely to contain an explosive, flammable, or combustible dust, mist, gas or vapour.
Or
The hazardous atmosphere contains or is likely to contain an atmosphere where the oxygen content is less than 19.5% or greater than 23%; or there is an accumulation of gases, vapours, fumes dust, or mist that can cause an immediate threat to life or prevent unaided escape out of the confined space.
There is an airborne concentration of dust or mist which is sufficient for explosion.
Or
The hazardous atmosphere contains an explosive or flammable gas or vapour.
Can the hazardous atmosphere be *purged* and vented?
Yes
If mechanical ventilation is required, you need a warning system and exit procedure in case of ventilation failure.
Entrance permitted.
No
Entrance permitted only if
• workers use adequate respiratory protective equipment
• adequate rescue equipment is provided so that the person outside can locate and rescue the worker
• other equipment is provided as is necessary to ensure the worker's safety.
Can **all** of the following conditions be met?
• The hazardous atmosphere can be rendered inert by adding an inert gas and it can be continuously monitored to ensure it remains inert.
• The workers can use adequate respiratory protective equipment.
• Adequate rescue equipment can be provided so that the person outside can locate and rescue the worker.
• Other equipment can be provided as necessary to ensure the worker's safety.
Yes
Entrance permitted.
No
No worker is allowed to enter or remain in a confined space if there is an airborne concentration of dust or mist sufficient for explosion.
No worker is allowed to enter or remain in the confined space unless, for each of the following types of work, certain conditions are met while performing the work.
For *hot work*
For *cold work*
For *inspection work*
Is the concentration of flammable or explosive gas less than 5% of its Lower Explosive Limit (LEL) and the oxygen content less than 23%?
Is the concentration of flammable gas or vapour less than 10% of its LEL?
Is the concentration of flammable gas or vapour less than 25% of its LEL?
Yes
No
No
Yes
No
Yes
Entrance permitted only if
• the atmospheric concentration is monitored continuously
• the entry permit provides for control measures for hot work
• an alarm system and exit procedures are provided.
Entrance permitted only if
• the hazardous atmosphere is rendered inert by adding an inert gas and it can be continuously monitored to ensure it remains inert
• the workers use adequate respiratory protective equipment
• adequate rescue equipment is provided so that the person outside can locate and rescue the worker
• other equipment is provided as is necessary to ensure the worker's safety.
Entrance permitted only if a worker can perform cold work that does not create a source of ignition.
Entrance permitted only if a worker can perform inspection work that does not create a source of ignition.

Sample confined space entry permit

Employer name _____ Project name _____

Date _____ Permit end time _____

Assessment performed by _____ Permit start time _____

Location of confined space (or spaces if they are similar)
Description of confined space (or spaces if they are similar)
Description of work to be performed

Monitoring equipment

Air testing equipment	Serial #	Last calibrated

Air quality results

	Location:			Location:			Location:		
	Test # 1	2	3	Test # 1	2	3	Test # 1	2	3
Time of test									
Oxygen %									
Combustibles %									
Atmospheric hazard:									
Atmospheric hazard:									
Atmospheric hazard:									
Other:									

Tester's name _____ Signature _____

Controls

Atmospheric hazards (existing or introduced)		Hazard controls		Personal protective equipment (type)
Flammable	☐	Purge using mechanical ventilation equipped with warning device in case of failure.	☐	Respirator _____
Toxic	☐			Gloves _____
Corrosive	☐			Boots _____
Oxygen deficient	☐			Coveralls _____
Oxygen enriched	☐	Natural ventilation (re-test/air quality)	☐	Eye protection_____
Other:_____	☐			Other: _____
		Continuous monitoring	☐	
		Other:_____	☐	

Physical hazards		Hazard controls		Personal protective equipment (type)	
Hot temperature	☐	Ventilation	☐	Hearing protection	☐
Cold	☐	De-energize, lockout	☐	Anti-vibration gloves	☐
Noise	☐	Blank, disconnect	☐	Other gloves: _____	☐
Electricity	☐	GFCI cords	☐	Goggles	☐
Vibration	☐	Lighting	☐	Fall protection	☐
Slippery surface	☐	Other:_____	☐	Other:_____	☐
Lighting	☐				
Working at height	☐				
Moving machinery	☐				
Influx of liquid	☐				
Influx of gas	☐				
Hazard above	☐				
Other:_____	☐				

Attendant

Attendant's name _____ Signature _____

Communications

Method of communication with workers	Method of communication to summon rescue
_____	_____

Onsite rescue

Adequate number of trained persons are available to implement rescue procedures	☐

Appropriate rescue equipment is readily available to be used for a rescue	☐	Appropriate rescue equipment has been inspected and is in good working order:	☐
List of equipment required for entry		☐ Respirator	☐ Coveralls
Tripod ☐	Harness ☐	Winch/cable ☐	Other:_____

Rescue Plan

_____

_____

_____

_____

_____

Training

Names of workers approved for entry	Has confined space training	Trained in the entry plan	Time of entry	Time of exit

Hot work (complete if hot work will be conducted)

Will space be rendered inert by adding inert gas? Yes ❑ No ❑

If "yes," ensure the following.

- ☐ Space is monitored continuously to ensure it remains inert
- ☐ Worker(s) entering use adequate respiratory equipment. List equipment:_____
- ☐ There is adequate equipment to allow persons outside to locate and rescue worker. List equipment: _____
- ☐ There is other equipment necessary to ensure safety of worker. List equipment: _____
  _____

If "no," ensure the following.

Flammable gas is maintained below 5% of its LEL by purging and continuous ventilation.	O_2 content is maintained below 23%.	Atmosphere will be monitored continuously.	Alarm and exit procedures are in place should the LEL exceed 5% or the O_2 exceed 23%.
☐	☐	☐	☐

Supervisor's name _____ Signature _____

28 BACKING UP

Reversing vehicles and equipment on construction projects pose a serious problem for personnel on foot.

Fatal accidents resulting from workers being backed over by dump trucks and other equipment occur all too frequently.

Anyone on foot in the vicinity of reversing vehicles and equipment is at risk. More then 20 deaths have occurred on construction sites over a ten-year period as a result of reversing vehicles.

Blind Spots

The main problem with reversing vehicles and equipment is the driver or operator's restricted view.

Around dump trucks and heavy equipment such as bulldozers and graders there are blind spots where the operator has no view or only a very limited view.

The operator may not see someone standing in these blind spots. Anyone kneeling or bending over in these areas would be even harder to see.

Consequently the driver or operator must rely on mirrors or signallers to back up without running over someone or into something. Figure 1 shows the blind spots for common types of construction equipment.

Dump trucks and cranes are the kinds of equipment that hit overhead powerlines most often. Beware of powerline contact whenever a crane, dump truck, or other vehicle is going to be operated near an overhead electrical conductor. If equipment operates within reach of (and could therefore encroach on) the minimum permitted distance from an overhead powerline (see the chapter on Electrical Hazards in this manual), the constructor is required to have written procedures in place to prevent the equipment from encroaching on the minimum distance.

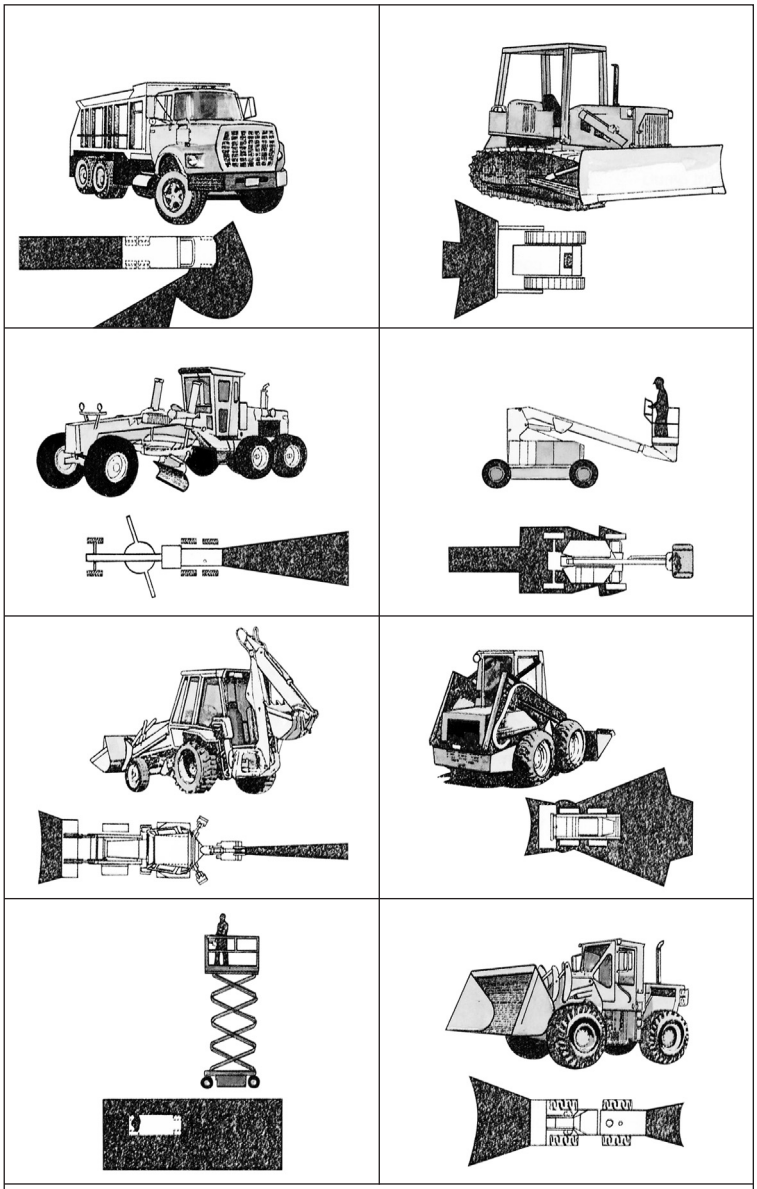


Figure 1 – Dark areas indicate operator blind spots.

Accident Prevention

To prevent injuries and deaths caused by vehicles and equipment backing up, there are four basic approaches:

1) site planning
2) signallers
3) training
4) electronic devices.

Site planning

Wherever possible, site planners should arrange for drive-through operations to reduce the need for vehicles to back up (Figure 2).

Foot traffic should be minimized where trucks and equipment operate in congested areas such as excavations. Where feasible, a barricade can help to

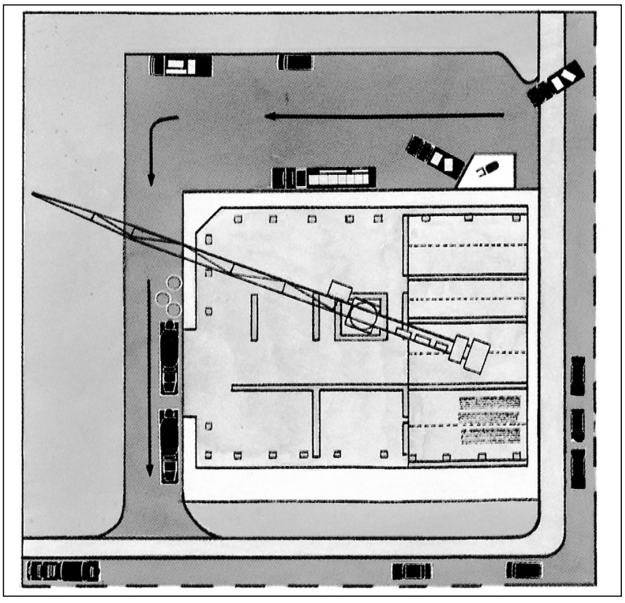


Figure 2

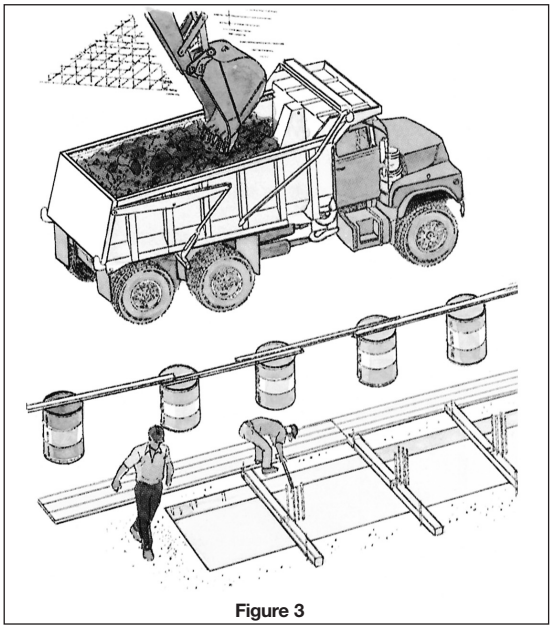


Figure 3

protect workers: (e.g., by keeping excavation work separate from forming operations as in Figure 3.)

The hazards of reversing vehicles can also be reduced through separate access for workers on foot. Where possible, for instance, a scaffold stair system should be provided for worker access to deep excavations.

Near loading and unloading areas, pedestrian walkways can be roped off or barricaded.

Signallers

On some projects, you cannot avoid having reversing vehicles or equipment on site. Often, they must share an area with other vehicles and operating equipment—as well as workers on foot.

You must have a signaller or spotter when

a) a vehicle or equipment operator's view of the intended path of travel is obstructed
b) a person could be endangered by the operation of the vehicle or equipment, or by its load
c) any part of the equipment could encroach on the minimum distance to an overhead powerline (see the chapter on Electrical Hazards in this manual for minimum distances).

A signaller must be a competent worker and must not have any other duties to fulfill while acting as a signaller.

Before a worker can act as a signaller, the employer must ensure that the worker has been given adequate oral and written instructions in a language that he or she understands. The employer must keep on site a copy of the written instructions and a record of the worker's training.

A signaller must wear a garment—usually a nylon vest—that is fluorescent or bright orange, with 2 vertical 5-centimetre-wide yellow stripes on the front and 2 similar stripes forming a diagonal "X" pattern on the back. These stripes must be retro-reflective and fluorescent. The vest must have an adjustable fit and have a front and side tear-away feature.

If a signaller has to work during the night, he or she must wear retro-reflective silver stripes around each arm and leg.

The signaller must maintain clear view of the path that the vehicle, machine, or load will be travelling and must be able to watch those parts of the vehicle, equipment, or load that the operator cannot see. The signaller must maintain clear and continuous visual contact with the operator at all times while the vehicle or equipment is moving (Figure 4), and must be able to communicate with the operator using clearly understood, standard hand signals (Figure 5). The signaller must warn other workers on foot of the approaching vehicle or equipment, and must alert the operator to any hazards along the route.

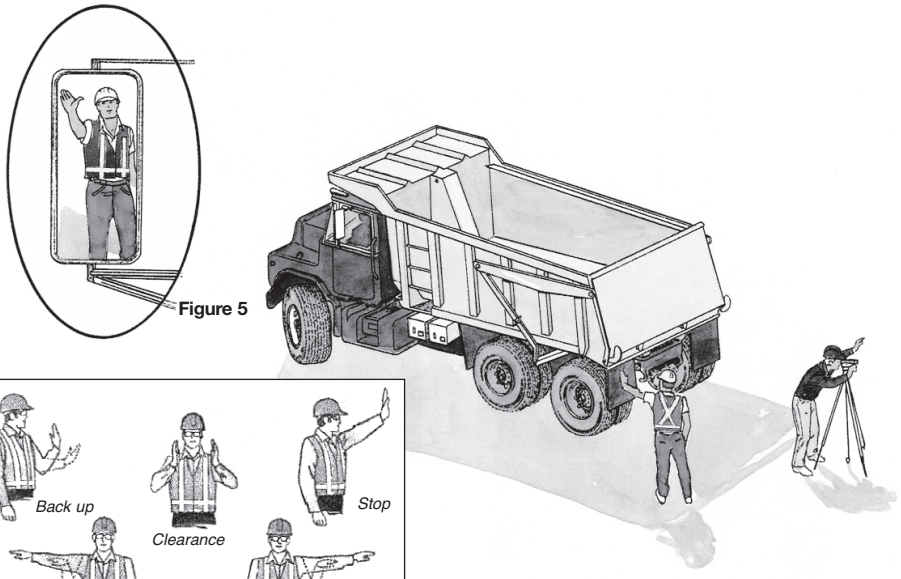


Figure 5

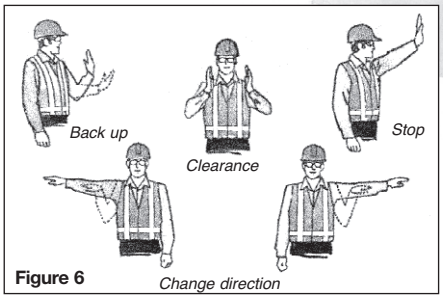


Figure 6

Training

Instruction for drivers, operators, signallers, and workers on foot is essential to reduce the hazards created by reversing vehicles and equipment.

For example, all construction personnel must be made familiar with blind spots—the areas around every vehicle that are partly or completely invisible to the operator or driver, even with the help of mirrors (Figure 1).

Specific training can then focus on the following points.

Workers on Foot

- Know how to work safely around trucks and operating equipment.
- Understand the effect of blind spots (Figure 7).
- Avoid entering or standing in blind spots.
- **Make eye contact with the driver or operator before approaching equipment.**
- Signal intentions to the driver or operator.
- When possible, use separate access rather than vehicle ramps to enter and exit the site.
- Avoid standing and talking near vehicle paths, grading operations, and other activities where heavy equipment is moving back and forth.

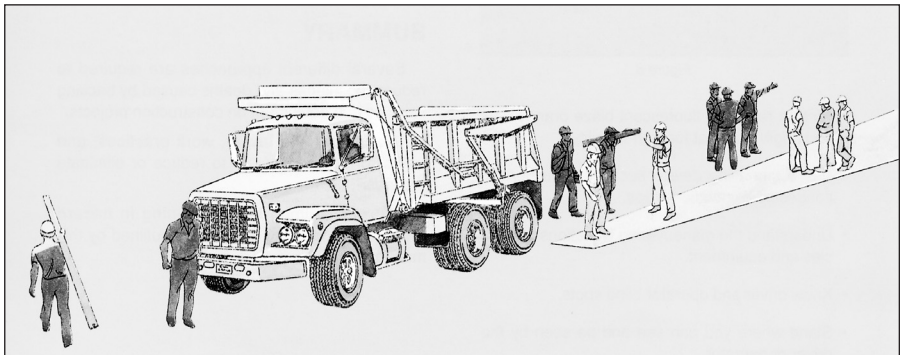


Figure 6 - *This illustration shows how some personnel on foot are visible to the driver while others are not. The driver cannot see the dark figures because they are passing through blind spots at the front and rear of the truck.*

Drivers and Operators

- Always obey the signaller or spotter. If more than one person is signalling, stop your vehicle and determine which one to obey.
- If possible, remain in the cab in areas where other equipment is likely to be backing up.
- Make sure that all mirrors are intact, functional, and properly adjusted for the best view.
- Blow the horn twice before backing up.
- When no spotter is present, get out and quickly walk around your vehicle. If the way is clear, back up at once (Figure 7).
- Stop the vehicle when a spotter, worker, or anyone else disappears from view.

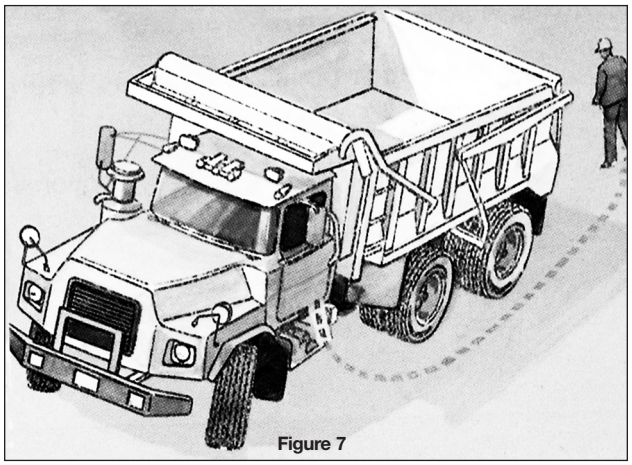


Figure 7

Signallers

- Stay alert to recognize and deal with dangerous situations.
- Know and use the standard signals for on-site traffic (Figure 5).
- Wear a reflective fluorescent or bright orange vest and a bright hard hat for high visibility.
- Use a signalling device such as a bullhorn in congested excavation areas.
- Understand the maneuvering limitations of vehicles and equipment.
- Know driver and operator blind spots.
- Stand where you can see and be seen by the driver or operator.
- Make eye contact with driver or operator before signalling or changing location.

Electronic Devices

Since 2000, automatic audible alarms that signal when a vehicle is being operated in reverse have been required on dump trucks.

Alarms offer the greatest benefit when traffic is limited to only one or two vehicles. The warning effect of the alarm is greatly reduced, however, when it simply becomes part of the background noise on-site.

This is a common shortcoming with devices that sound continuously when the transmission is put in reverse, especially in areas where several vehicles are operating at once.

Newer devices using a type of radar to sense objects or people within a pre-set radius appear to be more effective but are not readily available or widely used.

Other technologies such as infrared or heat sensors and closed-circuit television are limited by the effects of vibration, dust, and dirt—conditions all too common on construction sites.

10 PERSONAL PROTECTIVE EQUIPMENT

INTRODUCTION

Personal protective equipment (PPE) is something all construction workers have in common.

PPE is designed to protect against safety and/or health hazards. Hard hats, safety glasses, and safety boots, for instance, are designed to prevent or reduce the severity of injury if an accident occurs.

Other PPE, such as hearing and respiratory protection, is designed to prevent illnesses and unwanted health effects.

It is important to remember that PPE only provides protection. It reduces the risk but does not eliminate the hazard.

This manual's chapters on particular kinds of PPE will enable users to

- assess hazards and select a suitable control method
- locate and interpret legislation related to PPE
- effectively use and maintain PPE.

Legal Requirements

While common to all trades, PPE varies according to individual, job, and site conditions.

Legal requirements for personal protective equipment also vary and the appropriate sections of the construction regulation (O. Reg. 213/91) under the *Occupational Health and Safety Act* should be consulted.

The *Occupational Health and Safety Act* makes employers and supervisors responsible for ensuring that required PPE is worn. This does not mean that the employer must provide PPE but only ensure that it is provided by someone.

Workers, meanwhile, have a duty under the Act to wear or use PPE required by the employer. This addresses situations where the regulations may not require PPE but the employer has set additional health and safety standards, such as mandatory eye protection.

The construction regulation (O. Reg. 213/91) broadly requires that such protective clothing, equipment, or devices be worn "as are necessary to protect the worker against the hazards to which the worker may be exposed." It also requires that the worker be trained in the use and care of this equipment.

Control Strategies

Personal protective equipment should be the last resort in defence. Better alternatives lie in engineering controls that eliminate as much of the risk as possible. Engineering controls fall into five categories:

- substitution
- alternative work methods
- isolation
- enclosure
- ventilation.

Substitution

This control substitutes a less toxic chemical that can do the same job. A common example is the substitution of calcium silicate or fibreglass insulation for asbestos insulation. Substitution is an effective control as long as the substitute is less hazardous.

Alternative Work Methods

This simply means doing the job in a way which is less hazardous. For example, brushing or rolling paint produces much lower vapour levels than spray painting. Similarly, wet removal of asbestos releases up to 100 times less dust than dry removal. The change should be checked to ensure that it is safer.

Isolation

Isolation isolates the worker from the hazard. In a quarry, for example, the operator of a crusher can be isolated from dust by a filtered, air-conditioned cab.

Enclosure

A substance or procedure may be enclosed to contain toxic emissions. It may be as simple as putting a lid on an open solvent tank or enclosing asbestos removal projects with polyethylene sheeting (Figure 1). Enclosures have also been built around compressors to reduce the noise level. Enclosures must not restrict access when maintenance is required.

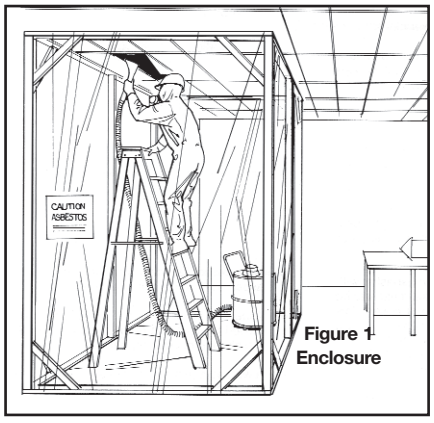
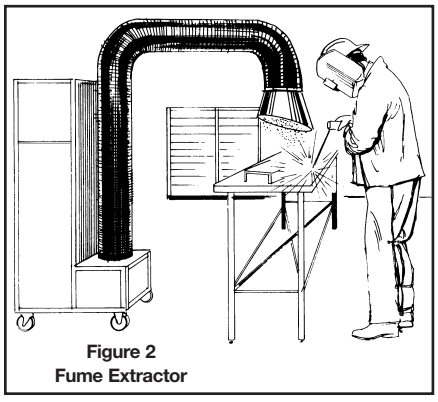


Figure 1
Enclosure

Ventilation

A common engineering control is to dilute the contaminant in the air by using general ventilation. Local ventilation is better because it removes the contaminant. General ventilation may employ fans to move large volumes of air and increase air exchange. This is not suitable, however, for highly toxic materials.


Figure 2
Fume Extractor

Local ventilation captures and removes contaminants at their source. At a shop bench, a fume hood can be constructed to remove dusts and fumes. On sites, portable fume extractors (Figure 2) can be used. Remember: many filtering systems can only remove fumes—not gases or vapours.

Personal Protective Equipment

When it is not possible to apply any of the five engineering controls, personal protective equipment may be the last resort.



CSA logo

Regulations often refer to Canadian Standards Association (CSA) or other equipment standards as a convenient way to identify equipment which meets requirements and is acceptable. CSA-certified equipment can be identified by the CSA logo. For instance, there are CSA standards for

- Head Protection - CSAZ94.1
- Eye Protection - CSAZ94.3
- Foot Protection - CSAZ195

For respiratory protection, National Institute for Occupational Safety and Health (NIOSH) standards and approvals are usually referenced throughout North America.

For life jackets, Transport Canada certification is the standard reference.

See the following chapters on particular kinds of PPE.

12 HEAD PROTECTION

Standards

Requirements for head protection are specified in the current edition of the construction regulation (O. Reg. 213/91).

Under this regulation, hard hats are mandatory for all construction workers on the job in Ontario. The hard hat must protect the wearer's head against impact and against small flying or falling objects, and must be able to withstand an electrical contact equal to 20,000 volts phase to ground.

At the present time, the Ministry of Labour (MOL) considers the following classes of hard hats to be in compliance with the regulation.

CSA

- Z94.1-05: Class E, Type 1
- Z94.1-05: Class E, Type 2
- Z94.1-1992: Class E

ANSI

- ANSI Z89.1-2009: Class E, Type I
- ANSI Z89.1-2009: Class E, Type II
- ANSI Z89.1-2003: Class E, Type I
- ANSI Z89.1-2003: Class E, Type II

The "Type" and "Class" of hard hat can be identified by the CSA or ANSI label. Some manufacturers also stamp the CSA or ANSI classification into the shell of the hard hat under the brim. Other markings that should be found here include:

a) manufacturer's identity

b) model

c) class and type (e.g. Class E, Type 2)

d) reverse orientation mark if applicable

e) year and month of manufacture

f) size or size range

g) the following wording

This protective headwear is designed to absorb some of the energy of a blow through destruction of its component parts and, even though damage may not be apparent, any partial protective headwear subjected to severe impact should be replaced.

This protective headwear must not be painted or cleaned with solvents. Any decals applied to the protective headwear must be compatible with the surface material and known not to affect adversely the characteristics of the materials used in the protective headwear.

Any addition or structural modification may reduce the protective properties afforded by this protective headwear.

Styles

Class E hard hats come in three basic styles:

1) standard design with front brim, rain gutter, and attachment points for accessories such as hearing protection

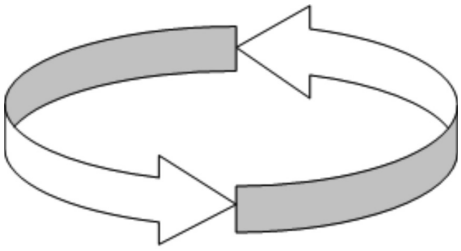
2) standard design with front brim and attachment points for accessories, but without a rain gutter

3) full-brim design with attachment points for accessories and brim that extends completely around the hat for greater protection from the sun.

Reversible Hard Hats

You should normally wear your hard hat facing forward. A hard hat should be worn in reverse only if

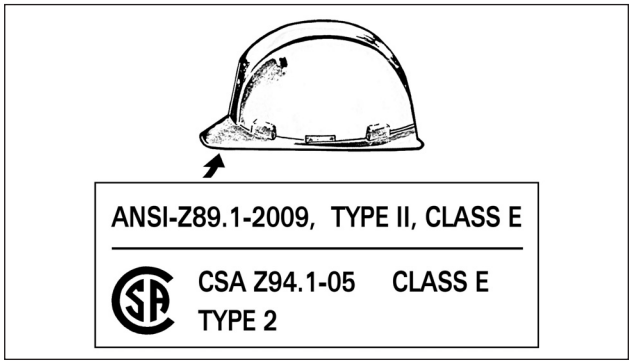
1) the hard hat has a reverse orientation mark as shown below



2) the job, task, or work environment necessitates wearing it backward (e.g. a face shield or welding helmet).

Use and care of hard hats

Always consult the manufacturer's instructions for use and care instructions of your hard hat. For instance, the instructions should indicate the service life of your hard hat. You may also need to know what components of the hard hat must be inspected before each use.



CSA label, stamped into the shell, indicating Class E, Type 2 hard hat

Figure 20

13 FOOT PROTECTION

Ankle injuries represent 65 per cent of all foot injuries in Ontario construction. Properly worn, a CSA-certified Grade 1 workboot meets the requirements of the current construction regulation (O. Reg. 213/91) and helps protect against ankle and other injuries.

One of three CSA grades, Grade 1 offers the highest protection and is the only one allowed in construction. In a Grade 1 boot, a steel toe protects against falling objects while a steel insole prevents punctures to the bottom of the foot.

Grade 1 boots can be identified by

- a green triangular patch imprinted with the CSA logo on the outside of the boot and
- a green label indicating Grade 1 protection on the inside of the boot.

Grade 1 boots are also available with metatarsal and dielectric protection. A white label with the Greek letter Omega in orange indicates protection against electric shock under dry conditions.



Greek Omega Label

Selection and Fit

Grade 1 boots are available in various styles and sole materials for different types of work. For example, Grade 1 rubber boots may be better suited than leather boots for sewer and watermain or concrete work.

Boots should provide ample “toe room” (toes about 1/2 inch back from the front of steel box toe cap when standing with boots laced).

When fitting boots, allow for heavy work socks. If extra sock liners or special arch supports are to be worn in the boots, insert these when fitting boots.

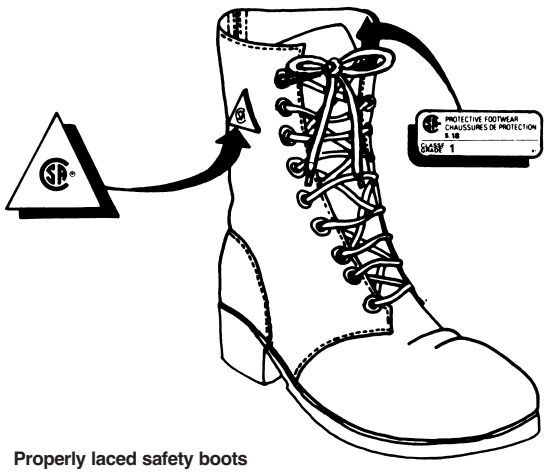
Care and Use

Lacing boots military style permits rapid removal. In an emergency, the surface lace points can be cut, quickly releasing the boot.

In winter, feet can be kept warm by wearing a pair of light socks covered by a pair of wool socks. Feet should be checked periodically for frostbite.

Use high-cut (260 mm or 9 in) or medium-cut (150 mm or 6 in) CSA Grade 1 workboots. The higher cut helps support the ankle and provides protection from cuts or punctures to the ankle.

Figure 21



Properly laced safety boots with CSA labels

11 EYE PROTECTION

With the permission of the Canadian Standards Association, some information in this chapter is reproduced from CSA Standard CAN/CSA-Z94.3-07, Industrial Eye and Face Protectors, *which is copyrighted by Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Ontario M9W 1R3. While use of this material has been authorized, CSA shall not be responsible for the manner in which the information is presented, nor for any interpretations thereof.*

Introduction

Eye protection is not the total answer to preventing eye injuries. Education regarding proper tools, work procedures, hazard awareness, and the limitations of eye protection is also very important. Like any other manufactured product, eye protection has material, engineering, and design limitations. But proper eye protection, selected to match the specific construction hazard, combined with safe work procedures, can help to minimize the number and severity of eye injuries.

When we consider that one out of every two construction workers may suffer a serious eye injury during their career, the importance of wearing proper eye protection cannot be over-emphasized. In the hazardous environment of the construction industry, wearing proper eye protection should be considered a labour-management policy, not a matter of individual preference.

Classes of Eye Protectors

Before outlining the type(s) of eye protectors recommended for a particular work hazard, it is necessary to explain the various types of eye protectors available. Eye protectors are designed to provide protection against three types of hazards — impact, splash, and radiation (visible and invisible light rays) — and, for purposes of this manual, are grouped into seven classifications based on the CSA Standard Z94.3-07, *Industrial Eye and Face Protectors.*

The seven basic classes of eye protectors are: spectacles, goggles, welding helmets, welding hand shields, hoods, face shields, and respirator facepieces.

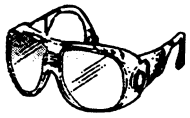
Class 1 – Spectacles (Figure 3)

CSA Standard Z94.3-07 requires that Class 1 spectacles incorporate side protection. Most side shields are permanently attached to the eyewear, but some may be detachable.

Figure 3 – Examples of Class 1 Spectacles



Class 1A
Spectacles with side protection



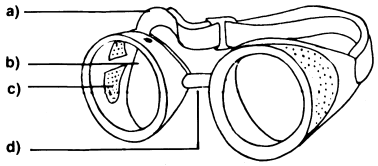
Class 1B
Spectacles with side and radiation protection

Class 2 – Goggles

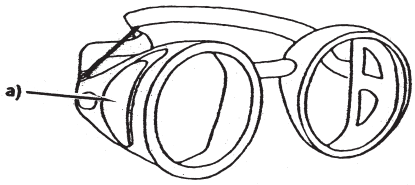
There are two types of goggles — eyecup and cover. Both must meet the CSA Z94.3-07 Standard.

Eyecup goggles (Figure 4) completely cover the eye socket to give all-round protection. They have adjustable or elasticized headbands and are equipped with ventilation ports to allow passage of air and prevent fogging. Some have direct ventilation ports which prevent the direct passage of large particles, but do not exclude dust or liquids. Others have indirect ventilation ports which prevent the passage of particles, dust, and liquids. There are also models available with an adjustable chain bridge.

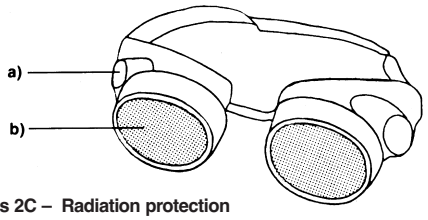
Figure 4 – Eyecup Goggles



Class 2A – Direct ventilated goggles for impact protection
Eyecup goggles with direct ventilation openings or ports. These openings exclude direct passage of large particles. They do not exclude dust and splash. a) headband; b) lens; c) direct ventilation port; d) bridge.



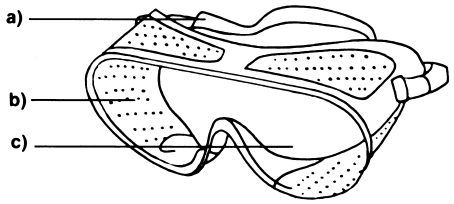
Class 2B – Non-ventilated and indirect ventilated goggles for impact, dust, and splash protection
Eyecup goggles with indirect ventilation ports to exclude direct passage of dust or liquids. These goggles are identical to class 2A except for the type of ventilation ports. a) indirect ventilation port.



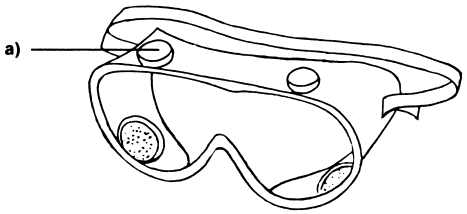
Class 2C – Radiation protection
Eyecup goggles for radiation protection with indirect ventilation ports not only to allow passage of air and prevent fogging, but also to exclude light. The lenses in these goggles are filter lenses. a) indirect ventilation port; b) filter lens.

Cover goggles (Figure 5) are designed to be worn over spectacles. They have adjustable or elasticized headbands and are equipped with direct or indirect ventilation ports to allow passage of air and prevent fogging.

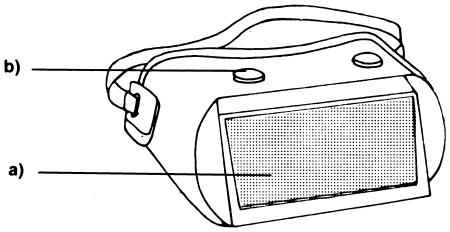
Figure 5 – Cover Goggles



Class 2A – Direct ventilated goggles for impact protection
Cover goggles with direct ventilation ports. (This type normally incorporates a soft-frame goggle.) As in class 2A eyecup goggles, these openings or ports exclude direct passage of large particles. They do not exclude dust and splash. a) headband; b) direct ventilation port; c) lens.



Class 2B – Non-ventilated and indirect ventilated goggles for impact, dust, and splash protection
Cover goggles for dust and splash with indirect ventilation ports to exclude direct passage of dust or liquid. a) indirect ventilation port.



Class 2C – Radiation Protection
Cover goggles for radiation protection. a) filter lens; b) indirect ventilation port.

Class 3 – Welding Helmets (Figure 6)

This class provides radiation and impact protection for face and eyes. There are two types of welding helmets available — the stationary plate helmet and the lift-front or flip-up plate helmet. There are also special models incorporating earmuff sound arrestors and air purification systems. Special magnifying lens plates manufactured to fixed powers are available for workers requiring corrective lenses.

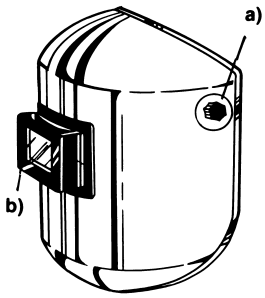


Figure 6 – Welding Helmets

Lift-front helmets or shields have three plates or lenses – a filter or shaded plate made of glass or plastic in the flip-up cover, along with a clear thin glass or plastic outer lens to keep it clean, and a clear, impact-resistant plastic or glass lens mounted in the helmet itself. a) hard hat attachment; b) flip-up lens holder.

Stationary plate helmets are similar to lift-front helmets except for the fact that they have a single filter lens plate, normally 51mm x 108mm (2" x 4-1/4") in size, or a larger plate 114mm x 113mm (4-1/2" x 5-1/4") in size which is more suitable for spectacle wearers.

The filter or shaded plate is the radiation barrier. Arc welding produces both visible light intensity and invisible ultraviolet and infrared radiation. These ultraviolet rays are the same type of invisible rays that cause skin burning and eye damage from overexposure to the sun. However, ultraviolet rays from arc welding are considerably more severe because of the closeness of the eyes to the arc and lack of atmospheric protection. In arc welding, therefore, it is necessary to use a filter plate of the proper lens shade number to act as a barrier to these dangerous light rays and to reduce them to the required safe degree of intensity. For proper welding shade numbers, see Table 1.

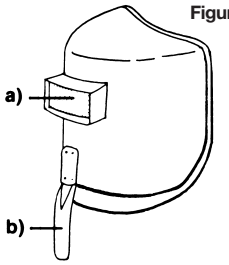
In addition to common green filters, many special filters are also available. Some improve visibility by reducing yellow or red flare; others make the colour judgment of temperature easier. A special gold coating on the filter lens provides additional protection by reflecting radiation.

Class 4 – Welding Hand Shields (Figure 7)

Welding hand shields are designed to give radiation and impact protection for the face and eyes.

NOTE: With welding helmets and hand shields, the user is continually lifting and lowering the visor. To protect the eyes when the visor is lifted, Class 1 spectacles should be worn underneath.

Figure 7 – Hand Shields



Hand-held shields or inspectors' shields are similar to Class 3 welding helmets except that there are no lift-front type models. a) stationary plate; b) handle.

Class 5 – Hoods (Figure 8)

Non-rigid helmets or hoods come with impact-resistant windows usually made of plastic. An air-supply system may also be incorporated. Hoods may be made of non-rigid material for use in confined spaces and of collapsible construction for convenience in carrying and storing.

Hood types include

5A	with impact-resistant window
5B	for dust, splash, and abrasive materials protection
5C	with radiation protection
5D	for high-heat applications.

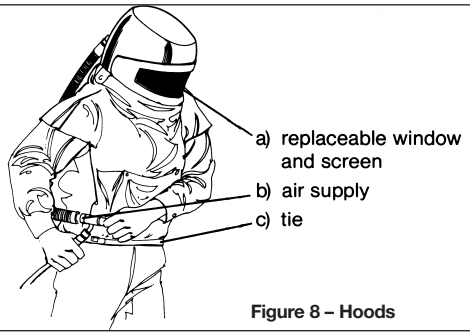


Figure 8 – Hoods

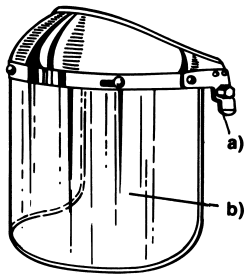
Class 6 – Face Shields (Figure 9)

Face shields are just what the name implies—a device that includes a transparent window or visor to shield the face and eyes from impact, splash, heat, or glare. With face shields, as with welding helmets and hand shields, the user is continually lifting and lowering the visor. To protect the eyes when the visor is lifted, Class 1 spectacles should be worn underneath. Face shields may also be equipped with an adjustable spark deflector or brow guard that fits on the worker's hard hat. Shaded windows are also available to provide various degrees of glare reduction; however, they do not meet the requirements of CSA Standard Z94.3-07 *Industrial Eye and Face Protectors* for ultraviolet and total heat protection and should not be used in situations where any hazard is present from ultraviolet or infrared radiation.

Class 6

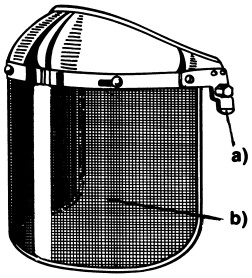
This class includes
6A for impact and splash protection
6B for radiation protection
6C for high-heat applications.

Figure 9 – Face Shields



Class 6A
Face shield for impact, piercing, splash, head, and glare protection.
a) hard hat attachment; b) face shield (window).

Class 6B
Face shield for light non-piercing impact, splash, low heat, and glare protection. The major difference between 6A and 6B is the degree of thickness in the shield.

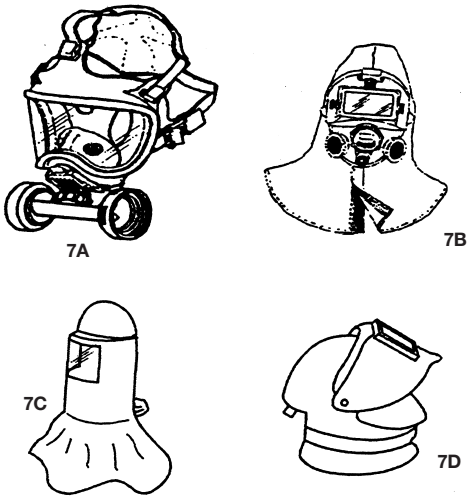


Class 6C
Face shield for light non-piercing impact and high heat protection only (usually wire screen windows). a) hard hat attachment; b) wire screen.

Class 7 – Respirator Facepieces (Figure 10)

This class includes
7A for impact and splash protection
7B for radiation protection
7C with loose-fitting hoods or helmets
7D with loose-fitting hoods or helmets for radiation protection.

Figure 10 – Respirator Facepieces



Hazards and Recommended Protectors

Reprinted from CSA Standard Z94.3-07 *Industrial Eye and Face Protectors*, Table 2 classifies the main eye hazards and outlines the types of protectors recommended for each. Each situation requires that all hazards be considered in selecting the appropriate protector or combination of protectors.

The practice of requiring all personnel to wear spectacles is strongly recommended. Spectacles should be worn underneath Classes 3, 4, 5, 6, or 7 protectors, where the hazard necessitates the use of spectacles.

The following classifications provide a general overview of eye protectors for each hazard group. For specific hazards, refer to Table 2 at the end of this chapter. Note that the best eye protection results from a combination of different classes of eye protectors.

Group A: Flying Objects (Figure 11)

Minimum eye protection recommended:
Class 1 spectacles

Optimum eye protection recommended:
Goggles worn with face shields to provide eye and face protection.

Group B: Flying Particles, Dust, Wind, etc. (Figure 12)

Minimum eye protection recommended:
Class 1 spectacles

Optimum eye protection recommended:
Goggles (for dust and splash) worn with face shields to provide eye and face protection.

Group C: Heat, Glare, Sparks, and Splash from Molten Metal (Figure 13)

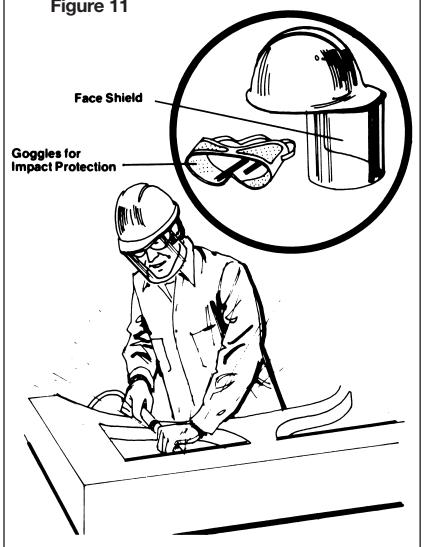
Minimum eye protection recommended:
Class 1 spectacles with filter lenses for radiation protection. Side shields must have filtering capability equal to or greater than the front lenses.

Optimum eye protection recommended:
Eyecup or cover goggles with filter lenses for radiation protection, worn with face shields to provide eye and face protection.

Table 1: Recommended Shade Numbers for Arc Welding and Cutting

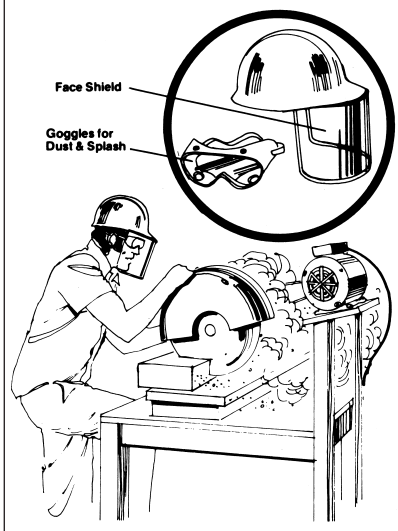
Operation	Current in amperes (0.5 2.5 10 20 40 80 125 175 225 275 350 450 / 1.0 5.0 15 30 60 100 150 200 250 300 400 500)
SMAW (covered electrodes)	7 | 8 | 10 | 11
GMAW (MIG)	7 | 10 | 10 | 10
GTAW (TIG)	8 | 8 | 10
Air carbon arc cutting	10
Plasma arc cutting	8 | 9 | 10
Plasma arc welding	6 | 8 | 10 | 11
	1.0 5.0 15 30 60 100 150 200 250 300 400 500

Figure 11



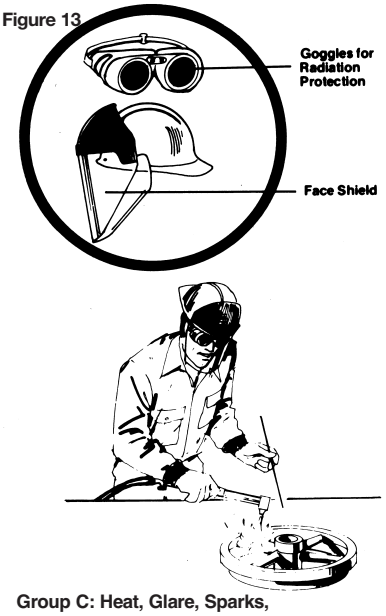
Group A: Flying Objects (Chipping)

Figure 12



Group B: Flying Particles, Dust, Wind, etc. (Sawing)

Figure 13



Group C: Heat, Glare, Sparks, and Splash (Brazing)

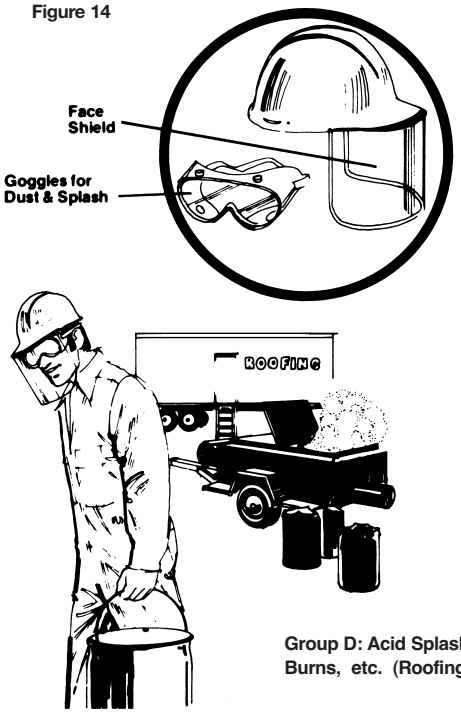
Group D: Acid Splash, Chemical Burns, etc. (Figure 14)

Only eye protection recommended:

Eyecup or cover goggles (for dust and splash) worn with face shields to provide eye and face protection.

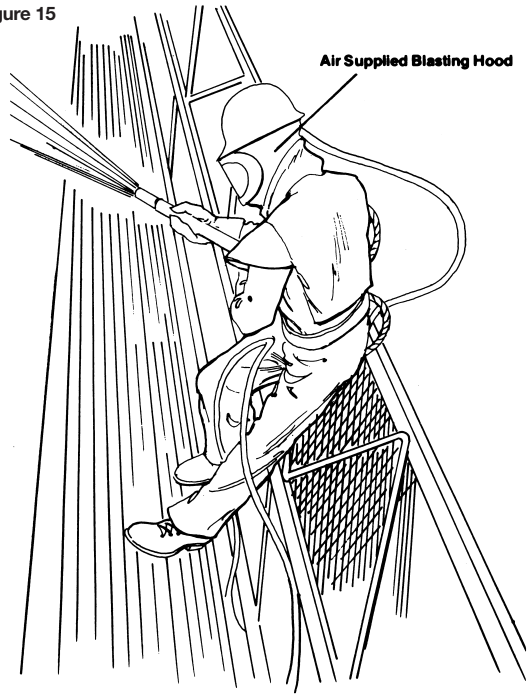
Hoods may also be required for certain hazardous activities such as chemical spraying.

Figure 14



Group D: Acid Splash, Chemical Burns, etc. (Roofing)

Figure 15



Group E: Abrasive Blasting

Group E: Abrasive Blasting Materials (Figure 15)

Minimum eye protection recommended:

Eyecup or cover goggles for dust and splash.

Optimum eye protection recommended:

Hoods with an air line.

Group F: Glare, Stray Light (Figure 16)

These are situations where only slight reduction of visible light is required (e.g., against reflected welding flash). Stray light would result from passing by a welding operation and receiving a flash from the side without looking directly at the operation.

Minimum eye protection recommended:

Filter lenses for radiation protection. Side shields must have filtering capability equal to or greater than the front lenses.

Optimum eye protection recommended:

Goggles with filter lenses for radiation protection. See Table 1 for recommended shade numbers.

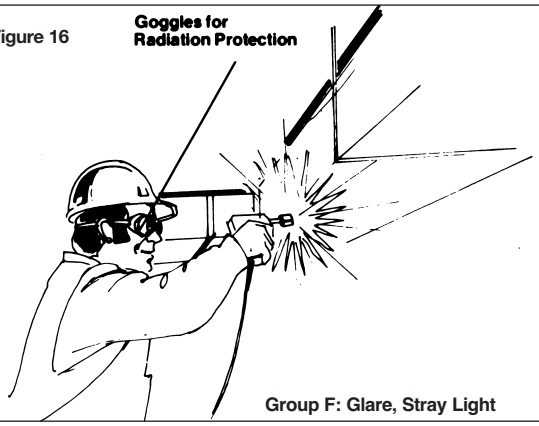
Group G: Injurious Radiation (Figure 17)

These are situations where only moderate reduction of visible light is required: for example, gas welding. Injurious radiation would result from looking directly at the welding operation.

Only eye protection recommended:

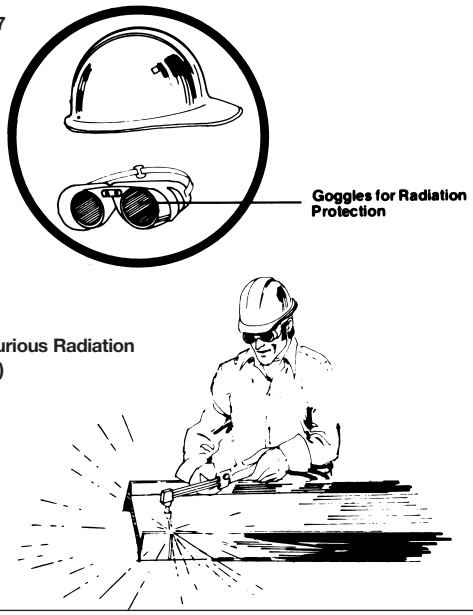
Goggles with filter lenses for radiation protection.

Figure 16



Group F: Glare, Stray Light

Figure 17



Group G: Injurious Radiation (Gas Cutting)

Note: The intensity of the flame and arc is lower in Group G than in Group H. For this reason, required filter shade numbers for this group are also lower. See Table 1.

Group H: Injurious Radiation (Figure 18)

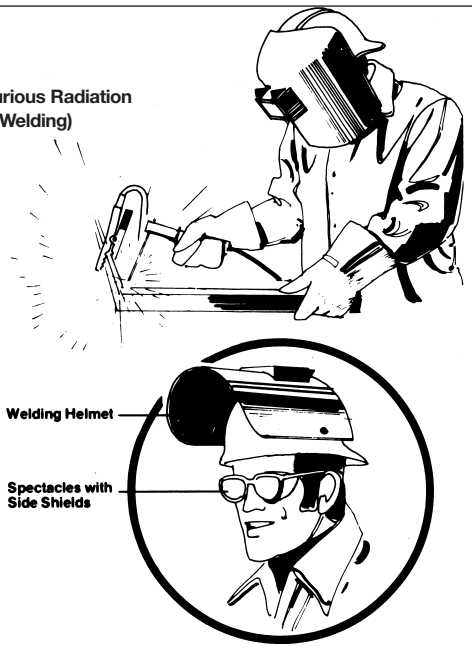
These are situations where a large reduction in visible light is essential (e.g., in electric arc welding).

Only eye protection recommended:

Class 1 spectacles worn with full welding helmets or welding hand shields. These spectacles should incorporate suitable filter lenses if additional protection is required when the welding helmet is in the raised position (e.g., when working near other welding operations). See Table 1.

Figure 18

Group H: Injurious Radiation (Electric Arc Welding)



Injuries Associated with Construction Hazards

The cornea is the front layer of the eye and the first point at which light enters the eye; if light rays cannot pass through the cornea, vision is prevented. Injuries to the cornea that cause scarring, scratching, or inflammation can impair sight.

1. **Flying Objects**
   A piece of metal can pierce the cornea and eyeball and possibly cause the loss of an eye.
2. **Dust**
   Dust, sawdust, etc. can cause irritation resulting in a corneal ulcer which is a breakdown of corneal tissue causing a red, watery, or pussy eye.
3. **Heat**
   Heat can burn and severely damage the cornea.
4. **Acid Splash**
   Acid splash and chemicals can burn the cornea, conjunctiva (white coat on the eye), and eyelid and possibly cause loss of sight.
5. **Abrasive**
   Sand can cause a corneal abrasion which can result in loss of sight.
6. **Glare**
   Glare can make it difficult to see and can cause extreme fatigue to the eye.
7. **Radiation**
   Ultraviolet light from a welding arc can damage the cornea.

Correct eye protection, when matched to the hazard, can prevent or reduce the degree of any eye injury. However, once an eye injury has occurred, it is critical that the injury, no matter how small, be given immediate attention and first aid.

Eye protection can only protect against injury if it is worn continuously on site.

It is often the time when a worker removes eye protection while working near or passing by other hazardous activities on the job that an eye injury results. When it is necessary to remove eye protection, do so only in a location that is completely away from hazardous work areas. The inconvenience of wearing eye protection is far outweighed by the risk of being blinded in one or both eyes.

Purchase of Protective Spectacles

Protective spectacles are available with “plano” or non-prescription lenses and with prescription lenses.

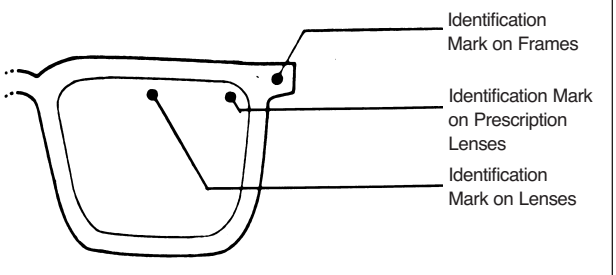
The polycarbonate materials used in safety glasses provide the best protection, while regular plastic CR-39 lenses in industrial thickness provide a substitute where polycarbonate is not available. Anti-scratch coatings are applied to the lens surface to extend useful lens life.

Glass lenses, even when thermally or chemically hardened, are not acceptable for the workplace. Current glass lenses do not meet the impact requirements of CSA Standard Z94.3-07.

When purchasing safety glasses, specify **industrial protection** lenses and frames. This term indicates that the eye protection meets specific test requirements.

Industrial protection safety glasses can be identified by the manufacturer’s or supplier’s logo or monogram which is located on the lens and frame (Figure 19).

Figure 19 – Where to Locate Identification Marks or Symbols



On non-prescription eye protectors, look also for the CSA logo.

This mark must appear on both the frame **and** the lens. It distinguishes industrial quality lenses and frames from streetwear lenses and frames.

The Canadian Standards Association (CSA) certification program for non-prescription (plano) industrial eye and face protection covers complete protectors only. It does not cover separate components such as lenses, frames, or shields.

In addition to the manufacturer's logo or I.D. mark which appears on the eye protector, the CSA logo will appear to indicate the eye protection meets the requirements of the CSA Z94.3-07 standard. Certification of industrial prescription safety glasses is not yet available.

Until such a program is available, the user should look for the manufacturer's or supplier's logo or I.D. mark on the frame and lens which indicates adherence to the American National Standards Institute (ANSI) Standard Z87.1-1989.

Fitting

Improper fit is the most common reason for resistance to wearing eye protection. A worker who wears non-prescription (plano) lenses and continues to complain about blurred vision after the fit has been checked by a competent person may require prescription lenses. Prescription lenses must be fitted by an optician or optometrist. Plano eye protection should be fitted individually by a trained person.

Here are some general guidelines to follow when fitting the various classes of eye protectors.

Class 1 – Spectacles require that the proper eye size, bridge size, and temple length be measured for each individual. The wearer should be able to lower his head without the spectacles slipping.

Class 2 – Goggles with adjustable headbands should fit snugly over the wearer's spectacles when worn.

Class 3 – Welding helmets are equipped with adjustable attachments to provide a comfortable fit over the head and face. Attachments are also available to fit on hard hats.

Class 4 – Hand-held shields require no adjustment.

Class 5 – Hoods Adjustments are located on the top inside of the hood. A tie is located around the neck to secure the hood and to prevent the entry of dust.

Class 6 – Face shields are equipped with adjustable attachments to provide a comfortable fit over the head and face. Attachments are also available to fit on hard hats.

Class 7 – Respirator facepieces should fit snugly without gaps to make an effective seal against airborne contaminants.

Care

Eye protectors in construction are subjected to many damage-causing hazards. Therefore, care is very important.

1. Lenses should be inspected regularly for pitting and scratches that can impair visibility.
2. Scratched or pitted lenses and loose frames or temples should be replaced or repaired as soon as possible with components from the original manufacturer.
3. Lenses should be cleaned with clear water to remove abrasive dust—cleaning dry lenses can scratch the surface.
4. Anti-fog solutions can be used on glass or plastic lenses.
5. Frames should be handled with care and checked daily for cracks and scratches.
6. Eye protectors should never be thrown into tool boxes where they can become scratched or damaged.
7. Cases should be provided and used to protect spectacle lenses when not being worn.

Contact Lenses

In the construction industry, contact lenses are not a substitute for protective eyewear. Dust and dirt can get behind the contact lenses causing sudden discomfort and impairment of vision.

Contact lenses are also difficult to keep clean when they have to be removed or inserted since there are seldom suitable washing-up facilities on a jobsite.

It is recommended that contact lenses not be worn on construction sites.

However, in cases where contact lenses must be worn to correct certain eye defects, workers should obtain written permission from their ophthalmologist or optometrist indicating the necessity of wearing contact lenses in order to function safely at work. In these cases eye protection, preferably cover goggles, must be worn with the contact lenses.

Table 2: Hazards and Recommended Protectors

Hazard groups	Nature of hazard	Hazardous activities involving but not limited to	Spectacles Class 1		Goggles Class 2			Welding helmet Class 3	Welding hand shield Class 4	Face shields Class 6			Non-rigid hoods Class 5			
			A	B	A	B	C			A	B	C	A	B	C	D
A	Flying objects	Chipping, scaling, stonework, drilling; grinding, buffing, polishing, etc.; hammer mills, crushing; heavy sawing, planing; wire and strip handling; hammering, unpacking, nailing; punch press, lathework, etc.	■		■	■				■			■	■		
B	Flying particles, dust, wind, etc.	Woodworking, sanding; light metal working and machining; exposure to dust and wind; resistance welding (no radiation exposure); sand, cement, aggregate handling; painting; concrete work, plastering; material batching and mixing	■		■	■				■			■	■		
C	Heat, sparks, and splash from molten materials	Babbiting, casting, pouring molten metal; brazing, soldering; spot welding, stud welding; hot dipping operations		■			■				■	■			■	■
D	Acid splash; chemical burns	Acid and alkali handling; degreasing, pickling and plating operations; glass breakage; chemical spray; liquid bitumen handling				■				■				■		
E	Abrasive blasting materials	Sand blasting; shot blasting; shotcreting				■				■				■		
F	Glare, stray light (where reduction of visible radiation is required)	Reflection, bright sun and lights; reflected welding flash; photographic copying	■		■	■				■			■	■		
G	Injurious optical radiation (where moderate reduction of optical radiation is required)	Torch cutting, welding, brazing, furnace work; metal pouring, spot welding, photographic copying		■			■				■				■	
H	Injurious optical radiation (where large reduction of optical radiation is required)	Electric arc welding; heavy gas cutting; plasma spraying and cutting; inert gas shielded arc welding; atomic hydrogen welding						■	■							

Note: ***Shaded areas are recommendations for protectors.*** *Class 1 and Class 2 protectors shall be used in conjunction with recommendations for Class 3, 4, 5, and 6 protectors. The possibility of multiple and simultaneous exposure to a variety of hazards shall be considered in assessing the needed protection. Adequate protection against the highest level of each of the hazards should be provided. This Table cannot encompass all of the various hazards that may be encountered. In each particular situation, thorough consideration should be given to the severity of all the hazards in selecting the appropriate protector or combination of protectors. The practice of wearing protective spectacles (Class 1B) with filter lenses under welding helmets or hand shields is strongly recommended to ensure impact and flash protection to the wearer when the helmet or lift front is raised or the shield is not in use. Protectors that meet the requirements for ignition and flame resistance are not intended to provide protection in environments that expose the user to open flames or high-energy arcs.* Courtesy Canadian Standards Association

14 HEARING PROTECTION

Introduction

Many jobs produce noise. Typical construction work may involve equipment driven by large and small engines, metal fabrication, power drilling and sawing, air hammering, and blasting — all of which can produce noise at harmful levels.

Depending on the noise level, duration of exposure, and other factors, a temporary or permanent hearing loss may result. Temporary hearing losses will usually be restored by the body within a few hours after the exposure has ceased. Hearing losses which cannot be restored by the body over any length of time are termed permanent.

A person suffering a hearing loss will frequently not realize it. Noise may be harmful at levels that an exposed person does not consider irritating or annoying. Therefore, despite **individual** preferences, prevention and control procedures must be based on the **general** potential for hearing loss.

Waiting for personal discomfort before taking preventive measures may be too late to avoid a permanent noise-induced hearing loss.

Noise Measurement

Measuring sound levels can determine

- whether or not a noise hazard is present
- noise exposures of workers
- which workers require hearing protection, hearing tests, education, and training.

Measurements are performed with a sound level meter (SLM). The unit used to measure the intensity of sound is the decibel (dB). Intensity is perceived as loudness.

Noise levels can't be added directly like other numbers. For example, two noise sources producing 90 dB each would have a combined output of 93 dB, not 180 dB. The combined output of 93 dB is actually a *doubling* of intensity.

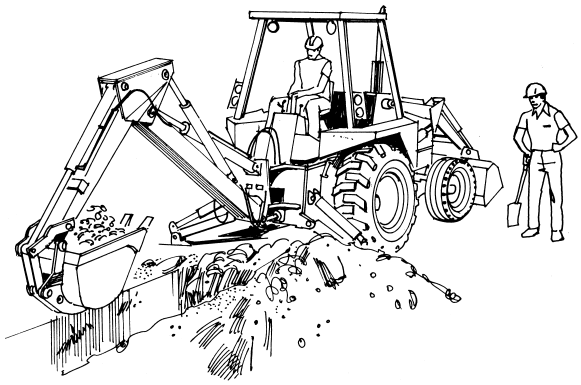
In many construction situations, several different sources each contribute to the overall noise. This means that a worker's exposure may be much higher than it would be if only one of the sources was present (Figure 22).

In addition to intensity, the SLM can detect a wide range of frequencies. Since the human ear tends to filter out the lower frequencies and slightly accentuate the higher ones, SLMs are engineered to do the same. They feature an internal mechanism called "A-weighting." The resulting noise level is expressed as decibels (dB) on the "A" scale or dBA.

Two types of noise measurements can be performed: area and personal.

An **area noise measurement** is taken in a specific work area. The measurement is generally used as a preliminary step to determine whether more detailed evaluation involving personal noise measurement is necessary. Area noise readings should not be used to determine what hearing protection is required or who needs a hearing test. Personal exposure measurement should be used for these purposes.

Figure 22



The backhoe is producing 90 dB of noise. The worker standing nearby is therefore exposed to 90 dB.



The backhoe is producing 90 dB. The compressor is also producing 90 dB. The worker standing between the two pieces of equipment is therefore exposed to their combined output. This double intensity is 93 dB.

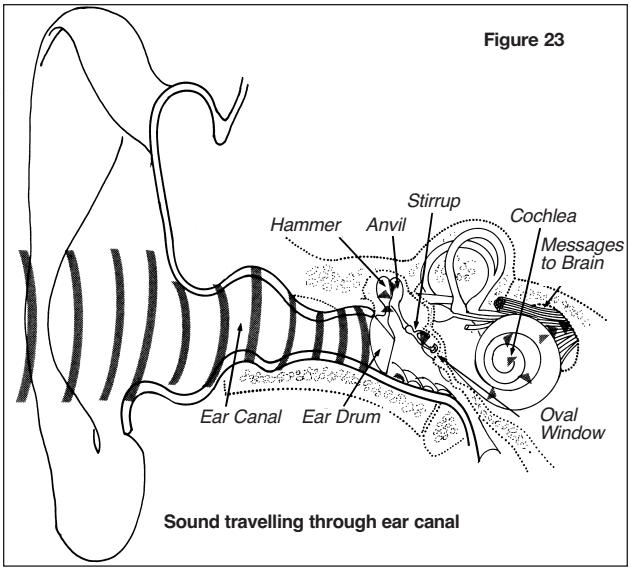
Personal noise measurement involves a small device called a noise dosimeter. Workers can wear the device to determine their average noise exposure over a whole shift. Usually worn around the waist, the dosimeter has a microphone that is placed as close to the worker's ear as possible.

Noise measurements should be carried out in accordance with acceptable standards. Canadian Standards Association (CSA) Standard Z107, *Procedures for the Measurements of Occupational Noise Exposure*, provides guidance on the type of equipment to use, which workers to test, and how to test.

Noise evaluation must be done by a knowledgeable person trained and experienced in conducting noise surveys.

Hearing Process

The hearing process begins when the outer ear directs sound waves into the ear canal (Figure 23). The eardrum vibrates as sound waves strike it. This vibration is then transmitted through the middle ear where it is amplified on a membrane called the oval window. The oval window separates the middle ear from the inner



ear where the sensitive hearing organs are located. Attached to the other side of the oval window is a tiny, snail-shaped structure called the cochlea. The cochlea contains fluid and hair cells. These thousands of small but highly sensitive hair cells feel the vibration. Responding to the cells are microscopic nerve endings that send messages to the brain, where the signals are interpreted as varieties of sound.

Hearing Loss

Any reduction in the normal ability to hear is referred to as a loss of hearing. A hearing loss can be either temporary or permanent.

Temporary Threshold Shift

With a temporary hearing loss, normal hearing will usually return after a rest period away from all sources of intense or loud noise. The recovery period may be minutes, hours, a day or perhaps even longer. It is believed that a temporary hearing loss occurs when hair cells in the inner ear have been bent by vibrations and need time to bounce back.

Most of the temporary hearing loss occurs during the first two hours of exposure and recovery takes place usually within the first two hours after exposure stops. However, the length of time needed for recovery depends primarily on how great the initial loss was. The greater the initial loss the longer the time needed to recuperate. This temporary decrease in hearing ability is called a temporary threshold shift (TTS) because the threshold or level at which sound can be heard has been raised.

For instance, to listen to your favourite music at the volume you like, you would have to turn it up a few more notches than usual. This phenomenon explains why some people, particularly those who suffer from some form of hearing loss, claim that they "get used to the noise."

If these previous exposures are allowed to continue under the same conditions and without the proper interval of rest, then a certain degree of permanent hearing loss is possible.

Permanent Threshold Shift

Permanent hearing loss is the result of hair cell or nerve destruction within the cochlea. Once these important parts of the hearing process are destroyed, they can never be restored or regenerated. The resulting permanent hearing loss, also referred to as permanent threshold shift (PTS), can range from slight impairment to nearly total deafness.

A symptom of PTS is the inability to pick up sounds with higher frequencies. As damage increases, the reception of speech becomes more difficult.

Unfortunately, the damage builds up gradually. Workers may not notice changes from one day to another. But once the damage is done there is no cure. Effects may include the following.

- Sounds and speech become muffled so that it's hard to tell similar-sounding words apart or to pick out a voice in a crowd.
- Sufferers ask people to speak up, then complain that they are shouting.
- There's a permanent ringing in the ears (tinnitus).
- Sufferers need to turn the volume on the radio or television way up or find it hard to use the telephone.

Determining Factors

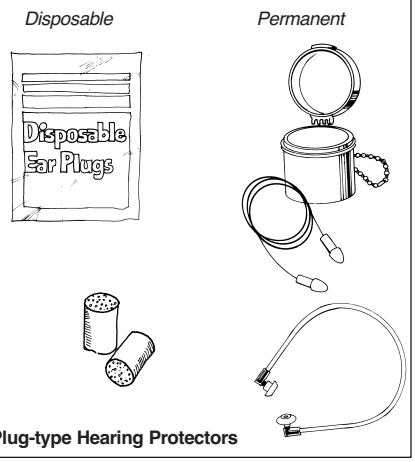
The following factors determine the degree and extent of hearing loss:

- **Type of Noise**
  (continuous, intermittent, impact, high or low frequency)
- **Intensity of Noise**
  (level of loudness)
- **Duration of Exposure**
  (length of time worker subjected to noise — for example, during day, on specific shifts)
- **Employment Duration**
  (years worker subjected to noise)
- **Type of Noise Environment**
  (character of surroundings – for example, enclosed, open, reflective surfaces)
- **Source Distance(s)**
  (distance of worker from noise source)
- **Worker's Position**
  (position of worker relative to noise source)
- **Worker's Age**
  (for instance, a 20-year-old apprentice versus a 50-year-old journeyperson)
- **Individual Susceptibility**
  (sensitivity difference, physical impairments)
- **Worker's Present Health**
  (whether a worker has any detectable losses or ear diseases)
- **Worker's Home and Leisure Activities**
  (exposures to noise other than occupational, such as hunting, skeet shooting, earphone music, snowmobiling, etc.)

Other prime causes of permanent hearing loss are age, traumatic injuries (such as from explosions or gunfire), and infection.

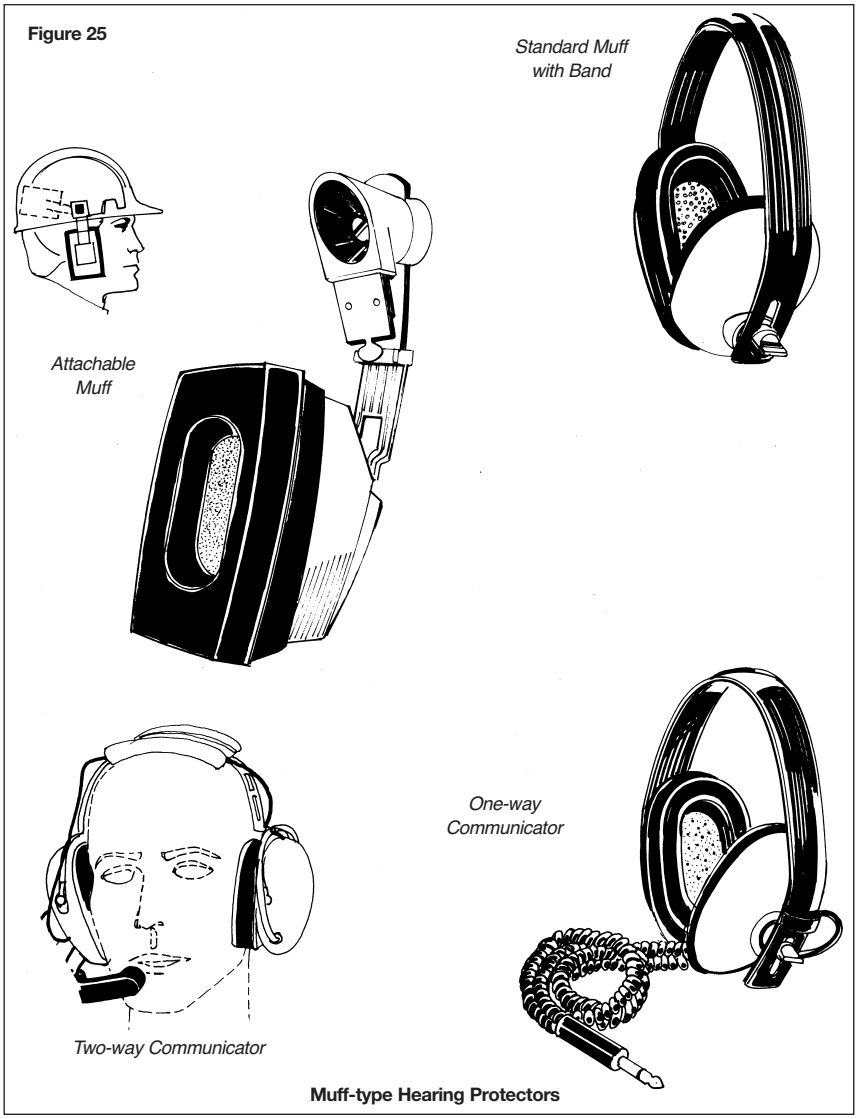
Noise, however, is the major identifiable cause of hearing loss. Therefore, it is important that controls are exercised wherever possible so that such losses can be prevented.

Figure 24



Plug-type Hearing Protectors

Figure 25



Muff-type Hearing Protectors

Hearing Protection

One form of controlling noise hazards is through the proper use of hearing protection devices (HPDs). Hearing protectors should be provided when engineering controls cannot be implemented or while such controls are being initiated.

Hearing protective devices are barriers that reduce the amount of noise reaching the sensitive inner ear. Fit, comfort, and sound reduction or "attenuation" are important considerations in choosing HPDs.

Commonly used hearing protection devices are either earplugs or earmuffs. Earplugs attenuate noise by plugging the ear canal (Figure 24). The muff-type protector is designed to cover the external part of the ear providing an "acoustical seal" (Figure 25). Table 1 describes some of the characteristics of these different types of hearing protectors.

Effectiveness

Obviously, the effectiveness of an HPD depends on the amount of time it is worn. What is not obvious to most wearers is the drastic reduction in protection if HPDs are not worn in noisy environments even for short periods of time.

The reduction in effectiveness can be as great as 95% or more if the protectors are not worn for as little as three or four minutes. It is therefore important to wear HPDs during the entire noise exposure period in order to achieve the maximum protection available.

The effectiveness of HPDs also depends on the manner in which noise is transmitted through or around the protector. The following points should be noted.

- Even relatively small openings or air leaks in the seal between the hearing protector and the skin can typically reduce attenuation by 5 to 15 dB or more.
- Constant movement of the head or body vibration can lead to air leaks, therefore making periodic adjustments necessary to ensure a proper seal.
- Hair, especially long hair and facial hair, can cause a poor fit.
- Proper fitting is crucial to obtaining a reasonable degree of protection from an HPD.
- Earmuff effectiveness is greatly influenced by headband tension. If tension decreases through routine usage or alteration by the user, earmuff effectiveness is reduced.
- Modifying the earmuff by drilling holes in the earcups renders the protection useless.
- Anatomical differences such as ear canal size, jaw size, and heads of different shape and size may affect the fit of earmuffs and earplugs. To accommodate these differences, HPDs should be made available to users in various shapes and sizes.
- Recreational headsets such as those used with radios and CD players are **not** to be used as hearing protection.

Table 3: Types of Hearing Protectors

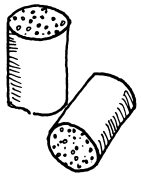
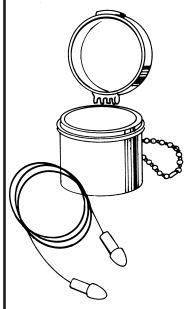
	FOAM EARPLUGS	PREMOULDED EARPLUGS	EARMUFFS	FORMABLE EARPLUGS	CUSTOM-MOULDED EARPLUGS	SEMI-INSERT EARPLUGS
						
STYLE and COMFORT	Consist of compressible plastic foam. Come in many shapes. Often described as "disposable plugs." Elasticity lets them adapt easily to changes in ear canal.	Usually made of plastic or silicone rubber attached to a flexible stem for handling and insertion. Come in many shapes and sizes to suit different ear canals.	Consist of two insulated plastic cups attached to metal or plastic band. Cups equipped with soft cushions for seal and comfort. Head band tension ensures good seal.	Made from pliable material such as cotton/wax mixture, silicone putty, and mineral wool.	Custom made to fit a particular ear by taking an impression of the ear, making a mould, and casting a plug.	Commonly known as banded earplugs or canal caps. They consist of small caps or pods that are held in place over the ear canal by spring-loaded bands.
INTENDED USE	Most brands can be reused a few times before being discarded.	To be used more than once.	To be used regularly. Can be worn with or without plugs. Easily attached to hard hats.	• Single-use for mineral wool products. • Multi-use for cotton/wax products. • Semi-permanent for silicone putty products.	Permanent use	To be used more than once.
HYGIENE PRACTICES	Clean hands required each time fresh plugs inserted.	Plugs should be cleaned regularly with warm soapy water, preferably after each removal from ear.	General maintenance required. Head band must be maintained. Cushions must be replaced when soiled or brittle.	Clean hands required for shaping and insertion.	Wash with hot water and soap, preferably after removal.	Wash with hot water and soap, preferably after removal.
ADVANTAGES	Low risk of irritation. One size fits most workers.	Reusable.	Less likely to cause irritation. When attached to hard hat, always available for use.	Relatively cheap	Good fit only if a proper impression of the ear is taken.	Good for when frequent removal is required.
DISADVANTAGES	Use requires clean hands. Large supply required for frequent removals and usage.	Plugs must be kept clean to prevent irritation. May produce some discomfort with pressure. Though reusable, plugs degrade over time. Inspect and replace as necessary.	Bands may wear out and tension decrease. Eyewear and hair may interfere with fit and reduce protection.	Not recommended for the noise levels found on construction projects.	If the wearer's weight changes drastically, new plugs should be made. Plugs can be lost, shrink, harden, or crack over time, and must be replaced.	Proper seal is necessary for good attenuation.

Table 4

Level of Noise Exposure L_{EX} (dBA)	Grade	Class
< 90	1	C
< 95	2	B
< 100	3	A
< 105	4	A
< 110	Dual*	
> 110	Dual†	

Based on an 8-hour exposure to noise levels in dBA. Adapted from CSA Z94.2-2002

* Dual hearing protection required. Use a minimum of a Grade 2 or Class B earmuff and a Grade 3 or Class A earplug.

† Dual hearing protection required. Also, it is recommended that exposure durations be limited, octave-band analyses be conducted for attenuation predictions, and twice-annual audiometry be provided to the affected individuals.

Selection Criteria

In addition to attenuation characteristics, the following factors should be considered when selecting hearing protectors:

- noise exposure levels and standards
- comfort
- appearance
- communication requirements
- work environment or work procedures
- overprotection.

Noise Exposure Levels and Standards

Identifying the noise level(s) to which an individual may be exposed throughout an entire working day determines the class or grade of hearing protector needed.

Evaluation is based on eight-hour noise exposure, not a spot or area measurement. For example, a quick-cut saw operated by a mason may produce a noise level of 110 dBA. But the mason may only be exposed to an average of 92 dBA over the full eight-hour shift. The reason is that the saw is not operated continuously during that period. There will be times when the worker is laying brick, taking a coffee break, or eating lunch.

CSA Standard Z94.2-2002 *Hearing Protectors*, classifies hearing protectors as A, B, and C or Grades 1, 2, 3, or 4 based on the level of protection they provide.

Grade 4 or Class A protectors offer higher protection than Grade 1 or Class C protectors if worn properly.

Table 4 provides guidelines for proper selection. Table 5 lists typical noise levels for various kinds of construction equipment. The upper limits of the noise levels can be used as a guide in selecting a specific class or grade of hearing protectors.

Comfort

Comfort is an important consideration in selection. An HPD that isn't comfortable will simply not be worn or will be worn improperly.

Table 5

Typical Noise Level Measurements for Construction

EQUIPMENT*	NOISE LEVEL (dBA) AT OPERATOR'S POSITION
Cranes	78 – 103
Backhoes	85 – 104
Loaders	77 – 106
Dozers	86 – 106
Scrapers	97 – 112
Trenchers	95 – 99
Pile drivers†	119 – 125
Compactors	90 – 112
Grinders	106 – 110
Chainsaws	100 – 115
Concrete saw	97 – 103
Sand blasting nozzle	111 – 117
Jackhammers	100 – 115
Compressors	85 – 104

* Generally, newer equipment is quieter than older equipment. (For noise levels of specific equipment, contact IHSA.)

† Pile drivers and explosive-actuated tools generate intermittent or "impulse" sound.

With earplugs, several factors affect comfort. Since some plugs are relatively non-porous, they can often create a pressure buildup within the ear and cause discomfort. Dirty plugs may irritate the ear canal. The shape of an individual's ear canals may not allow certain plugs to fit properly.

Earmuffs should be made of materials which do not absorb sweat and which are easy to maintain and clean. The earmuff cup should be adjustable to conform to various head sizes and shapes. Headband tension and earcup pressure should be adjusted so that they are effective without being uncomfortable. Weight may also be a factor.

Workers should be allowed to try out various HPDs to determine which are most comfortable.

Appearance

HPD appearance may influence selection. Those that look bulky or uncomfortable may discourage potential users. Allowing workers to select from various HPDs, or various makes of the same HPD, can help overcome this problem.

Speech Requirements

Consider the level of the noise hazard and the risks of impaired communication (Table 6). The potential for speech interference is greatest when background noise — meaning all noises generated in the surrounding area — is low. In this case, HPD wearers with impaired hearing may have difficulty understanding speech because they must contend not only with their hearing loss but also with the attenuation of their protector as well. In other cases, the use of HPDs by workers with normal hearing may

Table 6

Effects of Hearing Protectors on Understanding Speech

Hearing Ability of Wearer	Background / Surrounding Noise Levels in dBA		
	Less than 75	75 to 85	Greater than 85
Normal hearing	Little effect	No effect	Improves communication
Impaired hearing	Moderate effect	Little effect	No effect

actually *improve* their understanding of speech in noisy environments.

In other words, wearing HPDs doesn't always reduce the ability to communicate. Factors to consider include the user's hearing ability, noise levels, and the type of HPD. Where two-way communication is vital, radio-equipped hearing protectors can be worn (Figure 25).

Work Environment/Procedures

Choosing an HPD is sometimes dictated by the constraints of the work area or work procedures. For example, large volume earmuffs may not be practical in confined work situations with little head room or clearance.

In this case, flat-cup muffs or earplugs may be more practical. Where work is necessary near electrical hazards, it may be desirable to use non-conductive suspension-type muffs. The type of protector may also be determined by the nature of work, as in welding where certain types of earmuffs may interfere with the welder's helmet.

The attenuation of the muff-type hearing protector may be considerably reduced when worn with spectacle-type safety glasses. (The head configuration of the wearer and the type of glasses worn will determine the reduction in attenuation.) Where safety glasses must be worn, cable-type temples should be used in order to allow the smallest possible opening between the seal of the protector and the head. Otherwise earplugs should be worn, provided they are adequate.

Consideration should be given to hearing protectors which can be attached to hard hats where exposures to noise may be high but intermittent and where hard hats must be worn at all times. Periodic adjustments may be necessary because movement of the hard hat may break the seal of the HPD.

Consideration should also be given to work involving oils, grease, and other products which may soil hands. Ear infections may occur when earplugs are inserted by soiled hands.

Overprotection

Workers wearing HPDs that provide too much attenuation may feel isolated from their surroundings. Sounds may be heard as muffled. Speech or warning sounds may be unrecognizable. Overprotection can lead workers to resist wearing HPDs. Protectors should be chosen to provide sufficient, but not excessive, attenuation. The objective should be to reduce noise levels to or below the recommended maximum eight-hour exposure of 85 dBA, but not below 70 dBA.

Fit, Care, and Use

Workers should be instructed in the proper fitting of HPDs as recommended by the manufacturer. Training should include a demonstration. Workers should then practice using the HPDs under close supervision. Checks are needed to ensure the best possible protection. Many of these checks relate to fit.

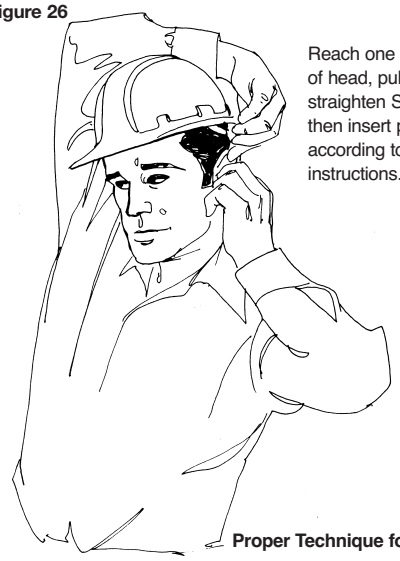
Earmuffs

1) Earmuffs should conform to the latest issue of CSA Standard Z94.2.
2) The cup part of the earmuff should fit snugly over the entire ear and be held firmly in place by a tension band.
3) The cup and band should not be so tight as to cause discomfort.
4) Cup, cushion, and band should be checked for possible defects such as cracks, holes, or leaking seals before each use of the HPD.
5) Because band tension can be reduced over a period of time, the band may require repair or replacement.
6) Defective or damaged parts should be repaired or replaced as needed. Tension band, cushions, and cups are readily replaceable.

Earplugs

1) Earplugs should conform to the latest issue of CSA Standard Z94.2.
2) For maximum attenuation, the method of insertion illustrated in Figure 26 should be used. Because the ear canal is slightly S-shaped, the ear must be pulled back to straighten the canal for the plug to fit properly.
3) Earplugs must be fitted snugly in the ear canal. This will cause some discomfort initially. However, in time (usually a period of two weeks) the discomfort vanishes. Should there be severe discomfort initially or mild discomfort for more than a few weeks, seek professional advice. In most instances it will only be a matter of re-sizing, although some ear canals cannot be fitted with plugs because of obstructions, unique shapes, or deformities. In fact, the shape of one ear canal may be entirely different from the other.

Figure 26



Reach one hand around back of head, pull ear upwards to straighten S-shaped ear canal, then insert plug with other hand according to manufacturer's instructions.

Proper Technique for Inserting Earplugs

4) Reusable earplugs should be washed daily with warm soapy water to prevent the remote possibility of infection or other discomfort. When not in use, they should be kept in a clean container.
5) Earplugs with torn or otherwise damaged flanges should be replaced.

WARNING: Cotton batten does not provide adequate protection from construction noise.

Training

Workers who wear HPDs should be trained to fit, use, and maintain the protectors properly. Workers should understand that

- there is risk of hearing loss if HPDs are not worn in noisy environments (eight-hour exposure of 85 dBA)
- wearing HPDs is required in all situations where noise exposure may damage hearing
- to be effective an HPD must not be removed even for short periods
- various HPDs are available to accommodate differences in ear canal size, jaw size, head size and shape, comfort level, compatibility with other forms of PPE, etc.
- proper fit is essential to achieve maximum protection.

Audiometry

Anyone who works with noisy equipment on a regular basis should take a periodic audiometric or hearing capability test for the following reasons:

1) **To determine whether or not a hearing loss exists.** Even if no hearing loss is detected, workers exposed to noise levels in excess of 85 dBA should wear hearing protectors. Workers who have some hearing loss should wear HPDs to minimize any further loss.
2) **To determine the type of hearing loss.** Certain hearing losses can be reversed. Some individuals have suffered for years only to find out that their hearing problem could have been corrected surgically. These situations usually occur as a result of birth defects and are known as “conductive losses.”
3) **To determine the effectiveness of programs for noise control and hearing protection.** Early identification is important so that prevention practices can be implemented, maintained, and revised when necessary.

Summary

Control of noise in workplaces is of growing importance as a result of increasing hearing loss claims.

Most noise problems can be analyzed in terms of source, transmission path, and receiver. This allows a convenient understanding of the overall problem and a useful approach to remedial measures. The three components can usually be treated in isolation, although sometimes all three must be considered together in order to control unacceptable noise levels.

At the source, remedial measures are aimed at reducing the noise being generated.

Along the transmission path, barriers can be introduced to reduce or eliminate noise reaching the ears.

At the worker, remedial measures involve personal protective equipment being properly selected, fitted, and worn. The equipment must be used in high noise environments **all the time.**

Failure to provide preventive or control measures will result in temporary and ultimately permanent hearing losses.

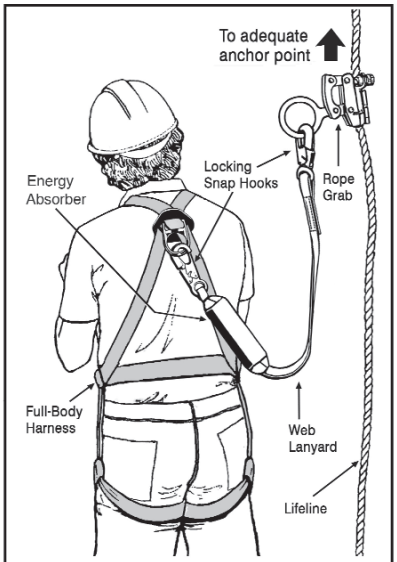
The Infrastructure Health & Safety Association can assist management and labour in the industry by providing useful information, research, and training. For more information, visit the hearing protection page on our website.

19 PERSONAL FALL PROTECTION

A worker at risk of falling certain distances (see chapter on Guardrails in this manual) must be protected by guardrails or, if guardrails are not practical, by a travel-restraint system, fall-restricting system, fall-arrest system, or safety net. This chapter describes travel-restraint systems and fall-arrest systems.

Personal fall protection equipment consists of the components shown in the following illustration.

This equipment can be used for travel restraint or fall arrest.



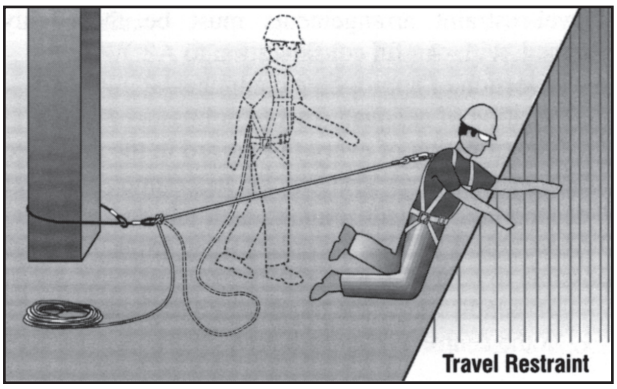
Full-Body Harness and Fall-Arrest System

Travel-Restraint Systems

A travel-restraint system lets a worker travel just far enough to reach the edge but not far enough to fall over.

The basic travel-restraint system consists of a

- CSA-approved full-body harness
- lanyard
- lifeline
- rope grab to attach harness or lanyard to lifeline
- adequate anchorage (capable of supporting a static load of 2 kilonewtons—450 pounds—with a recommended safety factor of at least 2, that is, 4 kilonewtons or 900 pounds).


Travel Restraint

Travel-restraint arrangements must be thoroughly planned, with careful consideration given to

- selection of appropriate components
- location of adequate anchor points
- identification of every fall hazard in the proposed work area.

Try to select an anchor point that is as close as possible to being

- perpendicular to the unprotected edge, and
- at the centre of the work area.

All fall hazards in the work area must be identified. Pay special attention to work areas with irregular shaped perimeters, floor openings, or locations near corners.

A fully extended lifeline and/or lanyard that adequately restrains a worker from a fall hazard in one section of the work area may be too long to provide the same protection in another section.

Two methods of travel restraint are commonly used in construction.

1) Connecting an adequately anchored lifeline directly to the D-ring of the worker's full-body harness. It's absolutely critical that the length of the lifeline, measured from the anchor point, is short enough to restrain the worker from any fall hazard.
2) Attaching a lanyard from the D-ring of the worker's full-body harness to a rope grab on an adequately anchored lifeline. There must be some means—such as a knot in the lifeline—to prevent the rope grab from sliding along the lifeline to a point where the worker is no longer restrained from falling.

Whether method 1 or 2 is used, the system must be adjusted so that the fully extended lifeline and/or lanyard prevents the worker from reaching any point where the worker may fall. The system must also be securely anchored.

Fall-Arrest Systems

Where workers cannot be protected from falls by guardrails or travel restraint, they must be protected by at least one of the following methods:

- fall-restricting system
- safety net
- fall-arrest system.

In the event of a fall, these systems must keep a worker from hitting the ground, the next level below, or any other objects below.

A fall-restricting system

A fall-restricting system is designed to limit a worker's free-fall distance to 0.6 metres (2 feet).

- Temporary fixed supports used for anchorage with a fall-restricting system must support at least six kilonewtons (1,350 pounds) without exceeding the allowable unit stress for each material used. A safety factor of two should be applied.
- Components described under fall-arrest systems can be used for fall-restricting systems.
- Fall-restricting systems generally fasten to a sternal connection on your harness, then to a wire rope grab or fixed ridged rail system used for climbing ladders.

Safety nets

A safety net system must be designed by a professional engineer. The system is installed below a work surface where a fall hazard exists.

- Safety nets must be inspected and tested by a professional engineer or supervised by the engineer. A copy of the inspection and test must be kept at the project until the net is no longer in service.
- Safety nets can be used around building edges, below formwork operations, and on bridge work. It is important to note that a rescue plan is still required.

A fall-arrest system

- must include a CSA-approved full-body harness
- must include a lanyard equipped with an energy absorber unless the energy absorber could cause a falling worker to hit the ground or an object or a level below the work
- must include an adequate fixed support; the harness must be connected to it via a lifeline, or via a lanyard and a lifeline
- must prevent a falling worker from hitting the ground or any object or level below the work
- must not subject a falling worker to a peak fall-arrest force greater than 8 kilonewtons.

The construction regulation (O. Reg. 213/91) requires that

- all fall protection equipment must be inspected for damage, wear, and obvious defects by a competent worker before each use
- any worker required to use fall protection must be trained in its safe use and proper maintenance.

Any defective component should be replaced by one that meets or exceeds the manufacturer's minimum performance standards for that particular system.

The regulation also requires that any fall-arrest system involved in a fall be removed from service until the manufacturer certifies all components safe for reuse.

For any worker receiving instruction in fall protection, the manufacturer's instructions for each piece of equipment should be carefully reviewed, with particular attention to warnings and limitations.

Components

Canadian fall protection standards are regularly updated to incorporate the most current changes to fall protection systems. The following is a list of current CSA standards for personal fall protection equipment:

- CAN/CSA-Z259.1-05 – Body Belts and Saddles for Work Positioning and Travel Restraint
- CAN/CSA-Z259.2.1-98 (R2008) – Fall Arresters, Vertical Lifelines and Rails
- CAN/CSA-Z259.2.2-98 (R2004) – Self-Retracting Devices for Personal Fall-Arrest Systems
- CAN/CSA-Z259.2.3-99 (R2004) – Descent Control Devices
- CAN/CSA-Z259.10-06 – Full Body Harnesses
- CAN/CSA-Z259.11-05 – Energy Absorbers and Lanyards
- CAN/CSA-Z259.12-01 (R2006) – Connecting Components for Personal Fall Arrest Systems (PFAS)
- CAN/CSA-Z259.14-01 (R2007) – Fall Restrict Equipment for Wood Pole Climbing

For any component not covered by these standards, confirm with the manufacturer that the component is suitable for the particular system being considered.

The minimum strength of fall-arrest components depends on whether or not the system uses an energy absorber. Note: IHSA does not recommend the use of a fall-arrest system without an energy absorber unless the deployment of the energy absorber will create a hazard of hitting a level or object below.

- In systems *without* energy absorbers all components—including lifeline and lifeline anchorage—must be able to support a static load of at least 8 kilonewtons (1,800 pounds) without exceeding the allowable unit stress of the materials used for each component.
- In systems *with* energy absorbers, all components—including lifeline and lifeline anchorage—must be able to support a static load of 6 kilonewtons (1,350 pounds) without exceeding the allowable unit stress of the materials used for each component.

In designing both systems, it is recommended that a safety factor of at least two be applied to the stated minimum load capacity. In practical terms, anchorage should be strong enough to support the weight of a small car (about 3,600 pounds).

Lifelines

There are three basic types of lifelines:
1) vertical
2) horizontal
3) retractable.

All lifelines must be inspected before each use to ensure that they are

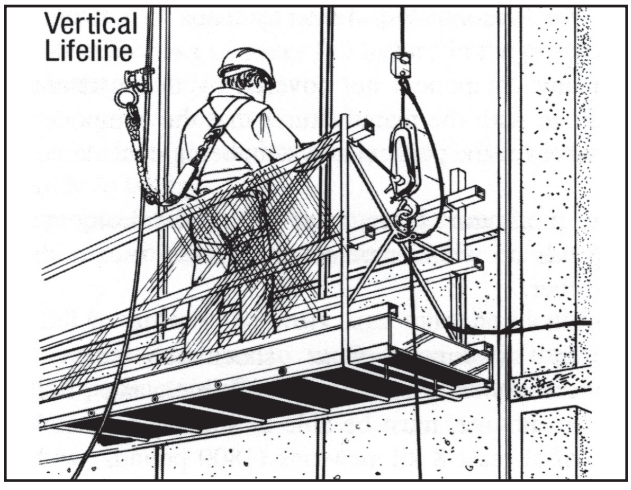
- free of cuts, burns, frayed strands, abrasions, and other defects or signs of damage
- free of discolouration and brittleness indicating heat or chemical exposure.

1) Vertical Lifelines

Vertical lifelines must comply with the current edition of the applicable CSA standard and the following minimum requirements:

- Only one person at a time may use a vertical lifeline.
- A vertical lifeline must reach the ground or a level above ground where the worker can safely exit.
- A vertical lifeline must have a positive stop to prevent the rope grab from running off the end of the lifeline.

Vertical lifelines are typically 16-millimetre (5/8-inch) synthetic rope (polypropylene blends).

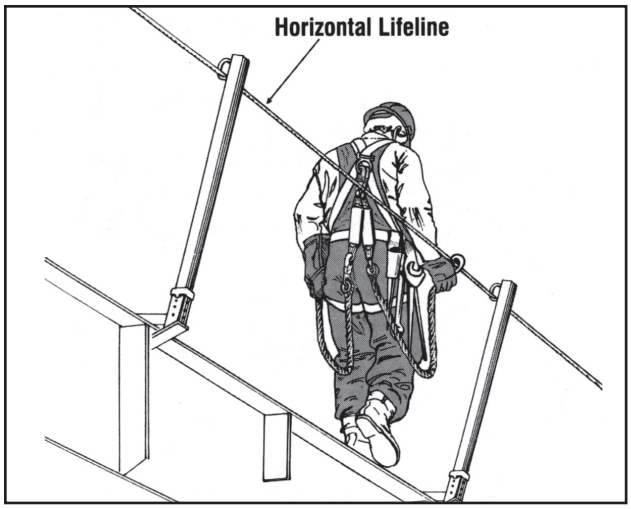


2) Horizontal Lifelines
The following requirements apply to any horizontal lifeline system:

- The system must be designed by a professional engineer according to good engineering practice.
- The design can be a standard design or specifically engineered for the site.

The design for a horizontal lifeline system must

✓ clearly indicate how the system is to be arranged, including how and where it is to be anchored
✓ list and specify all required components
✓ clearly state the number of workers that can safely be attached to the lifeline at one time
✓ spell out instructions for installation, inspection, and maintenance
✓ specify all of the design loads used to design the system.



The system must be installed, inspected, and maintained in accordance with the professional engineer's design.

Before each use, the system must be inspected by a professional engineer or competent worker designated by a supervisor. A complete and current copy of the design must be kept on site as long as the system is in use.

CAUTION: The construction regulation requires that "a horizontal or vertical lifeline shall be kept free from splices or knots, except knots used to connect it to a fixed support." Knots along the length of either a horizontal or vertical lifeline can reduce its strength by as much as 40%.

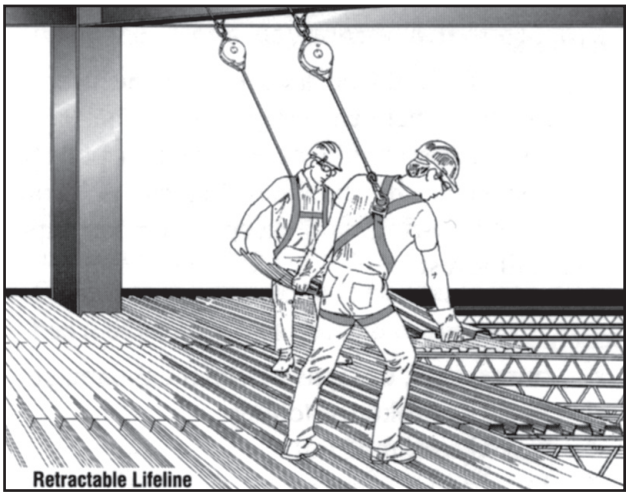
3) Retractable Lifelines
Retractable lifelines consist of a lifeline spooled on a retracting device attached to adequate anchorage. Retractable lifelines must comply with CAN/CSA-Z259.2.2.

In general, retractable lifelines

- are usually designed to be anchored above the worker
- employ a locking mechanism that lets line unwind off the drum under the slight tension caused by a user's normal movements
- automatically retract when tension is removed, thereby preventing slack in the line
- lock up when a quick movement, such as that caused by a fall, is applied
- are designed to minimize fall distance and the forces exerted on a worker's body by fall arrest.

Always refer to the manufacturer's instructions regarding use, including whether an energy absorber is recommended with the system and whether the device can be used in the horizontal position.

Any retractable lifeline involved in a fall arrest must be removed from service until the manufacturer or a qualified testing company has certified it for reuse.



Lifeline Hazards

Ultraviolet light – Exposure to the sun may damage or weaken synthetic lifelines. Ensure that material being considered for lifelines is UV-resistant.

Temperature – Extreme heat can weaken or damage some lifelines while extreme cold can make others brittle. Ensure that material being considered for lifelines can stand up to the most extreme conditions expected.

Friction and abrasion – Normal movement may wear, abrade, or otherwise damage lifelines in contact with sharp or rough surfaces. Protection such as wood softeners or rubber mats can be used at contact points to prevent wear and tear.

Sparks or flame – Hot work such as welding or flame cutting can burn, melt, cut, or otherwise damage a lifeline. Ensure that material being considered for lifelines is flame-resistant or provide appropriate protection where sparks or flame may be encountered.

Chemicals – Chemical exposure can burn or degrade a lifeline very quickly. Ensure that material being considered for lifelines will resist any chemicals encountered on the job.

Storage – Always store lifelines separately. Never store them where they may contact hazards such as sharp objects, chemicals, or gasoline.

Anchor Systems

There are three basic types of anchor systems for fall protection:

1) **designed fixed support** – load-rated anchors specifically designed and permanently installed for fall protection purposes as an integral part of the building or structure (for example, roof anchors on high-rise buildings)
2) **temporary fixed support** – anchor systems designed to be connected to the structure using specific

installation instructions (for example, nail-on anchors used by shinglers)

3) **existing structural features or equipment** not intended as anchor points but verified by a professional engineer or competent person as having adequate capacity to serve as anchor points (for example, rooftop mechanical rooms, structural steel, or reinforced concrete columns).

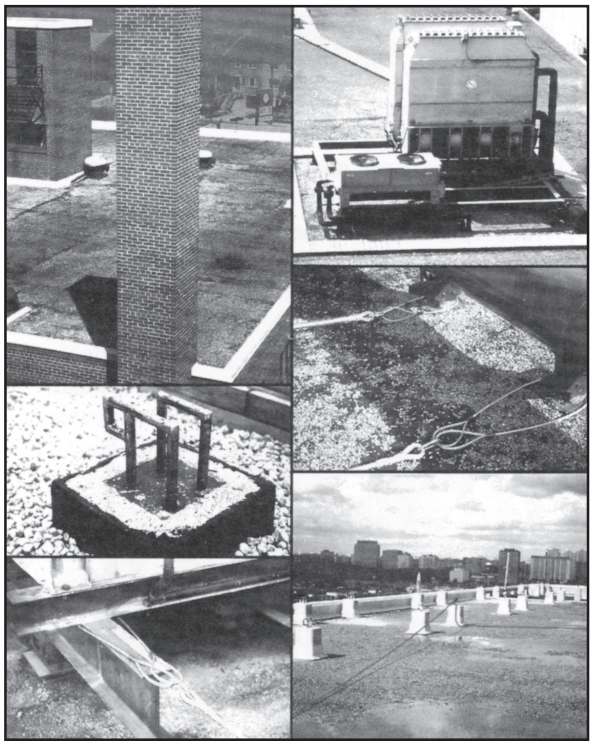
Designed fixed support can be used to anchor a fall-arrest system, fall-restricting system, or travel-restraint system if the support has been installed according to the *Building Code* and is safe and practical to use.

Temporary fixed support can be used as anchorage if it meets the following conditions:

✓ it can support at least 8 kilonewtons (1,800 pounds) without exceeding the allowable unit stress for each material used

✓ when used with a fall-arrest system incorporating an energy absorber, it can support at least 6 kilonewtons (1,350 pounds) without exceeding the allowable unit stress for each material used

✓ when used with a travel-restraint system, it can support at least 2 kilonewtons (450 pounds) without exceeding the allowable unit stress for each material used.



Examples of adequate anchorage

In all cases, **a safety factor of at least two** should be applied when determining the minimum load that an anchor point must support.

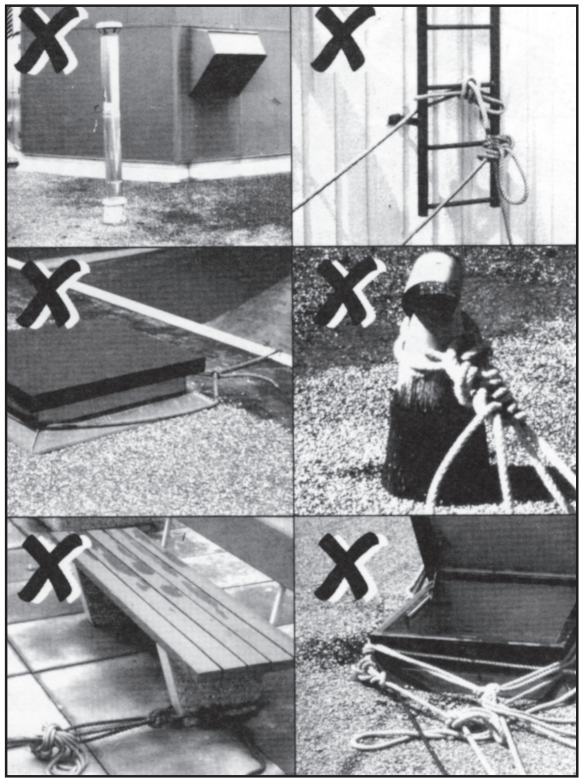
As a general rule with fall-arrest systems, choose an anchor capable of supporting the weight of a small car (about 3,600 pounds).

When existing structural features or equipment are used as anchor points, avoid corners or edges that could cut, chafe, or abrade fall protection components.

Where necessary, use softeners such as wood blocking to protect connecting devices, lifelines, or lanyards from damage.

Never anchor to

- roof vents
- roof hatches
- small pipes and ducts
- metal chimneys
- TV antennas
- stair or balcony railings
- fixed-access ladders.



Examples of inadequate anchorage

Full-Body Harness

- Chest strap should be adjusted so that it's snug and located near the middle of the chest. In a headfirst fall, a properly adjusted chest strap will prevent the worker from coming out of the harness.
- Leg straps should be adjusted so the user's fist can fit snugly between strap and leg.
- Harness straps should be adjusted to put the D-ring between the shoulder blades. A properly positioned D-ring will keep a worker upright after fall arrest.



All harnesses must be inspected before each use for

✓ burns, cuts, or signs of chemical damage

✓ loose or broken stitching

✓ frayed web material

✓ D-ring and keeper pads free from distortion and signs of undue wear or damage

✓ grommets and buckles free of damage, distortion, or sharp edges.

Make sure to check the fall-arrest indicator to confirm that it hasn't been deployed.

Lanyards

- Use manufactured lanyards only. They can be made of wire rope, synthetic fibre rope, or synthetic webbing.
- Lanyards are manufactured to specific lengths. Never try to shorten a lanyard by tying knots in it. Knots can seriously reduce its rated strength.
- Never store lanyards around chemicals, sharp objects, or in wet places. Never leave them exposed for long periods to direct sunlight.
- Most manufacturers do not permit two lanyards connected to the same D-ring. Consider using Y lanyards in place of two lanyards.

All lanyards must be inspected before each use for

- ✓ burns, cuts, or signs of chemical damage
- ✓ loose or broken stitching
- ✓ frayed web material.

Energy Absorbers

- Energy absorbers absorb some of the force generated by fall arrest. Energy absorbers can be purchased as separate equipment or built into lanyards.
- One end of the energy absorber must be connected to the D-ring on the full-body harness.
- In most cases the energy-absorbing component is enclosed in a snug-fitting jacket to protect it from the user's day-to-day activities. In a fall, the jacket tears open as the energy absorber deploys.
- Check the cover jacket for stress or tearing (many energy absorbers have a tag on the jacket that tears if the unit is exposed to a shock load—make sure this tag is intact).
- Ensure that an energy absorber built into a lanyard has a constant cross-section or diameter.

Connecting Devices

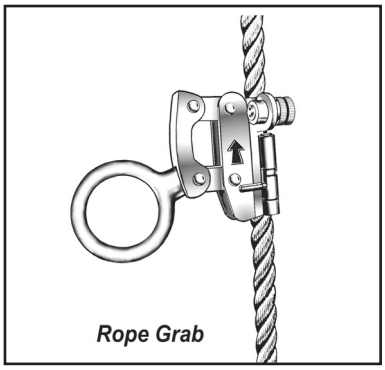
Locking Snap Hook – has a spring-loaded keeper across the opening of the hook that cannot be opened unless the locking mechanism is depressed.

Karabiner (D-Clip) – designed not to open under twist loads. To open the gate or keeper requires two separate actions: 1) twisting the locking mechanism and 2) pulling the locking mechanism back. When released, the spring-loaded locking mechanism flicks back into the locked position.

Rope Grab – used to connect lanyard to lifeline. These devices can be moved up and down the lifeline when a steady force is applied but will lock when a sharp tug or pull is applied. They will remain locked on the lifeline until the applied force is released.

Each rope grab is designed and manufactured for use with a specific diameter and type of lifeline. **Rope grab and lifeline must be compatible**. Specifications are usually listed on the housing.

The rope grab must also be attached to the lifeline in the correct direction—not upside down. On most rope grabs an arrow indicates the direction in which to orient the device. In addition, each rope grab is designed for use with a specific length of lanyard, normally two or three feet maximum.



Rope Grab

All connecting components must be inspected before each use for

- ✓ damage, cracking, dents, bends, or signs of deformation
- ✓ connecting rings centred—not bent to one side or otherwise deformed
- ✓ rust
- ✓ moving parts working smoothly
- ✓ signs of wear or metal fatigue.

Fall-Arrest Planning

Before deciding on a fall-arrest system, assess the hazards a worker may be exposed to in case of a fall.

Before the fall is arrested, will the worker "bottom out," that is, hit ground, material, equipment, or a lower level of the structure? Will the pendulum effect cause the worker to swing from side to side, possibly striking equipment, material, or structure? In the event of fall arrest, how will the suspended worker be rescued? Planning must take into account these and other concerns.

Total fall distance is the distance required to fully arrest a fall. It consists of

- Free-fall distance, which should be kept to 1.5 metres (5 feet) or less, plus
- Fall-stopping distance, which includes the stretch in the lanyard (minimal) and lifeline, slack in the harness (maximum 30 cm or 1 foot due to allowable adjustments for user's comfort), and deployment of the energy absorber (maximum 1.1 metres—or 42 inches).

Free-fall distance is measured from the D-ring of a worker standing on the work surface down to the point where either the lanyard or the energy absorber begins to arrest the fall. It is strongly recommended that this distance be kept as short as possible.

To minimize free fall, workers should tie off to an anchor overhead and use as short a lanyard as the work will allow.

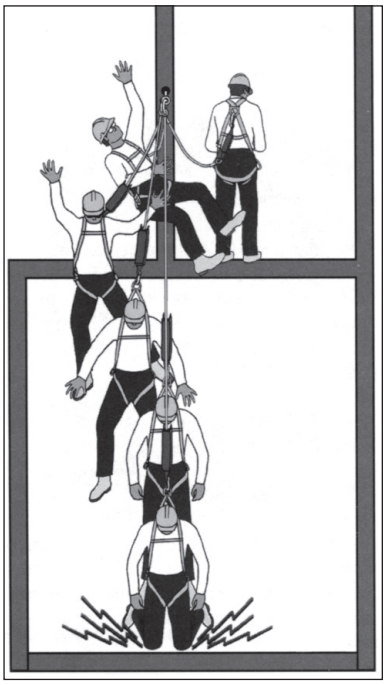
Where a worker is connected to a vertical lifeline by a rope grab, the rope grab should be positioned as high above the D-ring as the work will allow. By doing this, the worker minimizes not only the free-fall distance but also the fall-stopping distance required to completely arrest a fall.

Bottoming Out

Bottoming out occurs when a falling worker hits a lower level, the ground, or some other hazard before the fall is fully arrested.

This occurs when Total Fall Distance is greater than the distance from the work surface to the next level, the ground, or some other hazard below.

Fall-arrest systems must be planned, designed, and installed to prevent any risk of bottoming out.

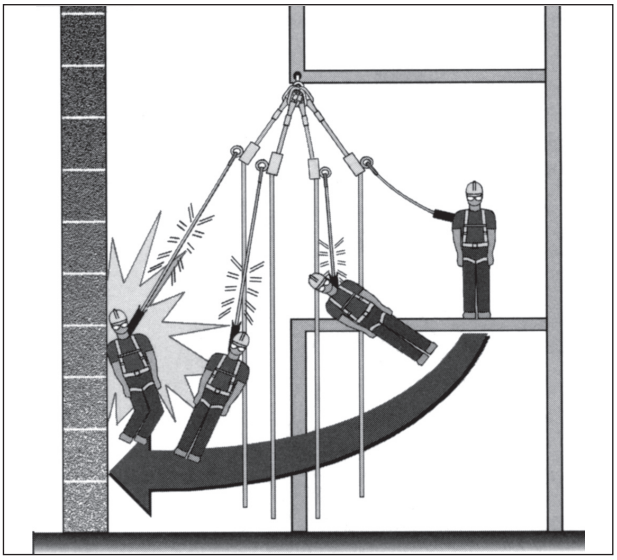


Bottoming Out

Pendulum Effect

The farther you move sideways from your anchor point, the greater the chance of swinging if you fall. This is known as the "pendulum effect." And the more you swing, the greater the force with which you'll strike columns, walls, frames, or other objects in your path.

Swinging may even cause your taut lanyard or lifeline to break where it runs over rough or sharp edges.



Swing Fall or Pendulum Effect

To minimize pendulum effect, workers should keep lanyard or lifeline perpendicular from edge to anchor. Where work extends along an open edge, anchor points can be changed to keep lanyard or lifeline perpendicular as work progresses.

Another solution is to run a horizontal lifeline parallel to the edge. The worker attaches lanyard to lifeline, moves along the edge, and the lanyard travels at the same pace, remaining close to perpendicular at all times.

Emergency Rescue

The construction regulation (O. Reg. 213/91) requires that before workers use any fall-arrest system or safety net on a project, the employer must develop written rescue procedures. It's important that a worker involved in a fall arrest be brought to a safe area as quickly as possible without causing injury or putting rescuers at risk.

In many cases, the rescue plan can be simple. A ladder or elevating work platform can be used to reach suspended workers and get them down safely. Other workers may be hauled back up to the level from which they fell or pulled in through a nearby window or other opening.

In other cases, procedures may be more complicated. For instance, workers trapped on a failed swingstage, or hanging from it, may need to be rescued by specially trained and equipped personnel from the local fire department. Aerial ladder trucks or other high-reach equipment may be necessary. In extreme cases, the fire department may use rappelling techniques to reach trapped workers and lift or lower them to a safe level.

Plans should cover the on-site equipment, personnel, and procedures for different types of rescue. Any off-site rescue services that might be required should be contacted and arranged in advance to familiarize them with the project. IHSA's Emergency Response poster (P103) can be used to indicate the nearest hospital and the phone numbers of fire, ambulance, and police services.

Site management must ensure that

- everyone on site is aware of the rescue plan
- equipment and other resources are available
- designated personnel are properly trained.

Workers must receive training from their employer regarding the specific fall protection equipment and procedures they will use. Products differ not only between manufacturers but also between product lines in a single company. Training must therefore cover the exact harness, lanyard, energy absorber, rope grab, lifeline, and anchorage each worker will rely on, as well as the applications to be encountered.

Conclusion

Employers, supervisors, and workers all have responsibilities in reducing or eliminating falls in construction.

This section has provided guidelines for fall protection, including both fall prevention and fall arrest. But the information means nothing unless employers, supervisors, and workers apply it on the job.

Workers who have any questions about fall hazards or fall protection should ask their supervisor. When it comes to fall protection, make sure you know how the equipment works and how to use it. Your life depends on it.

16 HAND/SKIN PROTECTION

In construction, exposed hands and skin are susceptible to physical, chemical, and radiation hazards. Personal hand/skin protection is often the only practical means of preventing injury from

- physical hazards—sharp or jagged edges on materials and tools; heat; vibration
- corrosive or toxic chemicals
- ultraviolet radiation.

Physical Hazards

For physical hazards such as sharp edges, splinters, and heat, leather gloves are the preferred protection. Cotton or other materials do not stand up well and are recommended only for light-duty jobs.

Vibration transferred from tools and equipment can affect hands and arms. One result may be hand/arm vibration syndrome (HAVS). This disease causes the following changes in fingers and hands:

- circulation problems such as whitening or bluish discoloration, especially after exposure to cold
- sensory problems such as numbness and tingling
- musculoskeletal problems such as difficulty with fine motor movements—for instance, picking up small objects.

Workers who use vibrating tools such as jackhammers, grinders, riveters, and compactors on a daily basis may develop HAVS. Preventing this disease requires cooperation between employers and workers.

Employers

- Provide power tools with built-in vibration-reducing components.
- Review exposure times and allow rest breaks away from vibrating tools.
- Ensure proper tool maintenance (worn grinding wheels or tool bearings can lead to higher vibration levels).
- Train exposed workers in prevention techniques.
- Provide anti-vibration gloves.

Workers

- Wear appropriate clothing in cooler weather to maintain core body temperature.
- Wear gloves whenever possible.
- Wear anti-vibration gloves when using power tools and equipment.
- Avoid smoking (smoking contributes to circulatory problems).
- Report any poorly functioning tools immediately.

Chemical Hazards

For protection against chemical hazards, the material safety data sheet (MSDS) for the product being used should identify whether gloves are needed and what they should be made of. MSDSs must be available on site for all controlled products being used.

Table 8: Glove Selection Chart

Chemical Name	Glove Selection
Acetone	Butyl Rubber
Cellosolve	PVA, PVC, Neoprene
Cellosolve Acetate	PVA, PVC
Cyclohexane	NBR, Viton®
Hexane	Neoprene, NBR, PVA
Methyl Alcohol	Neoprene, Rubber, NBR
Methyl Chloroform	PVA, Viton
Methylene Chloride	PVA, Viton
Methyl Ethyl Ketone	Butyl Rubber
Methyl Isobutyl Ketone	Butyl Rubber, PVA
Mineral Spirits	Neoprene
Naphtha	NBR, PVA
Perchloroethylene	NBR, PVA, Viton
Stoddard Solvent	PVA, NBR, Rubber
Toluene	PVA, Viton
Turpentine	PVA, NBR
Trichloroethylene	PVA, Viton
1, 1, 1 Trichloroethane	PVA, Viton
1, 1, 2 Trichloroethane	PVA, Viton
Xylene	PVA, Viton

PVA – Polyvinyl Alcohol
PVC – Polyvinyl Chloride
NBR – Nitrite Butyl Rubber
Viton® – Dupont tradename product

Table 8 identifies glove materials to be worn for protection against chemicals that may injure the skin. This information can be used when the MSDS does not specify the type of glove to be worn.

CAUTION: Common glove materials have limited protective properties and do not protect against all hazards. Some solvents, degreasers, and other liquids can penetrate and/or dissolve rubber, neoprene, or PVC.

Ultraviolet Radiation

In recent years, there has been growing concern over the health risks of exposure to the sun's ultraviolet (UV) radiation. Construction workers are particularly at risk because they often work outdoors.

Long-term health risks of UV exposure include skin cancer. Every year there has been an alarming increase in the incidence of skin cancer. Sunlight is the main source of UV radiation known to damage the skin and cause skin cancer. Exposure to the sun's UV radiation is widely recognized as a *highly preventable* cause of skin cancer.

Melanoma is the least common but most dangerous type of skin cancer. The incidence of melanoma in men is rising faster than all other cancers. According to the Canadian Dermatology Association (CDA), the mortality rate from malignant melanoma is increasing, particularly in middle-aged males.

Melanomas most often appear on the upper back, head, and neck. The CDA also notes that there is generally a lag time of 10 to 30 years for the clinical appearance of skin cancer to occur. Consequently, it is critical for young workers to beware of the cumulative effect of unprotected

sun exposure. The more time they spend unprotected in the sun, the higher the risk of developing skin cancer.

Although most construction workers generally cover up their arms, legs, and torso on site, their faces and necks are still exposed to the sun's harmful rays. In addition, areas like the tips of the ears and the lips are often overlooked when it comes to sun protection.

The type of skin cancer that develops on the ear or the lip has a high chance of spreading to other parts of the body and causing death. Melanoma may also occur on the sun-exposed parts of the head and neck.

In fact the majority of skin cancers (two out of three) occur on the head and neck, followed by the forearm and back of the hand. Workers too often leave these critical areas exposed to the harmful effects of UV radiation.

Individual risk factors for developing skin cancer include

- fair skin that burns easily
- blistering sunburns in childhood and adolescence
- family history of melanoma
- many freckles and moles.

In addition to the harmful effects of the sun's direct rays, some workers may be exposed to indirect UV radiation. Workers can receive additional radiation if they are on or near a surface that reflects sunlight. Reflective surfaces such as concrete, water, unpainted corrugated steel, building glass, and aluminum can increase the amount of ultraviolet radiation to which a worker is exposed.

Another source of indirect UV radiation is from the hard hat itself. UV rays can reflect off the hard hat onto a worker's face, magnifying the amount of UV exposure.

Although all construction workers are at risk, those who don't have ready access to shade and/or who work at heights are at a higher risk for UV overexposure. These trades include

- concrete finishing workers
- roofers
- rodworkers
- formworkers on high-rise and residential sites
- roadworkers
- traffic signallers
- ironworkers.

In addition, working at sites with southern exposure decreases the daytime shade available and increases UV exposure.

Remember—even on cloudy or hazy days, UV radiation can penetrate the atmosphere and burn your skin.

What Workers Can Do

✓ Apply a broad-spectrum sunscreen with a sun protection factor (SPF) of 30 or greater to all exposed skin areas. Be sure to cover your ears and the back of your neck. Apply sunscreen 20 to 30 minutes before you go out in the sun. Reapply sunscreen every two hours.

✓ Use an SPF 30 or higher sunscreen lip balm and reapply every two hours. Skin cancers can develop on lips.

✓ You may add UV protection to the back of your neck by using fabric to block the sun's rays. Neck protectors that clip onto your hard hat are available.

✓ Wear UV-absorbent safety glasses (CSA-approved polycarbonate glasses incorporate this feature).

✓ Wear clothing that covers as much of the skin as possible. Tightly woven material will offer greater protection as a physical block to UV rays.

✓ If you sweat heavily, you may need to reapply sunscreen more often. Additionally, when clothing is wet, it loses some of its ability to block out the sun's rays. Ensure you have additional dry clothing if necessary.

✓ Try to find a shaded area for your breaks and lunch.

✓ Wear a wide-brim hard hat designed to protect your face and neck from the sun. Adding a glare guard under the peak of your hard hat will help reduce reflective UV rays.

✓ Examine your skin regularly for any unusual changes. The most important warning sign for skin cancer is a spot on the skin that is changing in size, shape, or colour. The danger signs include any wound or skin patch that doesn't heal properly or scales. Be particularly attentive to any mole that grows or becomes irregular in shape, especially if it is multi-coloured. If anything looks unusual, see your doctor as soon as possible. **Skin cancers detected early can almost always be cured.**

What Employers Can Do

✓ Supply workers with a broad-spectrum sunscreen with an SPF of 30 or higher.

✓ Ensure adequate shaded areas for workers on breaks and lunch.

✓ If possible, rotate workers to shaded areas of the jobsite.

✓ Educate workers on the hazards of UV radiation.

✓ Ensure that workers use UV-absorbent safety glasses.

The majority of skin cancers are preventable. Taking basic precautions can significantly reduce the health effects of chronic sun exposure.

15 RESPIRATORY PROTECTION

Introduction

In the course of their work, construction personnel are often exposed to respiratory hazards in the form of dangerous dusts, gases, fumes, mists, and vapours.

In some cases, careful selection of materials and work practices can virtually eliminate respiratory hazards. Where that is not possible, the next best choice is engineering controls such as fume exhaust systems that deal with the hazard at the source.

Respirators are the least preferred method of protection from respiratory hazards because they

- do not deal with the hazard at the source
- can be unreliable if not properly fitted and maintained
- may be uncomfortable to wear.

In spite of these drawbacks, respiratory protective equipment is the only practical control in many construction operations.

Respiratory Hazards

Respiratory hazards may be present as

- gases
- vapours
- fumes
- mists
- dusts
- bioaerosols (e.g., moulds)

Gases consist of individual molecules of substances, and at room temperature and pressure, they are always in the gaseous state. Common toxic gases found in construction are carbon monoxide from engine exhaust and hydrogen sulphide produced by decaying matter found in sewers and other places.

Vapours are similar to gases except that they are formed by the evaporation of liquids (e.g., water vapour). Common vapours found in construction are produced by solvents such as xylene, toluene, and mineral spirits used in paints, coatings, and degreasers.

Fumes are quite different from gases or vapours, although the terms are often used interchangeably. Technically, fumes consist of small particles formed by the condensation of materials which have been subjected to high temperatures. Welding fume is the most common type of fume in construction. Another example is pitch fume from coal tar used in built-up roofing.

Mists are small droplets of liquid suspended in air. The spraying of paint, form oils, and other materials generates mists of varying composition.

Dusts are generated by crushing, grinding, sanding, or cutting and by work such as demolition. Two kinds of hazardous dust common in construction are fibrous dust from insulation materials (such as asbestos, mineral wool, and glass fibre) and non-fibrous silica dust from sandblasting, concrete cutting, or rock drilling.

Bioaerosols are airborne particles that contain microbes such as mould, bacteria, viruses, or pollen. If inhaled, they can cause infectious diseases (Legionellosis, Tuberculosis, etc.), respiratory infections, or allergic reactions.

In construction settings, respiratory hazards may be compounded, depending on the number and variety of jobs under way. For example, both mist and vapours may be present from paint spraying or both gases and fumes from welding.

Health Effects

Inhalation hazards can be divided into the following classes based on the type of effects they cause.

1. **Irritants** are materials that irritate the eyes, nose, throat, or lungs. This group includes fibreglass dust, hydrogen chloride gas, ozone, and many solvent vapours. With some materials (e.g., cadmium fume produced by welding or oxyacetylene cutting of metals coated with cadmium) the irritation leads to a pneumonia-like condition called pulmonary edema. **This effect may not be apparent until several hours after exposure has stopped.**

2. **Asphyxiants** are substances which result in inadequate oxygen in the body. They can be classified as either **simple asphyxiants** or **chemical asphyxiants.**

   Simple asphyxiants are other gases or vapours that cause oxygen to be displaced, creating an **oxygen-deficient atmosphere**. For example, nitrogen used to purge tanks can displace oxygen, resulting in unconsciousness and even death for those who enter. Oxygen may also be consumed by chemical or biological activity such as rusting or bacteria digesting sewage.

   Chemical asphyxiants interfere with the body's ability to transport or use oxygen. Two examples are carbon monoxide and hydrogen sulphide.

3. **Central nervous system depressants** interfere with nerve function and cause symptoms such as headache, drowsiness, nausea, and fatigue. Most solvents are central nervous system depressants.

4. **Fibrotic materials** cause "fibrosis" or scarring of lung tissue in the air sacs. Common fibrotic materials found in construction include asbestos and silica.

5. **Carcinogens** cause or promote cancer in specific body organs. Silica, asbestos, and hexavalent chromium are examples of carcinogens.

6. **Dusts** do not cause significant effects unless exposure is of high concentration and/or long duration. Excessive exposure to these substances can be adverse in itself or can aggravate existing conditions such as emphysema, asthma, or bronchitis. Examples include plaster dust, cellulose from some insulation, and limestone dust.

7. **Biological hazards** include moulds, bacteria, or viruses. If inhaled, they can cause eye, nose and throat irritation, hypersensitivity pneumonitis, or asthma.

8. **Respiratory sensitizers** are chemicals such as isocyanates in spray foam insulation or certain wood dusts. If inhaled, respiratory sensitizers can cause asthma.

Respiratory Protective Equipment

A wide variety of equipment can be used to protect workers from respiratory hazards. Devices range from a simple, inexpensive filtering facepiece respirator to a sophisticated self-contained breathing apparatus. Generally, the equipment can be divided into two distinct classes—air-purifying respirators and supplied-air respirators.

A. Air-purifying Respirators

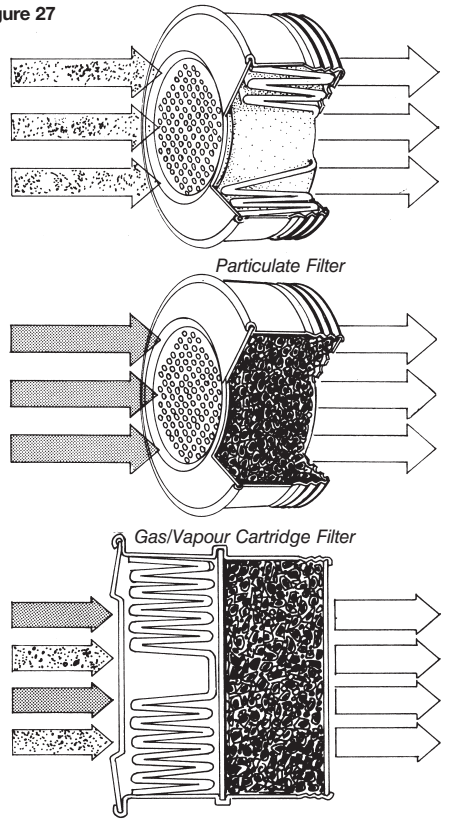
As their name indicates, these devices purify the air drawn through them. There are two main types of air-purifying respirators:

1) **Non-powered**
   Air is drawn through the air-purifying filter, cartridge or cannister by the wearer breathing in and creating a negative pressure in the facepiece. Non-powered respirators depend entirely on the wearer breathing in (inhaling) and breathing out (exhaling) to deliver an adequate supply of purified breathing air.
2) **Powered**
   These respirators have a blower carried by the wearer that passes contaminated air through an air-purifying component and supplies the purified air to the wearer (Figure 31).

Air-purifying respirators have limitations and should not be used where

- there is insufficient oxygen (less than 19.5%)
- very high concentrations of contaminant are present.

Figure 27



Filter Types

Warning: Air-purifying respirators simply remove certain airborne hazards. They do not increase or replenish the oxygen content of the air and should never be worn in atmospheres containing less than 19.5% oxygen.

Although many different filters have been designed for specific hazards, there are three basic types used with air-purifying respirators:

1) particulate filters
2) gas/vapour cartridge filters
3) combination particulate/gas/vapour cartridge filters (Figure 27).

1) Particulate Filters

This type removes solid particles such as dusts, fumes, or mists and operates like the air filter in a car engine. The devices may be filtering facepiece respirators or respirators with replaceable filters. Different grades of filters are available, depending on the size of particles to be removed.

When particulate filters fill up with dust or fume, they become harder to breathe through but are more efficient, since air is being filtered through the layer of trapped particles as well as the filter itself.

While particulate filters can provide good protection against particles such as dusts, mists, or fumes, they cannot filter out gases or vapours because of the very small size of gas and vapour molecules.

Particulate filters for non-powered air-purifying respirators are divided into three levels of filter efficiency: 95%, 99%, and 99.97%. These numbers refer to the percentage of particles the filter can remove, based on the particle size most difficult to trap. For workers removing asbestos insulation or lead paint, for instance, the 99.97% efficiency cartridge may be appropriate for the circumstances. This is known as the 100 efficiency class, previously identified as the HEPA filter.

Oil has been found to ruin the filtering ability of some filter material. Oil coats the filter fibres, preventing the electrostatic charge on the fibres from attracting and removing particulates. Therefore, to ensure that a suitable filter is being used, particulate filters have an N, R, or P designation:

N – **N**ot resistant to oil
R – **R**esistant to oil
P – oil-**P**roof.

The N series of filters is suitable for airborne particles such as wood dust, when there are no oil-based particles also in the air. For example, an N series filter would be recommended during the removal of old lead paint. However, when spraying form oil or putting down hot asphalt—operations that involve airborne oil particles—the correct filter would have an R or P designation.

The R series—resistant to oil—should only be used for an 8-hour single shift when solvent or oil mist is present in the air.

This filter resists oil but may lose its filtering ability when in contact with oil over a long time.

When using P series filters, check the manufacturer's instructions to determine how long the filter can be used when airborne oil particles are present.

Warning: N, R, and P series filters by themselves do not provide protection against organic vapours.

2) Gas/Vapour Cartridge Filters

This type uses substances which absorb or neutralize gases and vapours. Unlike particulate filters, gas/vapour cartridge filters become less efficient the longer they are used. They act like sponges and, when full, allow gas or vapour to pass through without being absorbed. This is called "breakthrough."

Common gas/vapour cartridge filters include the following:

- "Organic Vapour Cartridges" usually contain activated charcoal to remove vapours such as toluene, xylene, and mineral spirits found in paints, adhesives, and cleaners.
- "Acid Gas Cartridges" contain materials which absorb acids and may be used for protection against limited concentrations of hydrogen chloride, sulphur dioxide, and chlorine.
- "Ammonia Cartridges" contain an absorbent designed specifically to remove only ammonia gases.

Note:

Certain cartridges are available with an end-of-service-life indicator. These cartridges have been developed for a few contaminants with poor warning properties. The end-of-service-life indicator changes colour to warn the user to change the cartridge.

Cartridges must not be used for contaminants with poor warning properties unless the respirator manufacturer can offer cartridges with end-of-service-life indicators.

If the respirator is not equipped with an end-of-service-life indicator, a change-out schedule is required. The schedule is used to determine the service life of the cartridge. The respirator manufacturer should be consulted for guidance on the development of this schedule.

3) Combination Particulate/Gas/Vapour Cartridge Filters

This type removes particulate matter, vapours, and gases from the air. It is used where more than one type of hazard is present or may develop.

B. Supplied-Air Respirators

Supplied-air respirators provide clean breathing air from an uncontaminated source, usually a special compressor located in a clean environment, or from cylinders containing compressed breathing air. The quality of the air supplied should meet the requirements of CSA Standard Z180.1, *Compressed Breathing Air and Systems*.

The moisture content of supplied air should be limited to prevent fogging, corrosion, and freezing of regulators and valves and to prolong the service life of filters used to remove other contaminants.

The "pressure dew point" is important in relation to moisture. The term refers to the temperature at which moisture in compressed air, at a given pressure, will condense out as droplets or "dew." It must be kept at least 5°C below the lowest expected ambient temperature. Water vapour can be removed from compressed air with a drying system or water-absorbing materials.

Types of Supplied-Air Respirators

The three basic types of supplied-air respirators are air-line unit, self-contained breathing apparatus (SCBA), and multi-function unit (incorporates both SCBA and air-line).

The **air-line unit** consists of compressed breathing air, portable supplied air, or a clean ambient air system. The air is supplied to the user by a hose attached to the wearer's belt. This allows for quick disconnecting in an emergency. The clean air flows from the air supply system through the hose and to the user's respirator facepiece (Figure 28).

The **self-contained breathing apparatus** (SCBA) uses a cylinder of air carried by the wearer (Figure 29). SCBAs are awkward, heavy, and require frequent cylinder changes.

The **multi-function unit** (combination air-line/SCBA) is available for working in confined spaces and other high-risk assignments where reserve protection is required (Figure 30).

With these devices or with simple air-line units, the wearer's mobility is understandably restricted by the trailing hose and the length of line available. In addition, air-lines may get crimped or may snag on equipment.

If an atmosphere is immediately dangerous to life or health, a combination air-line/SCBA unit is required.

Both air-line and SCBA units are more expensive than air-purifying systems, but they generally provide much greater protection.

Modes of Operation

Respirators can operate in the following modes:

1) "pressure-demand" or "positive pressure"
2) "constant-flow"
3) "negative pressure" or "demand"

1) Pressure-Demand or Positive Pressure Mode

In "pressure-demand" or "positive pressure" mode, the pressure in the facepiece or hood always remains positive. When there is a slight decrease in positive pressure inside the facepiece, more air is supplied. If leakage occurs, it is directed outside of the facepiece rather than inside.

2) Constant-Flow Mode

As the name implies, these devices deliver a constant flow of air to the wearer. Powered air-purifying respirators (PAPRs) use a battery-powered fan to draw air through the filter and then blow it into the facepiece (Figure 31). Constant-flow supplied-air respirators such as sandblasters' hoods use a simple valve to control the flow of "clean" air from the compressor. Minimum flow rates of 170 litres per minute (6 cubic ft/min) for loose-fitting hoods or helmets and 115 litres per minute (4 cubic ft/min) for tight-fitting

facepieces must be maintained to minimize inward leakage of contaminated air and still provide adequate breathing air.

3) Negative Pressure or Demand Mode

In "negative pressure" or "demand" mode, air is delivered only when there is a slight negative pressure created in the facepiece. Contaminated air may leak inward around the facepiece, so these devices have limited use in high-exposure conditions.

Styles of Facepieces

In addition to the type of respirator and mode of operation, the style of facepiece is used to classify respirators. Different styles are available (Figure 32).

Assigned-Protection Factors

The assigned-protection factor (APF) is a measure of the anticipated level of protection provided by a properly functioning respirator to properly trained users. Most respirators are assigned an APF. APFs are used in the selection process to determine the maximum use concentration (MUC) for the respirator.

The MUC is the maximum level of an airborne contaminant from which an employee is expected to be protected when wearing a respirator. It is determined by multiplying the APF of the respirator or class of respirators by the occupational exposure limit for that contaminant.

For example, the exposure limit for chrysotile asbestos in Ontario is 0.1 fibre/cm^3 of air. If we are using a half-mask respirator with N100 filters (APF=10), the MUC is 1 fibre/cm^3. This is obtained by multiplying the assigned PF (10) by the exposure limit (0.1 fibre/cm^3). If the concentration of asbestos becomes greater than 1 fibre/cm^3 during the course of work, a respirator with a greater protection factor must be used.

The Canadian Standards Association (CSA), the US National Institute for Occupational Safety and Health (NIOSH), and the American National Standards Institute (ANSI) have each published slightly different assigned protection factors. In this manual, OHSA-assigned protection factors are used.

The degree of protection depends on the type of respirator, style of facepiece, and principle of operation.

Generally, supplied-air respirators provide better protection than air-purifying respirators; full-face masks provide better protection than half-face masks; and positive-pressure devices provide more protection than negative-pressure types.

Table 7 lists assigned-protection factors for the respirators described so far. The information can be used to select the most appropriate device for any given situation.

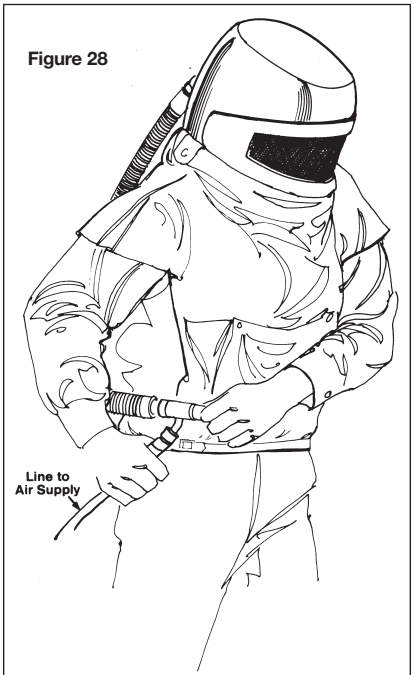
The assigned-protection factors listed in Table 7 were determined by testing a wide variety of devices worn by a large number of people and represent the average degree of protection achieved. Assigned-protection factors for individual wearers may differ significantly from the values listed.

Respirator Selection

In order to select the proper respirator for a particular job, it is necessary to know and understand

- the characteristics of the contaminant(s)
- the anticipated exposure conditions

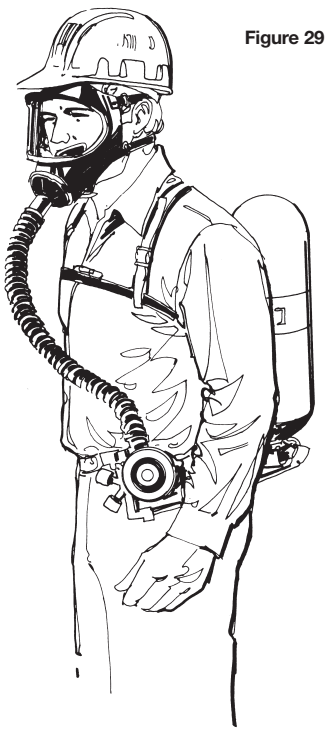
Figure 28



Type CE abrasive-blast supplied-air respirators are the only respirators suitable for abrasive-blast (sandblasting) operations. As a minimum, NIOSH recommends a type CE, positive pressure, with tight-fitting half-mask facepiece respirator.

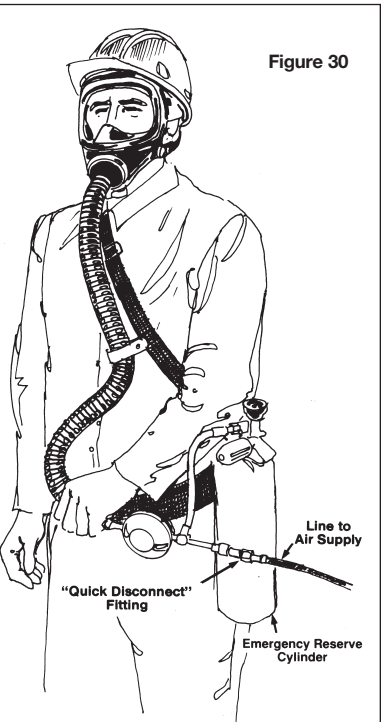
Abrasive–Blaster's Supplied-Air Hood

Figure 29



Self-Contained Breathing Apparatus (SCBA)

Figure 30



Combination Air-Line/SCBA Unit

Figure 31



Powered Air-Purifying Respirators (PAPRs)

- the performance limitations of the equipment
- any legislation that applies.

It is also important to realize that facial hair and deep facial scars can interfere with the seal between respirator and face. Respirators should only be selected by someone who understands all of these factors.

Before using or handling a controlled product, consult the material safety data sheet (MSDS). The MSDS will identify any respiratory protection required. Under the Workplace Hazardous Materials Information System (WHMIS), MSDSs must be available to users of controlled products. The MSDS should specify the type of respirator to be worn.

The chart at the end of this section is a guide to respirator selection. It is intended as a guide only and may not be applicable to every case.

For activities not listed, information regarding type of work, nature of material(s) involved, and working conditions is required and expert advice should be obtained.

If there is any doubt about the correct type of protection for a specific material and operation, consult the manufacturer of the product, a supplier or manufacturer of respirators, or IHSA. When seeking information on the type of respirator for use in specific situations, provide as much of the following information as possible:

a) Name and form of the material (oil or non-oil). If the form is unknown, consider it an oil.

b) Type of work to be done (e.g., painting, welding).

c) Description of worksite conditions (e.g., inside a tank, outdoors).

d) Exposure concentration, if known (e.g., 150 ppm of toluene).

e) Whether the material will be heated, sprayed, etc.

f) Other materials being used in the vicinity. The respiratory protection specialist will evaluate this information and compare it with the following additional data:

g) The occupational exposure limit of the dust, gas, or vapour, often referred to as the TLV® or Threshold Limit Value*. These values are used in conjunction with the assigned-protection factors listed in Table 1 to determine the maximum use concentration.

**TLV is a term copyrighted by the American Conference of Governmental Industrial Hygienists.*

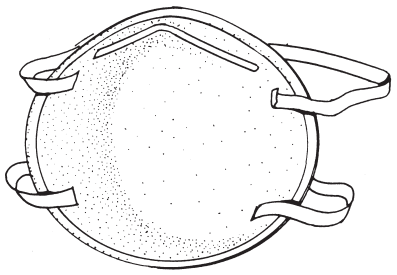
h) The physical properties of the contaminant:

- Vapour Pressure — The maximum amount of vapour that can be generated under given conditions.
- Warning Properties (e.g., irritation, odour, taste) – Warning properties of the contaminent shall not be relied on for cartridge/ canister change out.
- Health Effects — With cancer-causing materials, a higher degree of protection is usually specified.
- Performance of Filters — With some gases and vapours, the filter can become overloaded in just a few minutes. Therefore, knowledge of the filtering material and its performance against specific gases and vapours is necessary.

i) The concentration considered to be Immediately Dangerous to Life or Health (IDLH). IDLH atmospheres pose an immediate threat to life or health or the threat of a serious but delayed effect on health (e.g., radioactive dust exposures). One example of an IDLH situation is the repair of a chlorine leak where a worker could be overcome by the gas very quickly. IDLH atmospheres should only be entered by persons wearing SCBA or SCBA/air-line respirators as shown in Figures 29 and 30.

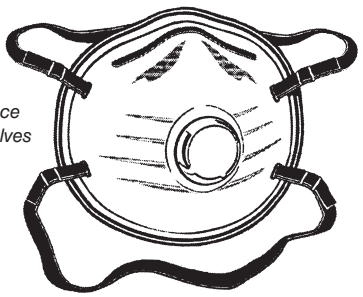
j) Possibility of skin absorption. With some chemicals the amount of material that can be absorbed through the skin is of equal or greater concern than the amount of gas or vapour that can be inhaled. For these situations, supplied-air protective suits may be necessary.

Figure 32

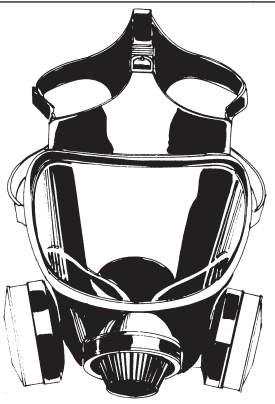


Filtering Facepiece for Particulates

Filtering Half-Facepieces
Most of these devices are designed to be worn only once. They fit over the mouth and nose, rest on the chin, and are held in place by two straps. Some of the more sophisticated versions with adjustable straps and exhalation valves can be worn more than once, provided they are not damaged.

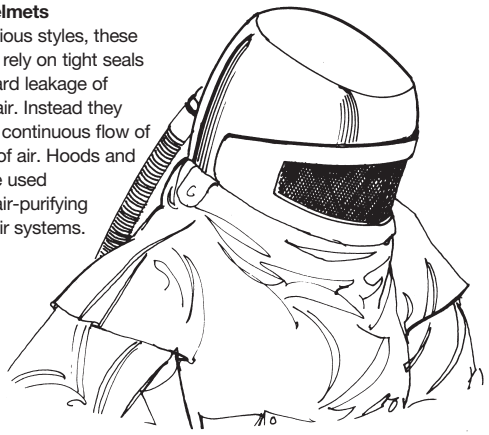


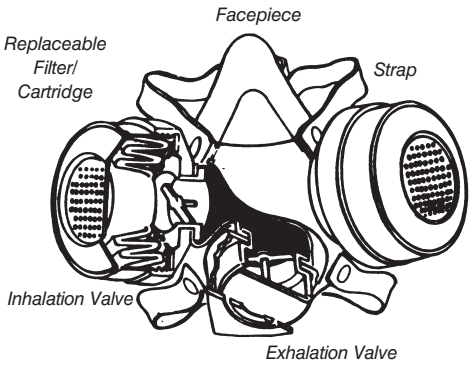
Filtering Facepiece with Exhalation Valves



Full-Face Mask
This style covers the entire face and consists of a moulded rubber or plastic frame and a clear visor. Since it fits against the relatively smooth rim of the face, it provides more protection than other face masks. Full-face masks can be used with air-purifying, powered air-purifying, and supplied-air respirators.

Hoods and Helmets
Unlike the previous styles, these devices do not rely on tight seals to prevent inward leakage of contaminated air. Instead they depend on the continuous flow of large volumes of air. Hoods and helmets can be used with powered air-purifying and supplied-air systems.





Half-Face Mask
This style is widely used as an air-purifying respirator with one or more filters or cartridges attached to the facepiece. The silicone, thermoplastic, or rubber facepiece covers the mouth and nose, cups under the chin, and is usually held in place by two straps. It generally provides better protection than quarter-face masks because the chin cup affords a more secure fit.

k) Eye irritation — some contaminants will cause eye irritation, making it difficult to see. For these contaminants, a full-face mask must be worn.

As shown by points a) to k), many factors must be considered to ensure that the proper respirator is selected for a specific situation.

Note

Facial hair and eye protection can adversely affect the respirator seal. Facial hair between the face and a tight-fitting respirator can cause a great deal of leakage and reduce the effectiveness of protection significantly. Respirator wearers should be clean-shaven to achieve the best possible seal. Where eye protection with temple bars or straps passing between face and respirator is necessary, consider wearing a full-face mask.

Fit Testing and Seal Checks

Once a respirator has been selected, the next critical step is ensuring that it fits properly. One size does not fit all.

No person should be assigned a tight-fitting respirator or wear one unless a fit test has been conducted.

With negative-pressure respirators (e.g., non-powered air-purifying respirators and demand supplied-air respirators) gaps in the seal will permit contaminated air to enter the breathing zone.

With positive-pressure respirators (e.g., powered air-purifying respirators and pressure-demand supplied-air respirators) a lot of air will be wasted through outward

Table 7: Protection Factors (according to NIOSH)

Type of Respirator	Type of Facepiece	Mode	Assigned-protection Factor
Non-powered Air-purifying	Filtering facepiece	Negative	10
	Half-facepiece	Negative	10
	Full-facepiece	Negative	50
Powered Air-purifying	Loose fitting helmet/hood	Continuous	25/1000*
	Loose fitting facepiece/visor	Continuous	25
	Half-facepiece	Continuous	50
	Full-facepiece	Continuous	1000
Supplied-air or Air-line	Half-facepiece	Demand	10
	Full-facepiece	Demand	50
	Half-facepiece	Continuous	50
	Full-facepiece	Continuous	1000
	Helmet/hood	Continuous	25/1000*
	Loose-fitting facepiece	Continuous	25
	Half-facepiece	Pressure-demand	50
	Full-facepiece	Pressure-demand	1000
SCBA	Full facepiece or tight-fitting hood	Pressure-demand	10,000

†The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1000 or greater to receive an APF of 1000. Without such information, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

leakage and the degree of protection provided to the wearer could be reduced. Also, "venturi effects" may allow air to escape in one area and draw contaminated air into the facepiece around the escaping air.

For these and other reasons, the fit of respirators must be carefully tested. Generally there are two types of fit testing — qualitative and quantitative.

Qualitative Fit Tests

1) **Irritant Smoke Test** — This test is used to determine the fit of P100 particulate filter respirators. (Note: It is not intended for N- or R- respirators.) A cloud of irritant smoke is created around the wearer. If leakage is detected the respirator should be adjusted.

   Caution: Most of the smoke clouds used in this test are very irritating to the eyes, nose, and throat. Workers are advised to keep their eyes closed during the test and to back out of the smoke as soon as they notice any leakage or irritation.

2) **Iso Amyl Acetate (Banana Oil) Test** — The wearer puts on the respirator with "organic vapour" cartridge filters in place. A cotton swab dipped in iso amyl acetate solution is passed along the outline of the facepiece (iso amyl acetate smells like very ripe bananas). If the wearer smells the solution, the respirator should be adjusted.

   Note: Some people cannot smell iso amyl acetate. Before starting the test, check to ensure that the person can detect the odour. Use two small jars, one containing water, the other containing the test solution. Ask the person whether one smells different and what it smells like.

3) **Saccharin Test** — This test is similar to the iso amyl acetate test except that it uses saccharin as the test material and a respirator equipped with a particulate filter. If the sweet taste or smell of saccharin is detected, the fit must be adjusted.



4) **Bitrex Solution Aerosol Test** — In this test the wearer puts on the respirator with any particulate filter. A hood or test enclosure is put over the wearer's head and shoulders. Bitrex is then sprayed into the hood or enclosure. Bitrex is a very bitter solution and can easily be detected if it leaks through the face seal. If the wearer cannot taste the Bitrex, then the respirator fits properly.

Quantitative Fit Tests

In these tests the wearer puts on a special respirator which has a probe mounted inside the facepiece. The fit of the respirator can be determined by

1) comparing the amount of test aerosol outside the respirator to the amount inside the respirator
2) comparing the amount of ambient aerosol outside of the respirator to the amount inside the respirator
3) measuring the amount of pressure leakage from the respirator.

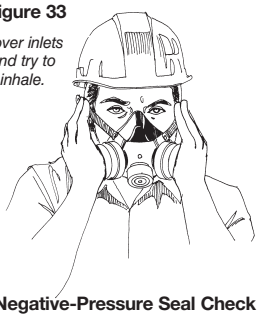
User Seal Checks

Every time you put a on a tight-fitting respirator, check the seal using the negative-pressure and positive-pressure method.

1) **Negative-Pressure Seal Check** — The wearer puts on the respirator and adjusts it so that it feels relatively comfortable. Then the air inlets are blocked off with the hands or a plastic cover, and the wearer inhales gently and holds for five seconds (Figure 33). If the respirator is properly fitted, it should collapse slightly and not permit any air into the facepiece. If leakage is detected, the mask should be readjusted and the test repeated until the fit is satisfactory.

Figure 33

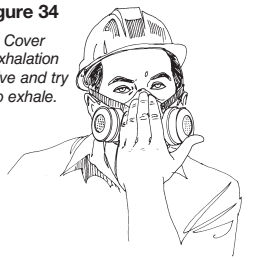
Cover inlets and try to inhale.



Negative-Pressure Seal Check

Figure 34

Cover exhalation valve and try to exhale.



Positive-Pressure Seal Check

2) **Positive-Pressure Seal Check** — The wearer puts on the respirator and adjusts it so that it feels relatively comfortable. Then the exhaust port of the respirator is covered and the wearer tries to exhale gently (Figure 34). The facepiece should puff away from the wearer, but no leakage should occur.

Respirator Maintenance

Like any equipment, respirators require maintenance. The following instructions cover the major points.

1) Filters should be changed as follows:
   - Dust/mist/fume filters should be changed when there is noticeable resistance to normal breathing.
   - Chemical cartridges should be changed when indicated by the end-of-service-life indicator or according to the change-out schedule.
   - Any filter should be changed at the interval specified by the manufacturer or when damaged in any way.
2) Inhalation and exhalation valves should be checked before the respirator is used.
3) Damaged facepiece, straps, filters, valves, or other parts should be replaced with “original equipment” parts.
4) Facepieces should be washed in accordance with the manufacturer’s instructions.
5) Respirators should be assigned to the exclusive use of individual workers.
6) Where a respirator must be assigned to more than one worker, it should be disinfected after each use (check with the manufacturer regarding acceptable sanitizers/disinfectants).
7) Check all supply hoses, valves, and regulators on supplied-air respirators as specified by the manufacturer.
8) SCBA units and high-pressure cylinders of compressed breathing air should be used and maintained in accordance with current Canadian Standards Association Z180.1 *Compressed Breathing Air and Systems,* and Z94.4 *Selection, Care and Use of Respirators*.
9) Compressors and filtration systems used with supplied-air respirators must be maintained in accordance with the manufacturers’ recommendations.
10) Consult manufacturer for information on respirator cartridge change-out.
11) Store respirators in a location away from dust, ozone, sun, heat, extreme cold, excessive moisture, vermin, damaging chemicals, oils, and grease. Also ensure the rubber facepiece is not deformed.

Approvals and Standards

The most commonly referenced standards for respiratory protection in North America are the test criteria used by the National Institute for Occupational Safety and Health (NIOSH).

NIOSH is a U.S. government agency which tests and approves respiratory protective equipment as one of its major activities and publishes a list of approved devices annually.

The Infrastructure Health & Safety Association recommends that only NIOSH-approved equipment be used for protection against respiratory hazards. Unapproved devices should be evaluated carefully by a competent respiratory protection specialist before use.

The Canadian Standards Association has issued two standards pertaining to respiratory protection, which should be reviewed by the person responsible for the respirator program:

- Z180.1 *Compressed Breathing Air and Systems* lists the criteria for air purity and delivery systems
- Z94.4 *Selection, Care and Use of Respirators* offers recommendations on these three aspects of the subject.

These standards are copyrighted by CSA. Copies can be purchased from www. csa.ca

Review

The following section lists common claims about respirators and explains why the statements are true or false. The information provides a convenient review of major points in this chapter.

1)	All respirators are the same.	(False)	Most respirators, especially air-purifying types, are limited to certain types of hazards. For instance, filtering facepiece respirators may be suitable for dusts, but do not provide protection against gases and vapours.
2)	One size fits all.	(False)	Most manufacturers offer three sizes of facepieces (small, medium and large) to ensure a proper fit. In some cases, no size from one manufacturer may fit an individual and a different brand may be necessary.
3)	Respirators make breathing more difficult.	(True)	With air-purifying respirators the air is being inhaled through a filter so some additional effort is required. With most pressure/demand supplied-air respirators additional effort is required to activate the inhalation and exhalation valves.
4)	Air-purifying respirators supply oxygen.	(False)	These devices simply filter out specific gases, vapours, dust, mists, or fumes, but do not increase the oxygen content of the air.
5)	Most respirators require maintenance.	(True)	With the exception of disposable and single-use respirators, some maintenance is required.
6)	Any source of compressed air will be adequate for supplied-air respirators.	(False)	Compressed breathing air must be “clean” and free from carbon monoxide, oil mist, and other contaminants.
7)	Assigned-protection factors are the same for everyone.	(False)	The assigned protection factors listed in Table 7 are averages obtained by testing a large number or wearers. Individual protection factors can be considerably different from those listed.
8)	Respirators are the best way to control respiratory hazards.	(False)	Good ventilation is the best way of controlling respiratory hazards, though it is not always practical in many construction applications.
9)	The moisture content of compressed air is important.	(True)	If the moisture content of the air in a pressurized breathing air system is too high, the regulators can freeze shut and cut off the supply of air. Moisture can also cause deterioration of storage cylinders.
10)	Parts can be interchanged from one manufacturer to another.	(False)	Using improperly fitted or matched components voids the NIOSH approval and can cause failure of the respirator posing serious risk to the wearer.
11)	Fitting of respirators is not important.	(False)	No matter how effective its protection against specific hazards, the respirator must be properly fitted to prevent inward leakage of contaminated air. The only exceptions are hoods and helmets, and even these depend on fit to a certain degree.
12)	Self-Contained Breathing Apparatus (SCBA) and air-line respirators provide the best protection.	(True)	They also have disadvantages which make their use impractical in some situations.
13)	Respirators should be checked each time they are used.	(True)	Damaged straps, missing or ill-fitting valves, and other problems can make the device useless.
14)	Only one respiratory hazard is present in a particular job.	(False)	Often there are two or more hazards present. For instance, spray painting produces mists **and** vapours while welding can produce fume **and** gases.
15)	Respirators can be fitted with filters suitable for more than one hazard.	(True)	Many manufacturers offer filters which will remove selected dusts, fumes, gases, and vapours all at the same time.

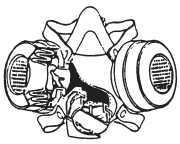
16) Single-use filtering facepiece respirators should not be worn more than once.	(True)	These inexpensive respirators are meant to be put on once only. They may not provide adequate protection once the straps have been stretched.
17) Respirators provide absolute protection.	(False)	Every respirator has limitations that the wearer must understand. Protection is ensured not only by the respirator but also by its proper use.
18) Respirators are simple to select for any job.	(False)	In many cases, even the respiratory protection specialists have problems in selecting the right device.
19) Respirators interfere with eye protection.	(True)	Protective goggles and glasses may not fit properly with many respirators. Full-face masks may be necessary.
20) NIOSH approvals are important.	(True)	NIOSH approvals indicate that the device has passed a set of minimum design and performance standards. Unapproved respirators may provide similar protection, but this can only be evaluated by expert review of the manufacturer's claims.
21) Beards and mustaches do not affect respiratory protection.	(False)	With the exception of hoods and some helmets, beards and mustaches cause a great deal of leakage and reduce the effectiveness of respirators significantly. Respirator wearers should be clean shaven to obtain the best possible protection.

Summary

Respiratory protective equipment can prevent illness, disease, and death from breathing hazards. But the equipment must be properly selected, fitted, worn, and maintained to ensure maximum protection.

The Infrastructure Health & Safety Association can provide assistance in selecting respiratory protection and training workers in its use, care, and maintenance. For additional information, contact IHSA.

Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece		Powered Air-Purifying Respirator (PAPR), tight-fitting	NIOSH type CE pressure demand Full-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive-demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000†, full facepiece=1000	1000	10,000

Asbestos: see Asbestos chapter in this manual.

Lead												
Application of lead-containing coatings with a brush or roller			Optional ✓ N, R, or P									
Spray application of lead-containing coatings										✓ Hood or helmet		
Removal of lead-containing coatings or materials by scraping or sanding using non-powered hand tools			✓ N, R, or P									
Removal of lead-containing coatings or materials using non-powered hand tools—other than manual scraping or sanding			Optional ✓ N, R, or P									
Removal of lead-containing coatings with a chemical gel or paste and fibrous laminated cloth wrap			Optional ✓ N, R, or P									
Removal of lead-containing coatings or materials using a power tool ***without*** a dust collection system equipped with a HEPA filter (airborne dust ≥ 0.05 mg/m³)										✓ Full facepiece		

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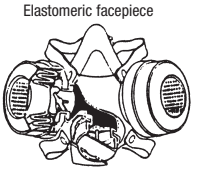
N = Not resistant to oil R = Oil-resistant P = Oil-proof OV = Organic vapour cartridge

4 indicates suitable protection. If oil mist is present, use R or P filters.

* Assigned-protection factor: The protection factor assigned by NIOSH, the US National Institute for Occupational Safety and Health. It's a measure of the effectiveness of a type of respirator and suitable filter. Higher numbers mean greater protection. You may use a respirator with a greater assigned-protection factor than the one recommended for your task. Never use a respirator with a smaller protection factor.

†The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1000 or greater to receive an APF of 1000. Without such information, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

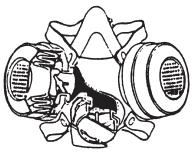
Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece	Powered Air-Purifying Respirator (PAPR), tight-fitting		NIOSH type CE pressure demand Full-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive-demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000
Lead cont'd												
Removal of lead-containing coatings or materials using a power tool ***with*** a dust collection system equipped with a HEPA filter (airborne dust must be controlled to < 0.05 mg/m³)			Optional ✓ N, R, or P									
Abrasive blasting of lead-containing coatings or materials											✓ Type CE blasting; positive pressure; tight-fitting half-facepiece	
Dry removal of lead-containing mortar using an electric or pneumatic cutting device										✓ Tight-fitting full facepiece		
Welding or high-temperature cutting of lead-containing coatings or materials indoors or in a confined space										✓ Tight-fitting full facepiece		
Welding or high-temperature cutting of lead-containing coatings or materials outdoors—long-term operations or if material not pre-stripped										✓ Tight-fitting full facepiece		
Welding or high-temperature cutting of previously stripped lead-containing coatings or materials outdoors—short term only			✓ N, R, or P									
Burning of a surface containing lead										✓ Tight-fitting full facepiece		
Soldering			Optional ✓ N, R, or P									
Installation or removal of lead-containing sheet metal			Optional ✓ N, R, or P									
Installation or removal of lead-containing packing, babbit, or similar material			Optional ✓ N, R, or P									

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Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece		Powered Air-Purifying Respirator (PAPR), tight-fitting	NIOSH type CE pressure demand Full-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive-demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour			
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000
Lead cont'd												
Demolition or cleanup of a facility where lead-containing products were manufactured										✓ Tight-fitting full facepiece		
Manual demolition of lead-painted plaster walls or building components using a sledgehammer or similar tool		✓ N, R, or P										
Removal of lead-containing dust using an air-mist extraction system											✓ Pressure demand; full facepiece	
Removal or repair of a ventilation system used for controlling lead exxposure										✓ Tight-fitting full facepiece		
An operation that may expose a worker to lead dust, fume, or mist, that is not a Type 1, Type 2, or Type 3b operation										✓ Tight-fitting full facepiece		
Painting												
Spraying latex paint	✓ N, R, or P (small-scale)		✓ N, R, or P (small-scale)			✓ N, R, or P (large-scale)						
Alkyds, enamels, and sealers: brush and roller application indoors but well-ventilated					✓ R or P							
Alkyds and enamels: spray painting in well-ventilated area						✓ R or P						
Alkyds and enamels: painting in a confined space												✓
Epoxy or polyurethane spray painting											✓	
Spraying lead paint									✓ N, R, or P	✓		
Spraying stucco						✓ R or P						

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Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece	Powered Air-Purifying Respirator (PAPR), tight-fitting		NIOSH type CE pressure demand Half-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive-demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000

Roofing												
Removal of roofing material (built-up roofing, no asbestos)	✓ R or P		✓ R or P									
Heat welding roofing membrane	✓ N, R, or P		✓ N, R, or P									
Adhesive welding roofing membrane					✓ N, R, or P							
Roofing kettle operators (asphalt)									✓ N, R, or P	✓ +OV		
Silica												
Breaking concrete outdoors	✓ N, R, or P		✓ N, R, or P									
Crushing rock and gravel			✓ N, R, or P	✓ N, R, or P								
Blasting rock			✓ N, R, or P	✓ N, R, or P								
Abrasive blasting—either ≥ 1% silica in the abrasive blasting media or ≥ 1% silica in the target material being blasted											✓	
Drywall sanding	For short-term applications, a filtering facepiece respirator may be appropriate		✓ N, R, or P	✓ N, R, or P								
Machine mixing concrete or mortar			✓ N, R, or P	✓ N, R, or P								
Drilling holes in concrete or rock that is not part of a tunnelling operation or road construction			✓ N, R, or P	✓ N, R, or P								
Milling of asphalt from concrete highway pavement			✓ N, R, or P	✓ N, R, or P								
Charging mixers and hoppers with silica sand (sand consisting of at least 95% silica) or silica flour (finely ground sand consisting of at least 95% silica)			✓ N, R, or P	✓ N, R, or P								
Any other operation at a project that requires the handling of silica-containing material in a way that a worker may be exposed to airborne silica			✓ N, R, or P	✓ N, R, or P								

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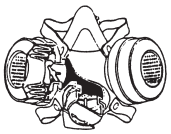
Respirator Selection Guide for Common Construction Activities

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	Filtering facepiece		Elastomeric facepiece									
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000

Silica cont'd											
Entry—for less than 15 minutes—into a dry mortar-removal or abrasive-blasting area for inspection or sampling where airborne dust is visible	For short-term applications, a filtering facepiece respirator may be appropriate	✓ N, R, or P	✓ N, R, or P								
Entry into an area where abrasive blasting is being carried out for more than 15 minutes	For short-term applications or applications involving tools or equipment with adequate controls (local exhaust ventilation or water), a half-facepiece respirator may be appropriate						✓ N, R, or P				
Dry method dust clean-up from abrasive blasting operations							✓ N, R, or P		✓		
Removal of silica-containing refractory materials with a jackhammer							✓ N, R, or P		✓		
Drilling holes in concrete or rock as part of a tunnelling operation or road construction							✓ N, R, or P		✓		
Using a power tool to cut, grind, or polish concrete, masonry, terrazzo, or refractory materials							✓ N, R, or P		✓		
Using a power tool to remove silica-containing materials							✓ N, R, or P		✓		
Using a power tool **indoors** to chip or break and remove concrete, masonry, stone, terrazzo, or refractory materials							✓ N, R, or P		✓		
Tunnelling (operation of tunnel boring machine, tunnel drilling, tunnel mesh insulation)							✓ N, R, or P				
Tuckpointing and surface grinding							✓ N, R, or P				
Dry-mortar removal with an electric or pneumatic cutting device							✓ N, R, or P				
Using compressed air outdoors to remove silica dust							✓ N, R, or P				

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Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece		Powered Air-Purifying Respirator (PAPR), tight-fitting	NIOSH type CE pressure demand Full-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000

Synthetic Vitreous Fibres (Man-made mineral fibres)												
Installation, removal, or blowing cellulose, fiberglass, mineral wool, or calcium silicate	✓ N, R, or P	✓ N, R, or P	✓ N, R, or P	✓ N, R, or P								
Installation of refractory ceramic fibres (silica may be present)				✓ N, R, or P								
Removal of refractory ceramic fibres (silica may be present)								✓ N, R, or P		✓		

Other dust and fibre exposure												
Removal of roofing material (built-up roofing, no asbestos)	✓ R or P		✓ R or P					✓ R or P				
Dry method dust clean-up from abrasive blasting operations	For short-term applications or applications involving tools or equipment with adequate controls (local exhaust ventilation or water) a half-facepiece respirator may be appropriate.							✓ N, R, or P		✓		
Wood dust, including pressure-treated wood dust	✓ N, R, or P		✓ N, R, or P									
Vinyl or laminate floor sanding	✓ N, R, or P		✓ N, R, or P									

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Respirator Selection Guide for Common Construction Activities

	Air-purifying										Supplied-air	
	Half facepiece							Full facepiece	Powered Air-Purifying Respirator (PAPR), tight-fitting		NIOSH type CE pressure demand Full-facepiece pressure demand	SCBA or SCBA + air-line, full facepiece and positive-demand
	Filtering facepiece		Elastomeric facepiece									
												
Filter efficiency and type	95	100	95	100	Organic vapour	95+ organic vapour	100+ organic vapour	100	100+ organic vapour		100	
Assigned-protection factor* (NIOSH 1987)	10	10	10	10	10	10	10	50	50	helmet/hood=25/1000+ full facepiece=1000	1000	10,000
Welding and flame-cutting												
Any welding in confined spaces when the atmosphere is not monitored												✓
Aluminum**	✓ N, R, or P		✓ N, R, or P									
Mild steel	✓ N, R, or P		✓ N, R, or P									
Stainless steel	✓ N, R, or P		✓ N, R, or P									
Galvanized or plated metals	✓ N, R, or P		✓ N, R, or P									
Lead-painted steel: flame cutting or welding, short-term, not repeated, material stripped before work			✓ N, R, or P	✓ N, R, or P								
Welding or high-temperature cutting of lead-containing coatings or materials indoors or in a confined space								✓ N, R, or P		✓	✓	
Miscellaneous												
Epoxy adhesive (large-scale use)											✓	
Solvents, adhesives, and epoxy (small scale)					✓ R or P							
Caulking compounds, solvent-based, large-scale use					✓ R or P							
Form oil spraying					✓ R or P							
Paving						✓ R or P						

**** Protection from ozone may be required in some circumstances. Contact the respirator manufacturer.**

N = Not resistant to oil R = Oil-resistant P = Oil-proof OV = Organic vapour cartridge

These recommendations will provide adequate protection in most circumstances. Factors such as ventilation, duration of exposure, and user characteristics can affect how well a respirator protects you. If unsure about the respirator required for a task, contact the manufacturer or IHSA at 1-800-263-5024, www.ihsa.ca.

17 HIGH-VISIBILITY CLOTHING

The construction regulation (O. Reg. 213/91) requires that any worker who may be endangered by vehicular traffic on a project must wear a garment that provides a high level of visibility.

There are two distinct features to high-visibility clothing.

Background Material

This is the fabric from which the garment is made. It must be fluorescent orange or bright orange in colour and afford increased daytime visibility to the wearer. Fluorescent orange provides a higher level of daytime visibility and is recommended.

Retroreflective Stripes or Bands

The stripes or bands must be fluorescent and retroreflective and be arranged on the garment with two vertical stripes down the front and forming an X on the back. The stripes must be yellow and 50 mm wide. Retroreflective stripes are to afford the worker both low-light and night-time visibility.



For night-time work, additional stripes or bands are required on the arms and legs. One way to meet this requirement is to dress workers in fluorescent orange coveralls with retroreflective bands or stripes attached.

Risk Assessment

Before selecting high-visibility garments, assess the risks to be controlled. Workers who require greater visibility, such as roadway construction workers, should wear clothing that is highly conspicuous under the conditions expected.

For further recommendations on high-visibility clothing, consult CSA's standard Z96-02. As a minimum, we recommend that garments comply with CSA Standard Z96-02, *High Visibility Safety Apparel*, in particular a class 2 garment with Level 1, 2 or FR retroreflective stripes.

20 LADDERS

INTRODUCTION

Every year in the Ontario construction industry more than 350 lost-time injuries are caused by ladder accidents. Many of these accidents involve falls resulting in serious injuries and fatalities. Falls from ladders are common to all trades and pose one of the most serious safety problems in construction. The following are major causes of accidents.

- Ladders are not held, tied off, or otherwise secured.
- Slippery surfaces and unfavourable weather conditions cause workers to lose footing on rungs or steps.
- Workers fail to grip ladders adequately when climbing up or down.
- Workers take unsafe positions on ladders (such as leaning out too far).
- Placement on poor footing or at improper angles causes ladders to slide.
- Ladders are defective.
- High winds cause ladders to topple.
- Near electrical lines, ladders are carelessly handled or improperly positioned.
- Ladder stabilizers are not used where appropriate

We should always consider and plan for the safest way of undertaking work that cannot be done on or from ground level or while standing on the finished floor of a building or structure. In some cases, the use of ladders may be required. However, when dealing with elevated work or when working at heights, it's important to first consider whether the use of scaffolding, work platforms or powered elevating work platforms (PEWPs) is more appropriate and a safer alternative to ladders. If it is determined that a ladder will be used, then a risk assessment of the ladder work should be done.

This chapter provides guidelines for selecting, setting up, maintaining, and using ladders. Because ladders are frequently used in the construction industry, there are many thousands of hours of exposure to ladder hazards every week.

The extensive exposure, the high fatality rate, and the large number of lost-time injuries as well as the associated costs and suffering from ladder accidents justify increased training of the workforce and better supervision of ladder use. Worker training alone will not yield sufficient improvement. Any significant reduction in ladder accidents will require regular supervisory reinforcement of training as well as improved site control of operations involving ladders.

STANDARDS AND MATERIALS

Standard manufacturing specifications exist for most types of ladders. CSA Standard Z11 sets out standard requirements for manufacturing portable ladders. The Ontario Ministry of Labour has established standards for job-built wooden ladders, while the International Standards Organization has issued Standard ISO-2860 relating to "Access Ladders on Earth Moving Machinery".

The most common materials for ladders are aluminum, wood, steel, and fibreglass-reinforced plastic.

Wooden ladders deteriorate more rapidly than those made of more durable materials. They must never be painted because paint hides signs of deterioration and may accelerate rotting by trapping moisture in the wood. However, they may be treated with a clear non-toxic wood preservative or coated with a clear varnish. Inspect wooden ladders frequently for splits, shakes, or cracks in side rails and rungs; warping or loosening of rungs; loosening of attached metal hardware; and deformation of metal parts.

Although aluminum ladders are popular and more widely used than wooden ladders in construction, they are also more susceptible to damage by rough usage. Because they conduct electricity well, aluminum ladders must not be used where electrical contact is possible. Check side rails and rungs regularly for dents, bends, and loose rungs. If dented, the ladder should be taken out of service until repaired by a competent person. If repair is not possible, the ladder should be destroyed.

Fibreglass-reinforced plastic side rails are becoming more common and are generally used with aluminum rungs. They do not conduct electricity well and are resistant to corrosion. They are lightweight and available in various colours. They are, however, costly and heat-sensitive. They must not be exposed to temperatures above 93.3°C (200°F).

Fibreglass ladders should be inspected regularly for cracks and "blooming." This condition is evidenced by tufts of exposed glass fibre where the mat has worn off. The worn area should be coated with an epoxy material compatible with the fibreglass.

Because of their weight, steel ladders are generally not used as portable ladders in the construction industry. They are, however, often fixed to permanent structures or mobile machinery.

TYPES

The many types of ladders used on construction sites range from metal ladders permanently mounted on equipment to job-built wooden ladders.

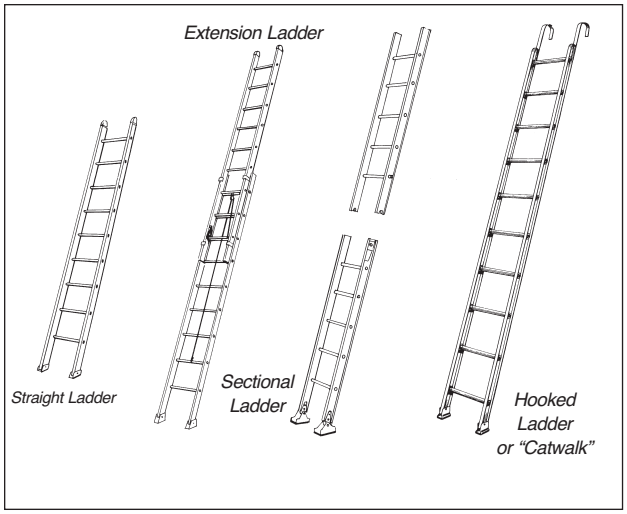
Portable Ladders (Figure 1)

All portable ladders must have non-slip feet or be set up so that the feet will not slip.

Portable ladders are available in various grades: light duty or grade 3; medium duty or grade 2; heavy duty or grade 1. The ladders may or may not be certified to CSA Standard Z11. For construction purposes, only ladders bearing the CSA certification label and with Grade 1 (heavy) load duty should be purchased and used. They may be slightly more expensive but CSA certification assures that the ladder has been manufactured to a high standard set by experts in ladder construction and use.

The type purchased should be compatible with the degree

of rough usage expected. For general construction applications, heavy duty portable ladders are recommended. Where medium duty ladders are used, they should be restricted to the application for which they were manufactured and not “borrowed” for rougher service.



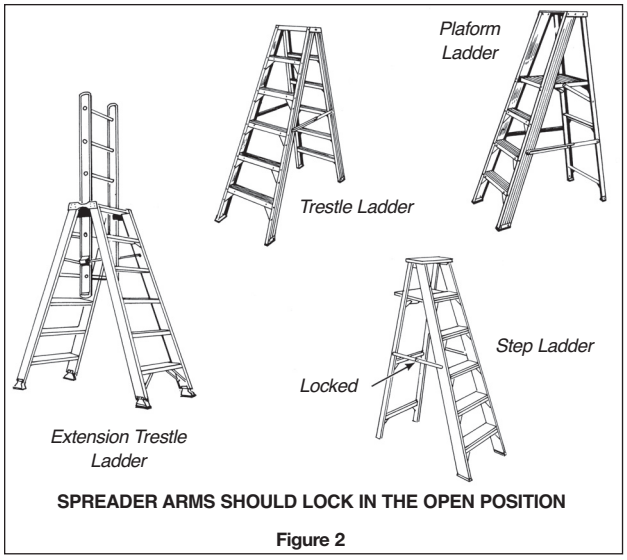


Figure 2

Step, Trestle and Platform Ladders (Figure 2)

Apart from the standards of sound construction and reliable service that should apply to all ladders used on site, the primary consideration with these ladders is that they have strong spreader arms which lock securely in the open position.

Fixed Ladders (Figure 3)

Steel ladders permanently fixed to structures such as stacks and silos are designed for service after construction is complete but are often used by work crews during construction. If the ladders are vertical and there is a risk of falling more than 3 metres (10 feet), a body harness and lifeline, or body harness and channel lock device, should be used by workers climbing up and down or working from the ladders. These ladders must have safety cages starting no more than 2.2 metres (7 feet) from the bottom of the ladder and extending at least 0.9 metres (3 feet) above the top landing. Rest platforms with ladder offsets are required at intervals no more than 9 metres (30 feet) apart where a fall-arrest system is not used. Vertical ladders permanently fixed to structures should comply with Ontario Ministry of Labour Engineering Data Sheet 2-04.

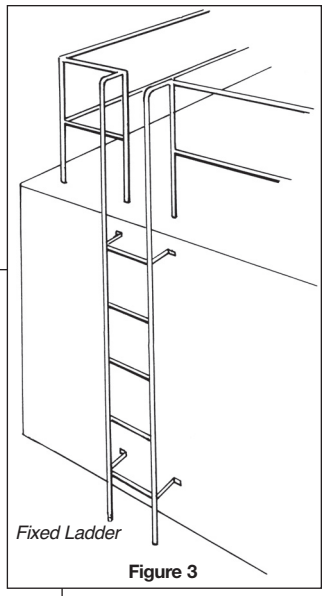


Figure 3

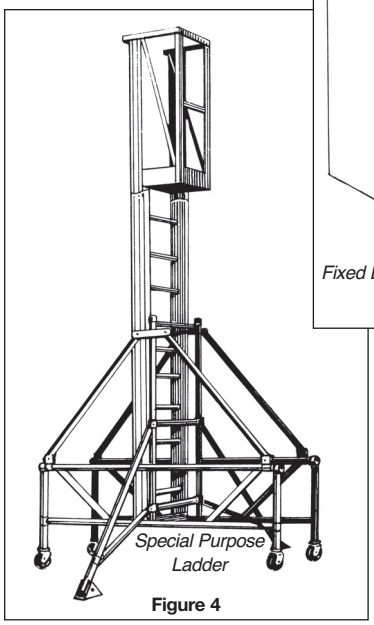


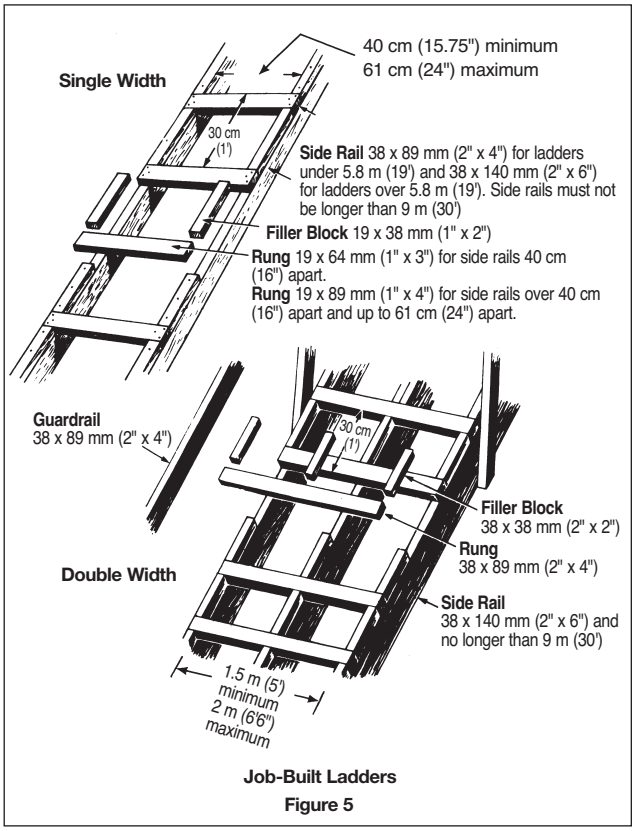
Figure 4

Special Purpose Ladders (Figure 4)

These ladders should be used in accordance with manufacturers' directions and only for the special applications intended.

Job-Built Wooden Ladders (Figure 5)

Job-built ladders should be constructed according to good structural carpentry practice.



Job-Built Ladders

Figure 5

The wood should be straight-grained and free of loose knots, sharp edges, splinters, and shakes. Rungs should be clear, straight-grained, and free of knots.

Job-built ladders must be placed on a firm footing and be securely fastened in position.

Remember — a wooden ladder should not be painted or coated with an opaque material.

A straight wooden ladder should not be longer than 9 metres (30 feet).

Job-built ladders are heavy and not recommended where portability is important. Because they are made of wood and often used by a whole crew of workers, job-built ladders deteriorate rapidly. They should be inspected every day or so. If defective, they must be repaired immediately or taken out of service and **destroyed**.

SUPERVISION AND USE

The Supervisor's Task

Ladder injuries can be significantly reduced by control of usage and improved site management. This requires that supervisory personnel

- train workers to maintain and use ladders properly
- perform a risk assessment of the ladder work to be conducted
- evaluate the access requirements of a specific work assignment
- choose the best means of access for the job.

Portable ladders should be used only where safer means of access such as stairs, scaffolds, manlifts, or ramps are not suitable or practical. Supervisors must consider the number of workers requiring access to elevated work locations as well as the extent and duration of the work before deciding on the safest and most economical means of access.

Ladders should not be used by large crews of workers. Basic considerations of efficiency usually indicate that other types of access such as stairs or even personnel hoists are much more suitable where significant numbers of workers are making repeated use of the access.

Always assess if another means of performing the work can be used. Other types of access such as stationary or rolling scaffolds or powered elevating platforms will usually be more efficient and significantly reduce the potential for accidents.

In deciding on the best type of access for various tasks and work locations, management should also consider the amount of material involved; the time workers spend on the access equipment; weather conditions; equipment available on site; condition of surface from which access must be made; room available; potential for shared use with other trades, and so on. It is critical that consideration be given to worker access for specific tasks and for entire work areas. Ladders must not be used where other means of access are practical and safer.

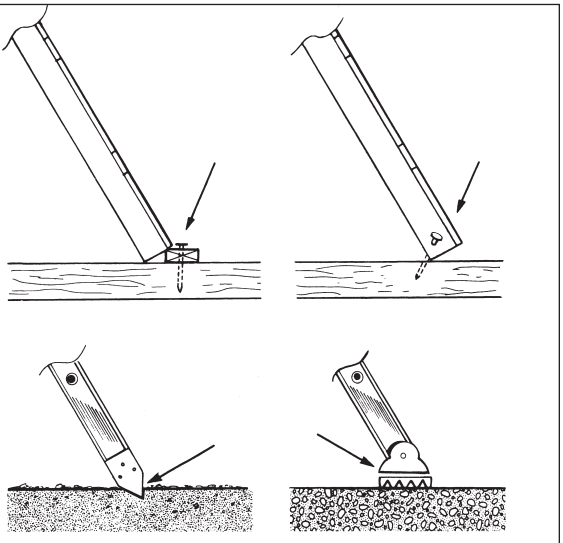
If there is no practical alternative to ladders, supervisors should ensure that ladders are suitable and in good condition and personnel are trained to use them properly. Ladder stabilizers on straight and extension ladders are strongly recommended where ladders are the only means of access.

In addition to proper training, planning, and organizing for worker access, supervisory personnel must exercise control of all access situations. The supervisor must check that planning and directions are being carried out by workers. Although very important, the control function is often given insufficient attention by the busy supervisor. With ladders, as with other supervisory responsibilities, details overlooked today can become problems tomorrow.

Proper Use of Ladders

More than 80 per cent of ladder accidents are related to improper use or application of the equipment. Supervisors must control the application of equipment to particular situations. But personnel using the equipment must also be trained to use it. Training should include the following precautions.

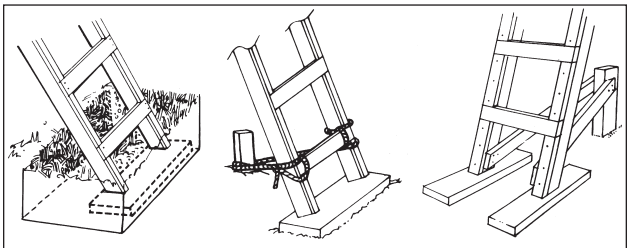
- Check the ladder for defects at the start of a shift, after it has been used in another location by other workers, or after it has been left in one location for a lengthy period of time. (See the end of this chapter for inspection procedures.)
- Areas surrounding the base and top of the ladder should be clear of trash, materials and other obstructions since getting on and off the ladder is relatively more hazardous than other aspects of use.
- The base of the ladder should be secured against accidental movement. Use a ladder equipped with non-slip feet appropriate for the situation, nail a cleat to the floor, or otherwise anchor the feet or bottom of the side rails (Figure 6).



Methods of securing ladder base against displacement

Figure 6

- The ladder must be set up on a firm level surface. If its base is to rest on soft, uncompacted or rough soil, a mud sill should be used (Figure 7).
- The top of the ladder should be tied off or otherwise secured to prevent any movement (Figure 8).
- If a ladder is used for access from one work level to another, the side rails should extend a minimum of 900 millimetres (3 feet) above the landing. Grab rails should be installed at the upper landing so that a worker getting on and off the ladder has secure handholds.
- All straight or extension ladders should be erected at an angle such that the horizontal distance between the top support and the base is not less than one-quarter or greater than one-third the vertical distance between these points (Figure 9).



Typical mud sill arrangements

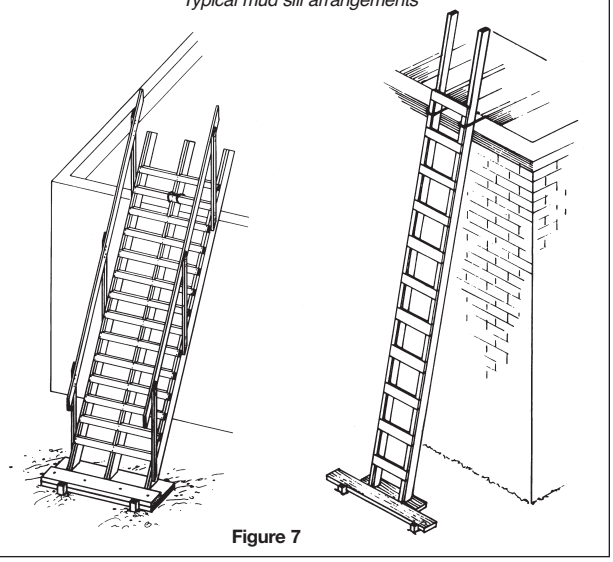


Figure 7

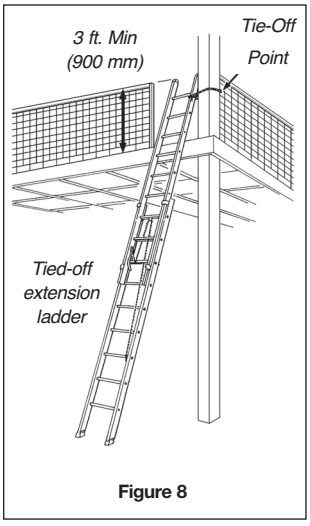
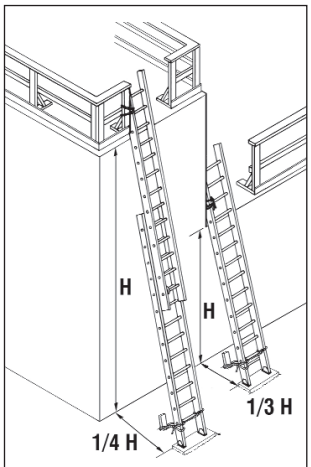


Figure 8



Proper Ladder Angles

— Before setting up straight or extension ladders, check the area for overhead powerlines. Ladders made of aluminum or other conductive material should never be used near powerlines. Only competent electricians and linemen using ladders made of non-conductive material are allowed to work in close proximity to energized electrical lines.
— Portable ladders should never be used horizontally as substitutes for scaffold planks, runways, or any other service for which they have not been designed.
— When a task can only be done while standing on a portable ladder, the length of the ladder must be such that the worker stands on a rung no higher than the fourth from the top. The ladder should also be tied off or equipped with a suitable stabilizer.
— Short ladders must never be spliced together to make a longer ladder. Side rails will not be strong enough to support the extra loads.
— Straight ladders should not be used as bracing, skids, storage racks, or guys. They were not designed for these purposes and the damage caused by such abuse can later result in an accident during normal use.
— Unless suitable barricades have been erected, ladders should not be set up in passageways, doorways, driveways, or other locations where they can be struck or displaced by persons or vehicles using the access route.
— Only one person at a time should be allowed on a single-width ladder. In the case of a double-width ladder, no more than two people should be allowed on it at one time and each should be on a separate side.
— Ladders should not be placed against flexible or movable surfaces.
— Always face the ladder when climbing up or down and when working from it.
— Maintain 3-point contact when climbing up or down a ladder. That means two hands and one foot or two feet and one hand on the ladder at all times. This is especially important when you get on or off a ladder at heights (Figure 10).

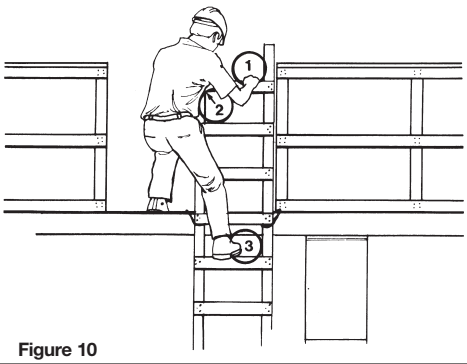
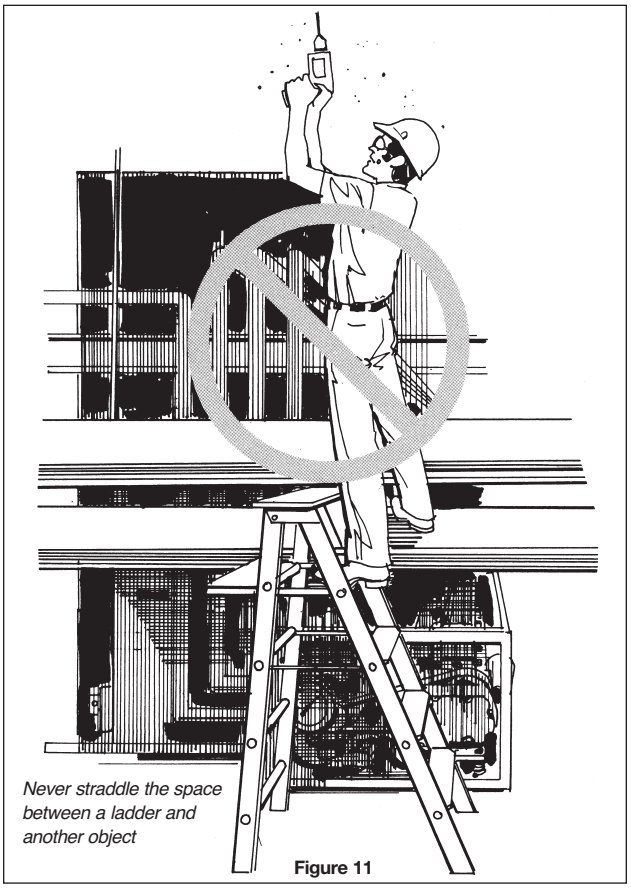


Figure 10

— When working from a ladder, keep your centre of gravity between the side rails. A person's centre of gravity is approximately in the centre of the body at belt height. The location of your centre of gravity can shift when you reach out to either side of a ladder, especially with materials, tools, or equipment in your hands. As the centre of gravity of your body and hand-held objects moves beyond the side rails, the ladder is tending toward instability.
— Whenever possible, avoid climbing up or down a ladder while carrying anything in your hands. Tools, equipment and materials should be placed in a container and raised or lowered by rope, if necessary.
— Workers should be instructed and frequently reminded to keep their boots free of mud, snow, grease, or other slippery materials if they are using ladders.
— Always hold onto the ladder with at least one hand. If this is not possible because of the task to be done and in particular if the work is 3 metres (10 feet) or more above the floor, the worker must wear a safety harness and tie the lanyard off to the structure or to a lifeline before beginning work.
— Never straddle the space between a ladder and another object (Figure 11).



Never straddle the space between a ladder and another object

Figure 11

— Persons frequently required to use or work from ladders should wear protective footwear with soles and heels made of slip-resistant materials such as soft urethane.
— Never erect ladders on boxes, carts, tables, or other unstable surfaces.
— Fall-arresting equipment such as ladder climbing devices or lifelines should be used when working from long fixed ladders or when climbing vertical fixed ladders.
— Never rest a ladder on any of its rungs. Ladders must rest on their side rails.
— When erecting long, awkward, or heavy ladders, two or more persons should share the task to avoid injury from over-exertion.
— Instruct all personnel to watch for overhead powerlines before attempting to erect any ladder. When overhead powerlines are in proximity of the work, aluminum ladders must not be used.

INSPECTION AND MAINTENANCE

Regular inspection and maintenance will increase the useful life of ladders and reduce the number of accidents. A suggested checklist for inspection has been provided at the end of this chapter. Repairs should only be carried out by the manufacturer of the ladders.

Ladders found to be defective should be taken out of service and either tagged for repair or scrapped. Once tagged, the ladder must not be used until repaired. Ideally, the tag should only be removed by the person who took the ladder out of service initially. The tag should be printed in big bold letters with the words “DANGER – DO NOT USE”.

General Procedures

Ladders should be inspected for structural rigidity. All joints between fixed parts should be tight and secure. Hardware and fittings should be securely attached and free of damage, excessive wear, and corrosion. Movable parts should operate freely without binding or excessive play. This is especially important for gravity-action ladder locks on extension ladders.

Non-skid feet should be checked for wear, imbedded material, and proper pivot action on swivel feet.

Deteriorated, frayed or worn ropes on extension ladders should be replaced with a size and type equal to the manufacturer's original rope.

Aluminum ladders should be checked for dents and bends in side rails, steps, and rungs. Repairs should be made only by the manufacturer or someone skilled in good aluminum or metal work practices. Replacing a rung with a piece of conduit or pipe is not good practice and should not be permitted.

Wooden ladders are susceptible to cracking, splitting, and rot and should be either unpainted or covered with a transparent finish in order that checks, cracks, splits, rot, or compression failures can be readily detected. Repairs should be consistent with good woodworking practice. Only wood equal to or better than the wood used by the manufacturer should be used in the repair.

The bases, rungs, and steps of all ladders should be examined for grease, oil, caulking, imbedded stone and metal, or other materials that could make them slippery or otherwise unsafe.

Methods of storage and transportation are important. Storage areas should permit easy access and be cool and dry, particularly if wooden ladders are kept there. Areas where the moving of other materials can damage ladders should be avoided. Ladders should be supported during storage and transportation to prevent sagging or chafing. When being transported, ladders should be “top freight” — nothing should be piled on them. If damage does occur, the condition causing the damage should be corrected as well as having the ladder repaired.

Special Considerations

All trades have frequent ladder accidents. To improve accident prevention, supervisors should devote more time to training and reinforcement of training on the job.

Approximately 50 per cent of all ladder accidents occur while tasks are being performed from the ladder. Many of these accidents could be prevented by using other types of access equipment such as scaffolds or powered elevating platforms.

Between 30 and 40 per cent of all ladder accidents involve unexplained loss of footing. Because inattention may be a cause, training should be strengthened to maintain awareness of the hazards involved in working from ladders.

Many ladder accidents are related to unfavourable weather conditions such as wind, mud, ice, snow, and rain which create slippery and unstable situations. This is an especially important consideration for the outside trades

such as labourers, bricklayers, sheet metal applicators, roofers, and carpenters.

A surprising number of accidents occur when workers take the first step onto the bottom rung of a ladder. While falls from this distance are usually not as serious as those from greater heights, they nevertheless create injuries such as sprains, strains, fractures, and contusions that often result in lost-time claims. Workers should be advised to be careful when stepping onto any ladder. It is often at this point that the unstable, insecure ladder will slide or tip and that muddy or snow-covered boots will slip on the first or second rung. Make sure that boots are clean, that ladders are secure and stable, and that workers are aware of the hazards. Again, this involves supervisor training and continuous reinforcement.

Finally, a large number of accidents occur because workers use straight ladders that are not secured. Site supervisors must rigidly ensure that ladders are either firmly secured (Figures 6-8) or held in place by a second worker.

LADDER USE CHECKLIST

DO

- ☐ Familiarize personnel with your ladder safety policy.
- ☐ Use a ladder properly suited to the task.
- ☐ Construct job-built ladders properly.
- ☐ Inspect ladders before use.
- ☐ Erect ladders with the proper slope (between 4:1 and 3:1).
- ☐ Avoid placing ladders in areas with high traffic or activity such as walkways, entrances, and exits.
- ☐ Tie ladders off at the top.
- ☐ Block or otherwise secure the ladder base or have the ladder held by a second worker when in use.
- ☐ When outdoors, place the ladder base on firm footings such as compacted soil or mudsills.
- ☐ Extend the ladder 900 mm (3 feet) above the top landing.
- ☐ Clear material, debris, and other obstructions from the top and bottom of ladders.

WHEN CLIMBING

- ☐ Use a single-width ladder one person at a time only.
- ☐ Maintain three-point contact.
- ☐ Do not carry anything in your hands.
- ☐ Face the ladder.
- ☐ Use a fall-arrest system on long ladders.

DO NOT

- ☐ use ladders when a safer means of access is available and practical.
- ☐ use metal ladders near live electrical equipment or conductors.
- ☐ use ladders horizontally or for some other purpose for which they haven't been designed.
- ☐ damage ladders during transport and storage.
- ☐ support ladders on their rungs.
- ☐ erect long or heavy ladders by yourself.

LADDER INSPECTION CHECKLIST

		YES	NO
1.	Are any wooden parts splintered?	☐	☐
2.	Are there any defects in side rails, rungs, or other similar parts?	☐	☐
3.	Are there any missing or broken rungs?	☐	☐
4.	Are there any broken, split, or cracked rails repaired with wire, sheet metal, or other makeshift materials?	☐	☐
5.	Are there any worn, damaged, or missing feet?	☐	☐
6.	Are there any worn, damaged, or unworkable extension ladder locks, pulleys, or other similar fittings?	☐	☐
7.	Is the rope on extension ladders worn, broken, or frayed?	☐	☐
8.	Has the rope on extension ladders been replaced by material inferior to the ladder manufacturer's original rope?	☐	☐
9.	Are the spreader arms on step ladders bent, worn, broken, or otherwise rendered partly or totally ineffective?	☐	☐

If the answer is “YES” to any of the questions on the Inspection Checklist, the ladder should be tagged so that workers will know it is defective and should not be used. It should be taken out of service immediately and placed in a location where it will not be used until repairs are completed. If the ladder is not to be repaired it should be destroyed.

21 SCAFFOLDS

Contents

1. Introduction
2. Problem areas
3. Selection
4. Basic types of scaffolds
5. Scaffold components
6. Erecting and dismantling scaffolds
7. Scaffold stability
8. Platforms
9. Proper use of scaffolds

1 INTRODUCTION

More than half of scaffold accidents in Ontario construction are falls. Several fatalities are also related to scaffolds each year. The number and severity of injuries involved make scaffold accidents one of the more serious safety problems in construction.

2 PROBLEM AREAS

The main problem areas are

- erecting and dismantling scaffolds
- climbing up and down scaffolds
- planks sliding off or breaking
- improper loading or overloading
- platforms not fully planked or “decked”
- platforms without guardrails
- failure to install all required components such as base plates, connections, and braces
- moving rolling scaffolds in the vicinity of overhead electrical wires
- moving rolling scaffolds with workers on the platform.

2.1 Erecting and Dismantling

From 15 to 20% of scaffold-related injuries involve erecting and dismantling. The most common problem is the failure to provide an adequate working platform for a worker to use when installing the next lift of scaffold. Working from one or two planks is not recommended.

The next important consideration involves components, such as tie-ins, which you should install as the assembly progresses. Failure to do so makes the scaffold less stable and, while it may not topple, it may sway or move enough to knock someone off the platform. This happens more often when platforms are only one or two planks wide and guardrails are missing, as is frequently the case during erection and dismantling.

2.2 Climbing Up and Down

Approximately 15% of scaffold-related injuries occur when workers are climbing up and down. Climbing up and down frames is a common but unacceptable practice that has resulted in numerous injuries and fatalities. Climbing up and down braces is also a frequent cause of accidents. You must provide adequate ladders to overcome this problem. In addition, workers must use proper climbing techniques (three-point contact).

2.3 Planks Sliding Off or Breaking

Many scaffold injuries involve problems with planks. If scaffold planks are uncleated or otherwise unsecured they easily slide off – this causes a surprising number of injuries. Scaffold planks can also break if they are in poor condition or overloaded. It is therefore important to use proper grades of lumber and to inspect planks before erection to ensure that there are no weak areas, deterioration, or cracks. Another common problem is insufficient or excessive overhang of planks at their support. Excessive overhang can cause a plank to tip up when a worker stands on the overhanging portion. Insufficient overhang is a leading cause of planks slipping off.

2.4 Improper Loading or Overloading

Overloading causes excessive deflection in planks and can lead to deterioration and breaking. Overloading occurs most often in the masonry trade where skids of material can exceed 1,500 kg (3,000 lb.). If material is left overhanging the scaffold platform it can cause an imbalance leading to the scaffold overturning.

2.5 Platforms Not Fully Decked

This situation is related to injuries not only during erection and dismantling but in general scaffold use. The Construction Regulation (Ontario Regulation 213/91) requires that all scaffold platforms must be at least 450 mm (18 inches) wide. All platforms above 2.4 metres (8 feet) must be fully decked.

2.6 Platforms without Guardrails

Platforms without guardrails are a serious safety problem in construction. Guardrails are an important fall prevention measure not only for high platforms but also for low ones. Over one-third of the falls from scaffolds are from platforms less than 3 metres (10 feet) in height. Therefore, guardrails are recommended during normal use for all scaffold platforms over 1.5 metres (5 feet) high. Guardrails for all working platforms should consist of a top rail, a mid-rail, and a toeboard.

2.7 Failure to Install All Required Components

Failure to use all of the proper scaffold components is a serious safety problem. Workers are more likely to cut corners when scaffolds are only a few frames in height. All too frequently they fail to install base plates, braces, proper securing devices such as “banana” clips or “pig tails” at the pins of frame scaffolds, and adequate tie-ins. Those erecting the scaffold must have all the necessary components, and must use them to ensure that the scaffold is safe. Furthermore, workers should install these parts as the scaffold erection progresses.

2.8 Electrical Contact with Overhead Wires

Scaffolds seldom make contact with overhead electrical lines, but when it does happen it almost always results in a fatality. Failure to maintain safe distances from overhead powerlines while moving scaffolds is a major problem. Before attempting to move rolling scaffolds in outdoor open areas, check the route carefully to ensure that no overhead wires are in the immediate vicinity. Partial dismantling may be necessary in some situations to ensure that the scaffold will make the required safe

clearances from overhead powerlines. The required minimum safe distances are listed in Table 1. Hoisting scaffold material by forklift or other mechanical means requires careful planning and should be avoided in the vicinity of powerlines. Transporting already-erected scaffolds by forklift, particularly in residential construction, has been the cause of many electrical contacts — this is a dangerous practice. Workers handling materials or equipment while working on the platform must also take care to avoid electrical contact.

Table 1: Minimum distance from powerlines

Voltage Rating of Powerline	Minimum Distance
750 to 150,000 volts	3 metres (10 feet)
150,001 to 250,000 volts	4.5 metres (15 feet)
over 250,000 volts	6 metres (20 feet)

2.9 Moving Rolling Scaffolds with Workers on the Platform

Moving rolling scaffolds with workers on the platform can be dangerous. Where it is impractical for workers to climb down, and the scaffold is over 3 metres (10 feet) in height, each worker must be tied off with a full body harness and lanyard. Lifelines must be attached to a suitable anchor point other than the scaffold. Holes, depressions, curbs, etc. have all been responsible for scaffolds overturning while being moved. In some jurisdictions, moving a scaffold with workers on the platform is prohibited if the platform exceeds a certain height.

3 SELECTION

The safe and efficient use of scaffolding depends first on choosing the right system for the job. If the scaffold's basic characteristics are unsuited to the task, or if all the necessary components are not available, personnel are forced to make do and improvise. These conditions lead to accidents.

Proper selection of scaffolding and related components requires basic knowledge about site conditions and the work to be done. Considerations include

- weight of workers, tools, materials, and equipment to be carried by the scaffold
- site conditions (e.g., interior, exterior, backfill, concrete floors, type and condition of walls, access for the equipment, variations in elevation, anchorage points)
- height or heights to which the scaffold may be erected
- type of work that will be done from the scaffold (e.g., masonry work, sandblasting, painting, metal siding, mechanical installation, suspended ceiling installation)
- duration of work
- experience of the supervisor and crew with the types of scaffolds available
- requirements for pedestrian traffic through and under the scaffold
- anticipated weather conditions
- ladders or other access to the platform
- obstructions
- configuration of the building or structure being worked on
- special erection or dismantling problems including providing practical fall protection for the erector
- the use of mechanical equipment to aid in erecting the scaffold.

4 BASIC TYPES OF SCAFFOLDS

4.1 Standard Tubular Frame Scaffolds

This is the most frequently used scaffold in construction. Historically it has been made of steel tubing, but aluminum is gaining popularity. The scaffold is manufactured in various configurations and spans. On some systems, ladder rungs are built into the end frames (Figure 4.1). These ladders are not suitable for tall scaffold towers unless rest platforms are installed at regular intervals and trapdoors are provided in the platforms. Other models are equipped with ladders that attach to the end frames (Figure 4.3). The ladder shown in Figure 4.3 is continuous and workers gain access via gates at the platform level. Again this ladder is not suitable for high scaffolds. Scaffolds in excess of 9 metres (30 feet) should have built-in stairs with rest platforms. Vertical ladders can reach up to 9 metres, but above 2.2 metres (7 feet) they require a safety cage.

The advantages of the frame scaffold are that it is simple to assemble, many construction trades are familiar with its use, and the components can be lifted manually by workers. However, as with other systems, all parts must be used. Failure to install any of the components, such as bracing and base plates, may lead to accidents.

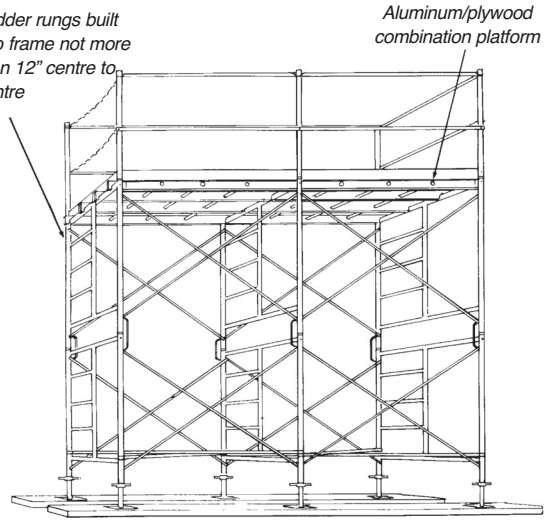


Figure 4.1
STANDARD FRAME SCAFFOLD

4.2 Standard Walk-through Frame Scaffolds

This is a variation of the standard tubular frame scaffold. An example is shown in Figure 4.2. Although primarily designed to accommodate pedestrian traffic at the ground or street level, the walk-through scaffold is frequently used by the masonry trade to provide greater height per tier and easier distribution of materials on platforms at intermediate levels.

4.2.1 Spans of Tower Base

Span lengths are varied using different lengths of vertical bracing. Most manufacturers have braces providing spans between 5 and 10 feet in length, with 7-foot spans being the most common. The use of 7-foot spans is ideal when using 16-foot planks as this allows a 1-foot overhang at each end. When using spans in excess of 7 feet, the load-bearing capacity of the platforms is reduced and must be accounted for in the design.

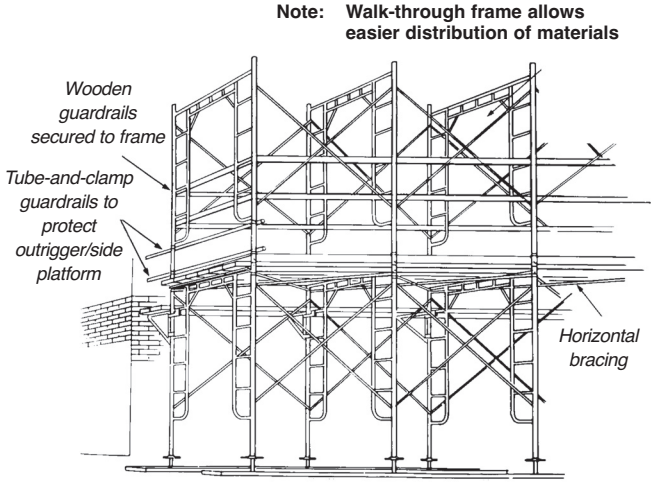


Figure 4.2
WALK-THROUGH SCAFFOLD

4.3 Rolling Scaffolds

Rolling scaffolds are best suited where short-duration work must be carried out at multiple locations. They are used mainly by mechanical and electrical trades. There are two main types of rolling scaffold.

- **Castor Type.** This type of scaffold is best suited for work on smooth floors and is typically used inside buildings. All castors should be equipped with braking devices (Figure 4.3). This kind of scaffold should be erected so that its height-to-width ratio is no greater than 3 to 1. This limits the height of platforms with standard outrigger stabilizers and single span towers to approximately 9 metres (30 feet).
- **Farm Wagon Type**. Scaffolds erected on farm wagons or other devices with pneumatic tires are frequently used for installing sheet metal siding and similar materials on industrial buildings. For safe, effective use, the area around the building should be well compacted, relatively smooth and level. This type of scaffold must also have outrigger beams with levelling devices (Figure 4.4). It is subject to the 3-to-1 height-to-width ratio and is impractical for heights greater than 7.5 metres (25 feet). The scaffold should always be resting on the outriggers while workers are aboard. It should never be used as a work platform while it is "on rubber."

Rolling scaffolds other than those that are lifted off the ground on outriggers should have brakes on all wheels. All brakes should be applied when the scaffold reaches the desired location.

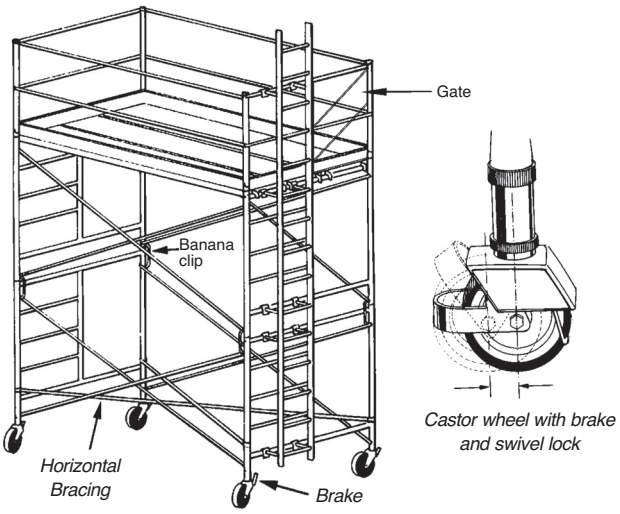


Figure 4.3
ROLLING SCAFFOLD

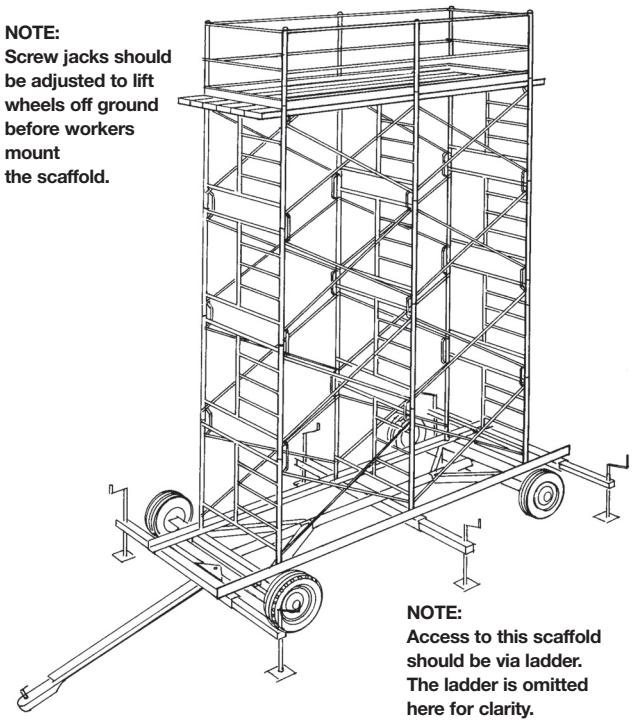


Figure 4.4
FARM WAGON ROLLING SCAFFOLD

It is best not to move rolling scaffolds while a worker is on the platform. If people must remain on the platform when the scaffold is being moved, they should be tied off to an independent structure using a fall-arrest system. In some jurisdictions, moving a scaffold with workers on the platform is prohibited if the scaffold exceeds a certain height. The area through which the scaffold is to be moved should be free of bumps or depressions and cleared of all debris. Overhead hazards, especially powerlines, should be identified.

Rolling scaffolds should always have guardrails. They should also be securely pinned together and be fitted with horizontal bracing as recommended by the manufacturer.

Scaffolds that are not securely pinned together can separate if they drop into a hole or depression, or run into an obstacle at ground level. Horizontal bracing is necessary on a rolling tower scaffold to keep it from folding up because the connections between frames and braces are essentially pinned joints.

Castors should be secured to the frame. A castor dropping off in a hole or depression in floors has been the cause of serious accidents and injuries. Each castor should have a brake and swivel lock which are in good working order and can be applied easily. The castors or wheels should be suitable for the surface on which the scaffold is being used. Small wheels are suitable for pavement or concrete floors. You need larger pneumatic wheels when soils are the working surface. Before using rolling scaffolds, the surface must be smooth, free of depressions and reasonably level.

4.3.1 Electrical Contact

One of the biggest concerns with rolling scaffolds is the possibility of contact with overhead electrical wires. Scaffolds making accidental contact with powerlines have caused many deaths. Before moving a rolling scaffold, check the intended path of travel and maintain the required minimum clearances as set out in Table 1.

4.4 Fold-up Scaffold Frames

Fold-up scaffold frames (Figure 4.5) are frequently used by trades such as electricians, painters, and suspended-ceiling erectors. Widths range from dimensions that will pass through a 750-mm (30-inch) opening to the standard width of about 1.5 metres (5 feet). Frequently made of aluminum, this type of scaffold is easily and quickly transported, erected, and moved about construction sites and from job to job. It should be used only on a smooth, hard surface.

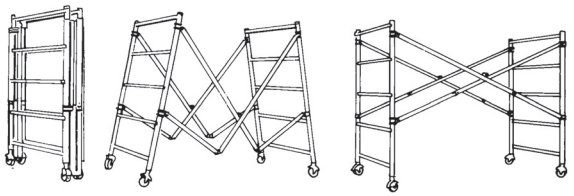


Figure 4.5
FOLD-UP SCAFFOLD

4.5 Adjustable Scaffolds

Figure 4.6 illustrates another type of scaffold with uses similar to the fold-up model. Although it is not so easily erected, the system is light and very easily adjusted for height. It breaks down into a minimum of components readily transported from job to job. These devices should also be used only on smooth, hard surfaces. They are not intended to carry heavy loads.

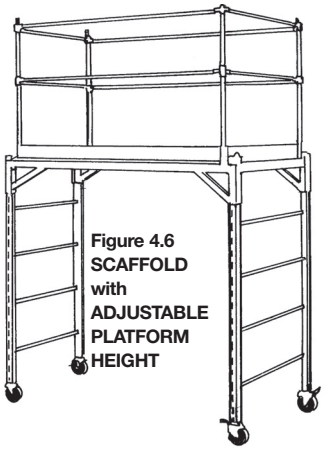


Figure 4.6
SCAFFOLD with ADJUSTABLE PLATFORM HEIGHT

4.6 Tube-and-Clamp Scaffolds

Tube-and-clamp scaffolds (Figure 4.7) are frequently used where obstructions or non-rectangular structures are encountered. The scaffolds are infinitely adjustable in height and width. They can also be used for irregular and circular vertical configurations.

Personnel erecting tube-and-clamp scaffolds must be experienced. It is strongly recommended that, for each application, a sketch or drawing be prepared by someone who understands general structural design and the need for diagonal and cross bracing. In general, this type of scaffold takes longer to erect than the standard tubular frame type. Tube-and-clamp scaffolds above 10 metres (33 feet) must be designed by a professional engineer.

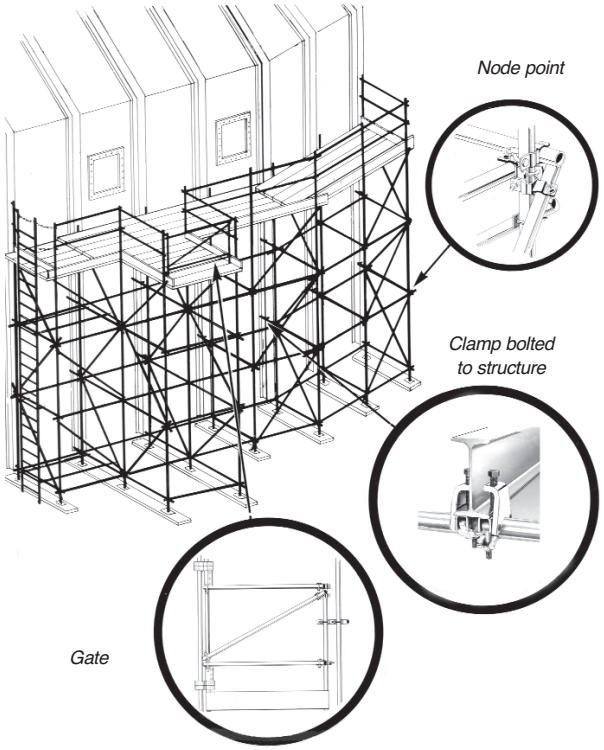
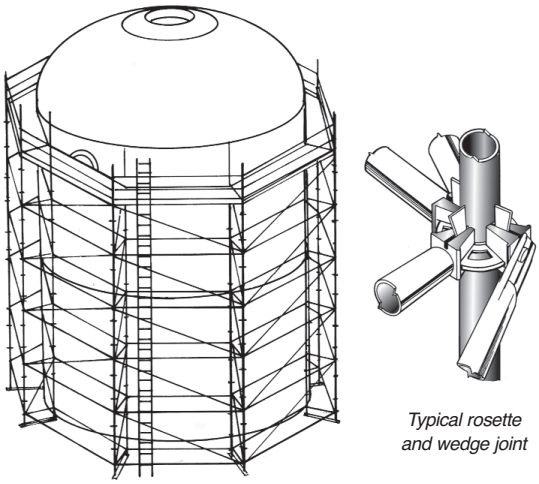


Figure 4.7
TUBE-AND-CLAMP SCAFFOLD

4.7 Systems Scaffolds

European scaffold systems have become very popular in applications that were traditionally suited to tube-and-clamp. Although they are not as adjustable as tube-and-clamp scaffolds, they can be applied to a wide variety of non-rectangular, circular, or dome-shaped structures. A typical example is shown in Figure 4.8. As with tube-and-clamp scaffolds, personnel carrying out the erection should be experienced with that type of system and a sketch or drawing of the scaffold to be erected is recommended for each application. Systems scaffolds above 10 metres (33 feet) in height must be designed by a professional engineer.

There are a great many systems available, ranging from light-duty aluminum to heavy-duty steel support structures. They all employ different patented locking devices (wedges, locking pins, etc.) which are not intended to be interchanged with other systems.



Typical rosette and wedge joint

Figure 4.8
SYSTEMS SCAFFOLD

4.8 Mast-Climbing Work Platforms

The use of mast-climbing work platforms (Figure 4.9) is becoming increasingly common, particularly in the masonry industry. They are best suited for medium to high-rise projects, and are used also by siding installers, window installers, drywallers, and other trades. For low to medium-height projects, they can be freestanding, depending on ground conditions and manufacturers' instructions. For high-rise applications, they can be tied to the structure at regular intervals as set out by the manufacturer.

Mast-climbing work platforms can be used as a single tower or as multiple towers braced together. The platform climbs the mast, normally powered by an electric or gas engine. The climbing mechanism will have a failsafe system to prevent accidental lowering or failing of the platform.

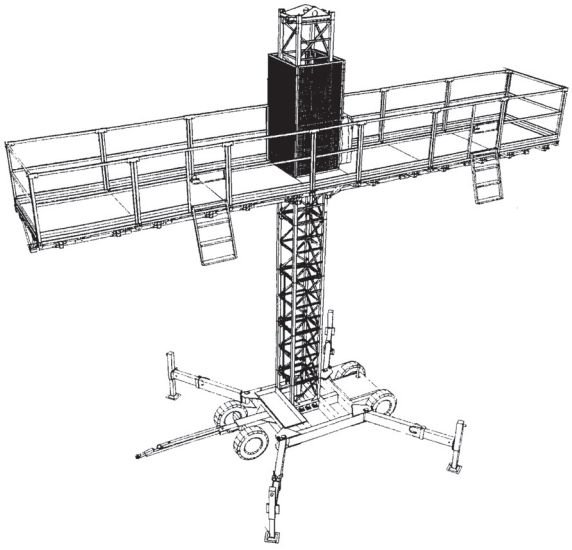


Figure 4.9
MAST-CLIMBING WORK PLATFORM

Although not shown here, the working platform can be a set distance below the material platform. This allows material to be stacked at a convenient height for the worker. The entire platform can be raised to whatever height is required. As such it has significant ergonomic advantages.

Engineered drawings should accompany this work platform outlining such components as load capacity, tie-in requirements, and bracing.

The potential for fall-related accidents is reduced when using mast-climbing work platforms since workers stay on a wide, secured platform even during erection and dismantling. **Manufacturers' instructions must be followed at all times.** A competent worker should supervise the erection.

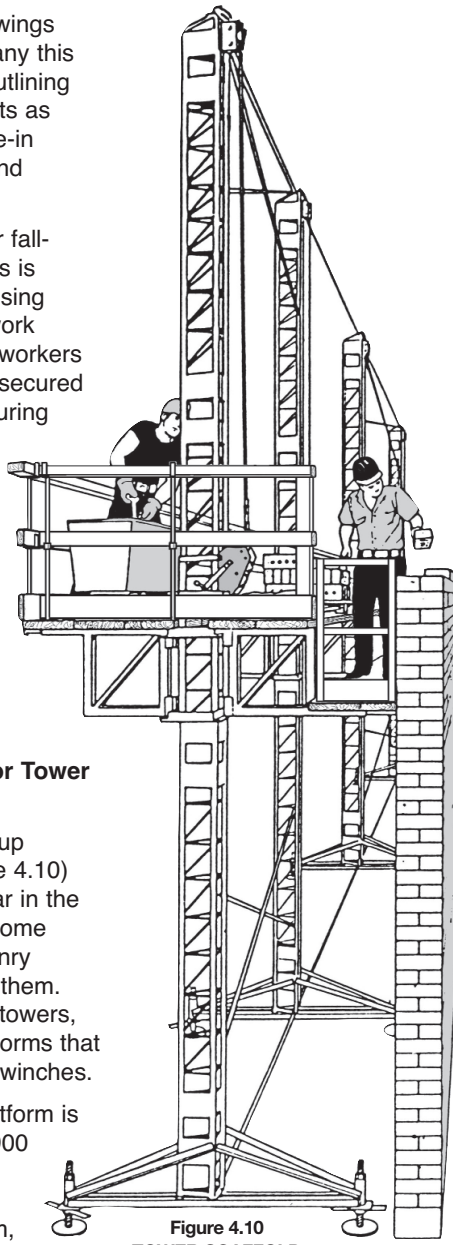


Figure 4.10
TOWER SCAFFOLD

4.9 Crank-up or Tower Scaffolds

Although crank-up scaffolds (Figure 4.10) are more popular in the United States, some Canadian masonry contractors use them. They consist of towers, bases, and platforms that can be lifted by winches.

The working platform is located 600 to 900 mm (2 to 3 feet) below the material platform, which is in an ergonomically good position for the worker.

The entire scaffold can be raised easily, allowing the worker a comfortable working height. Crews must be trained to erect, use, dismantle, and maintain tower scaffolding safely and efficiently. **Manufacturers' instructions must be followed at all times.** Tower scaffolds must be tied to the structure according to manufacturer's instructions.

5 SCAFFOLD COMPONENTS

Tubular Frame Scaffolds: There are many tubular frame scaffold components available (Figures 5.1, 5.2). Some components are necessary in almost all situations; others are optional depending on use and manufacturers' instructions. In addition to scaffold end frames, the minimum components required are

- base plates or castors
- mudsills
- adjustable screw jacks
- vertical braces on both sides of frames unless

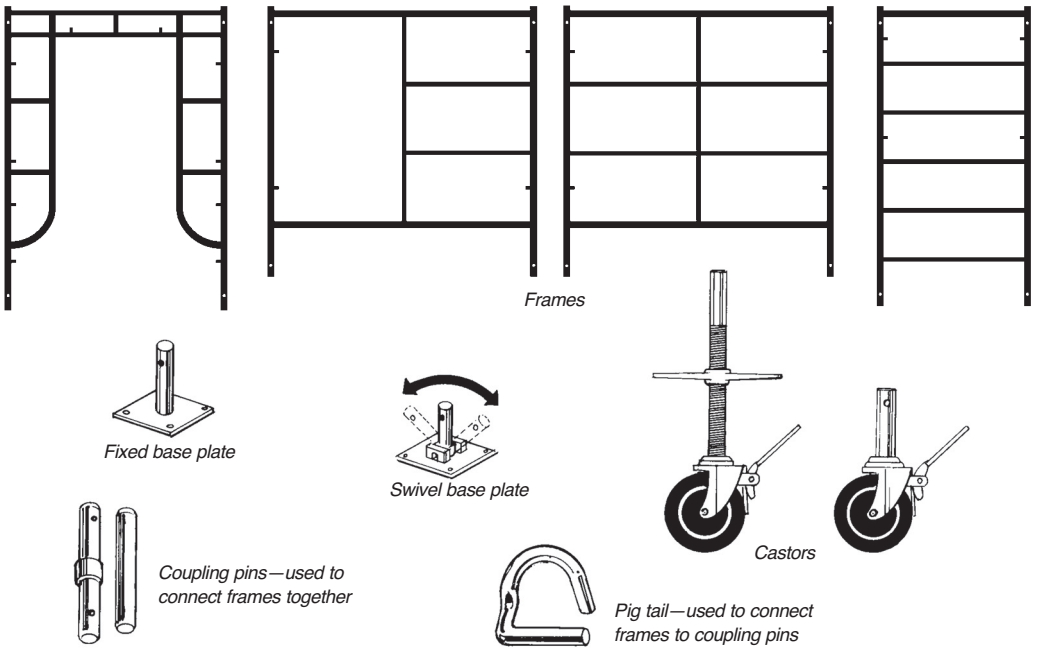


Figure 5.1
FRAME SCAFFOLD COMPONENTS

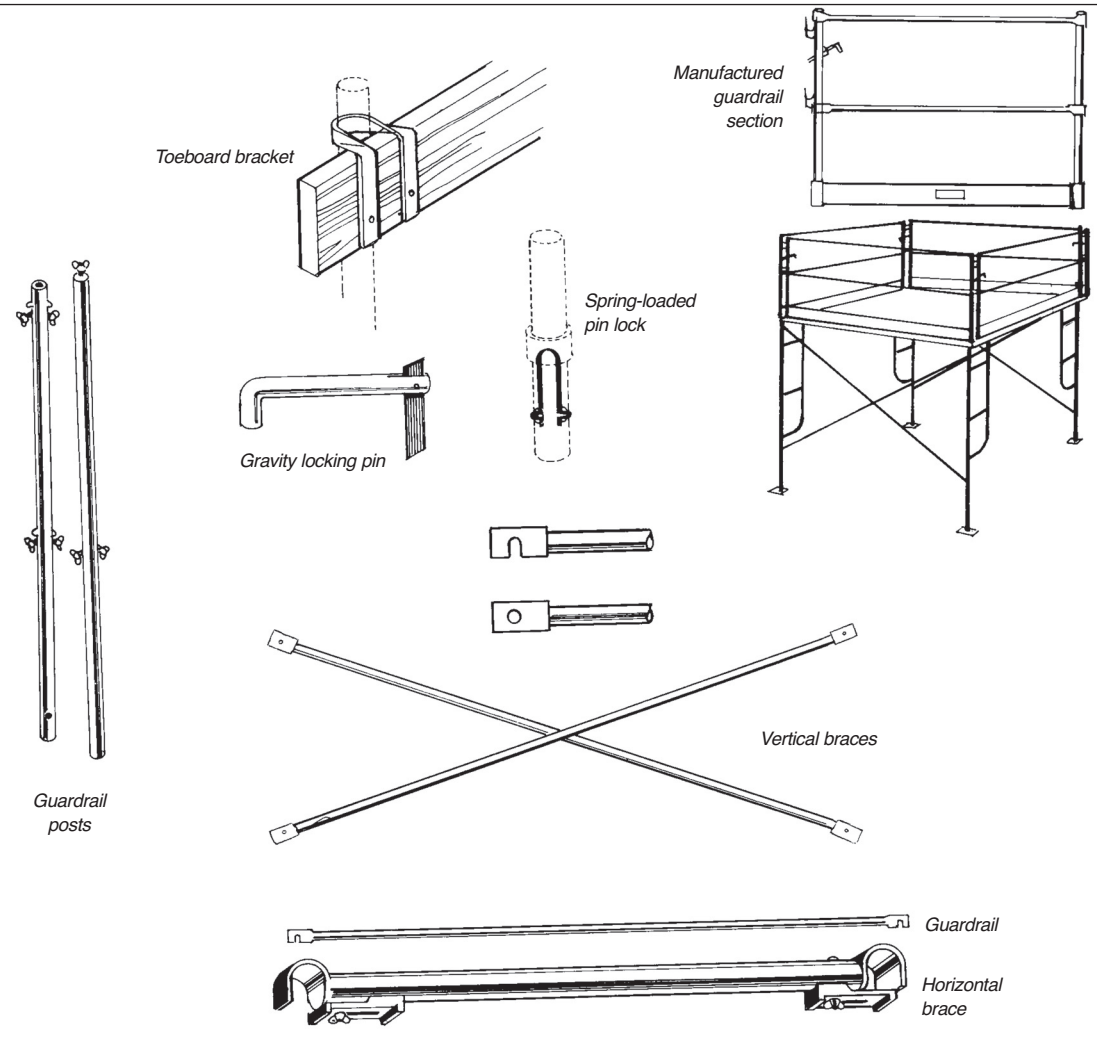


Figure 5.2
FRAME SCAFFOLD COMPONENTS

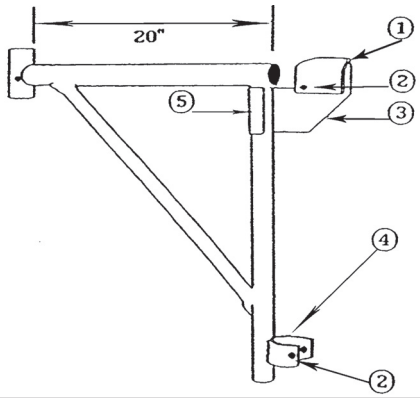


Figure 5.3 – Outrigger/Side Bracket

When purchasing outrigger/side brackets, look for the following features, numbered to correspond with Figure 5.3.

1. Hook tops out at a V-point to sit securely on varying diameters of horizontal frame members
2. Hook and bottom shoe are prepared to receive pin
3. Hook is heavy-gauge, fabricated from one piece of steel
4. Ensure that the lower shoe won't interfere with braces, locks, or other features of different manufacturer's frames
5. Hook plate is wrapped around vertical member and welded on three sides only

  - frames are designed with "non-pinned" joints
  - additional bracing is provided by a designed system using tube-and-clamp accessories
- horizontal braces on every third tier of frames
- platform materials to fully deck in the intended working level
- guardrails complete with toeboards
- guardrail posts where working platforms will be at the top level
- ladders or stairs for access
- intermediate platforms where required—not more than 9 metres (30 feet) apart and adjacent to vertical ladders.

Tube-and-Clamp Scaffolds and Systems Scaffolds have individual components unique to each type. These components are identified and discussed in detail in Section 6.

5.1 Platforms

Platforms for frame scaffolds are normally either aluminum/plywood platforms or wood planks. Planks normally come in 8-foot or 16-foot lengths to cover one or two 7-foot bays with adequate overhang. Platforms are dealt with in-depth in Section 8.

5.2 Outrigger/Side Brackets

The use of outrigger brackets—also known as side brackets (Figure 5.3)—is very popular in the masonry industry. They are attached to the inside of the frame and accommodate a platform approximately 20" (two planks) wide. They provide a work platform for the mason at an ergonomically convenient location—lower than the material platform. Intended as a work platform only, they are not to be used for material storage.

Instances have been reported of brackets installed on the "wrong" side of the scaffold—facing the forklift, for example–to provide a landing area for skids of material. This is not acceptable because outrigger brackets are not designed for supporting material. Furthermore, the practice may lead to unbalanced loading of the scaffold, causing tip-over.

Figure 5.4 illustrates typical outrigger/side brackets attached to the scaffold for masonry use. For efficient, comfortable work, the brackets should be adjustable in lifts of no more than 600 mm (24 inches). A space no greater than 150 mm (6 inches) should be maintained between the bracket platform and the wall. Although the outrigger brackets illustrated are side brackets, end brackets are also available from most manufacturers.

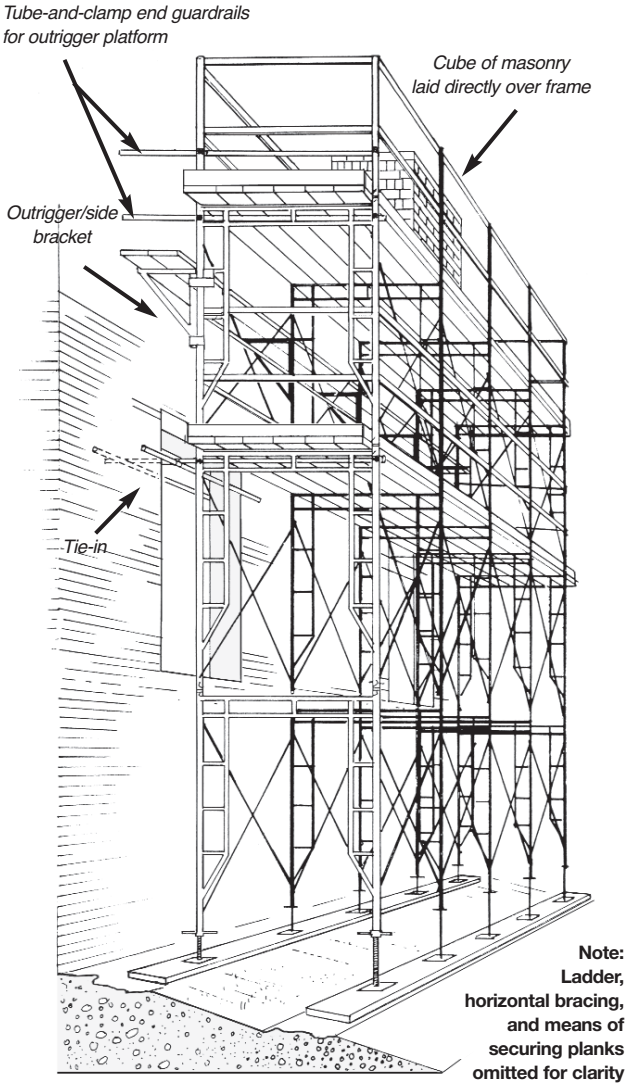


Figure 5.4
MASONRY SCAFFOLD WITH OUTRIGGER/SIDE BRACKETS

Use the following good work practices:

- Do not drop or roughly handle outrigger/side brackets during erection or dismantling. This can bend or damage hooks.
- Use planks that are double-cleated at one end to ensure that the cleats are engaged over a bracket to prevent the bracket from pivoting.
- Inspect brackets as they are being installed on the scaffold to ensure that only sound brackets with no defects are used.

- Tag for repair any brackets that have deformed or cracked hooks, cracked welds, or other defects.
- Make sure that brackets are mounted securely on the frame all the way down.
- Never stock material on the bracket working platform. The working platform is for the worker only.
- Make sure that planks laid on the brackets extend at least 150 mm (6 inches) beyond the frames at either end.
- Place brackets so the level where the worker stands is no more than 1 metre (40 inches) below the level where the material is stored.

Beware of common hazards with outrigger/side brackets:

- hooks bent or deformed to the extent that they will roll off the frame under load
- hooks bent back into place, thereby causing cracks in the metal or welds which then break under load
- homemade brackets that are poorly designed and fabricated, too flimsy to bear the load, or not sized properly to hold two planks
- failure to inspect brackets during erection to ensure that they are not damaged
- failure to use planks that have double cleats on one end.

Other features to look for are

- manufacturer's plate showing name and model number
- brackets that are hot-dipped galvanized
- manufacturer's literature stating that the bracket has been designed and fabricated to meet loading requirements specified in the Ontario regulations and applicable CSA standards.

5.3 Ladders

Whether built into frames, attached as a separate component, or portable, ladders are an important means of access to scaffold platforms. We would substantially reduce the number of falls connected with climbing up and down scaffolds if workers always used adequate and properly erected ladders. Unfortunately, suitable ladders are not often provided or used.

A major problem with ladders built into the frame is that planks sometimes stick out so far that it's difficult to get from the ladder to the platform. This situation results in many injuries but can be overcome in one of three ways:

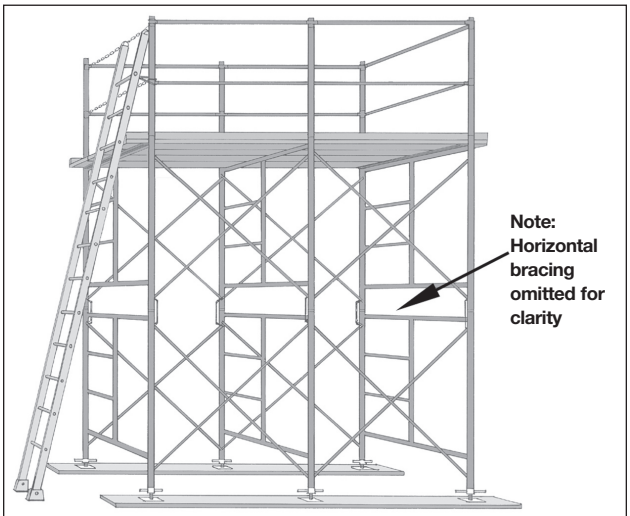
- use manufactured platform components which do not project beyond the support
- use a portable ladder where platform elevations are less than 9 metres (30 feet) in height (Figure 5.5)
- use a stand-off vertical ladder with a cage if the scaffold is above 3 metres (10 feet).

Ladder rails should extend at least 900 mm (3 feet) above the platform level to facilitate getting on and off. Injuries are often connected with stepping on and stepping off the ladder at the platform level.

Rest stations should be decked in on scaffold towers at intervals no greater than every 9 metres (30 feet). Climbing is strenuous work and accidents happen more frequently when climbers suffer from overexertion.

5.4 Guardrails

Failing to use guardrails is one of the main reasons for falls from scaffold platforms. Manufacturers of frame



NOTE:
Ladder rails should extend at least 1 m (3 ft) above platform

Figure 5.5

scaffolds have guardrail components that can be attached to the scaffold frames. These have posts that sit directly onto the connector pins and to which the rails are attached using wing nuts.

Where manufactured guardrails are not available, guardrails can be constructed from lumber (Figure 5.6) or tube-and-clamp components.

Tube-and-clamp guardrails may be constructed from standard aluminum scaffold tubing using parallel clamps to attach the vertical posts to each frame leg (Figure 5.6). Top rails and mid-rails should be attached to the vertical posts using right-angle clamps. Connections in these rails should be made with end-to-end clamps.

Most manufacturers have toeboard clips to fasten toeboards quickly and easily to standard tubular posts on either frames or guardrail posts.

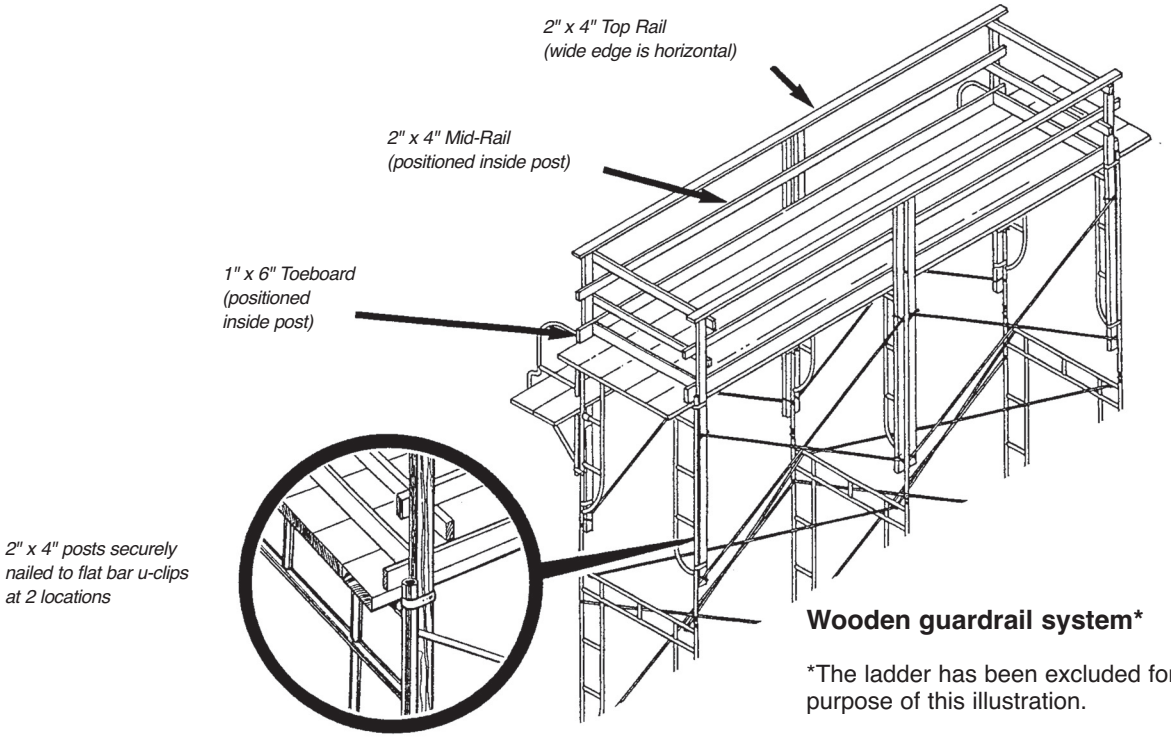
A guardrail should consist of:

- a top rail about 1 metre (40 inches) above the platform
- a mid-rail about halfway between the platform and the top rail
- a toeboard at least 89 mm ($3^1/_2$") high at the platform level if made from wood, and
- posts no more than 2.4 metres (8 feet) apart if made from wood. Guardrail posts can be farther apart if the materials used are adequate to support the loads specified.

Guardrails should be designed to resist the forces specified in the Construction Regulation.

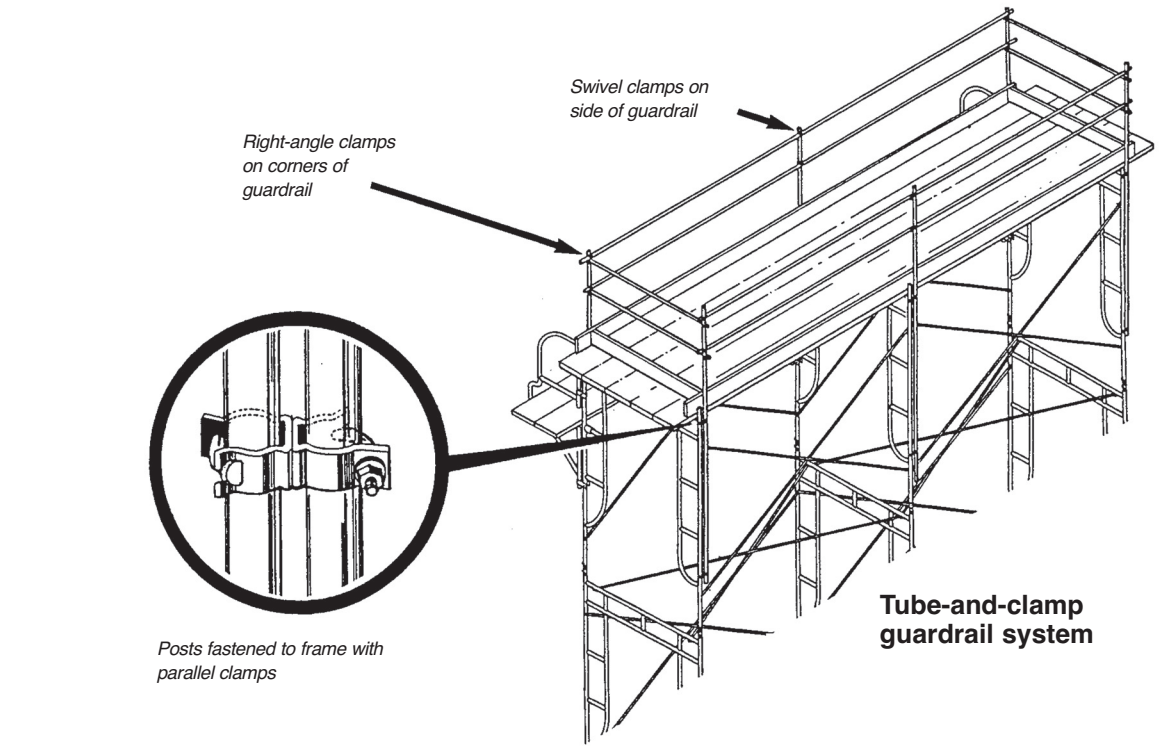
Frequently, guardrails must be removed to allow material to be placed on the scaffold platform. Workers must protect themselves from falling by using a fall-arrest system properly worn, used, and tied off. The fall-arrest system should be worn while the worker is removing the guardrail, receiving the material, and replacing the guardrail. Too often, guardrails are removed to receive materials and then not replaced. Many workers have fallen because other workers have left unguarded openings on scaffold platforms.

Figure 5.6
GUARDRAILS



Wooden guardrail system*

*The ladder has been excluded for the purpose of this illustration.



Tube-and-clamp guardrail system

6 ERECTING AND DISMANTLING SCAFFOLDS

6.1 General

Scaffolds should always be erected under the supervision of a competent worker. Although scaffold systems vary between manufacturers, certain fundamental requirements are common to all scaffold systems. Frame scaffolds over 15 metres (50 feet) in height, and tube-and-clamp and systems scaffolds over 10 metres (33 feet), must be designed by a professional engineer. Supervisors must ensure that the scaffolds are constructed in accordance with that design.

6.1.1 Foundations and Support Surfaces

Scaffolds must be erected on surfaces that can adequately support all loads applied by the scaffold. To support scaffolds, backfilled soils must be well compacted and levelled. Mud and soft soil should be replaced with compacted gravel or crushed stone. Embankments that appear unstable or susceptible to erosion by rain must be contained. Otherwise, the scaffold must be set far enough back to avoid settlement or failure of the embankment.

Where mudsills must be placed on sloping ground, levelling the area should be done, wherever possible, by excavating rather than backfilling (Figure 6.1).

In some cases it may be necessary to use half-frames to accommodate grade changes. For these situations, the side bracing is usually provided by using tube-and-clamp components.

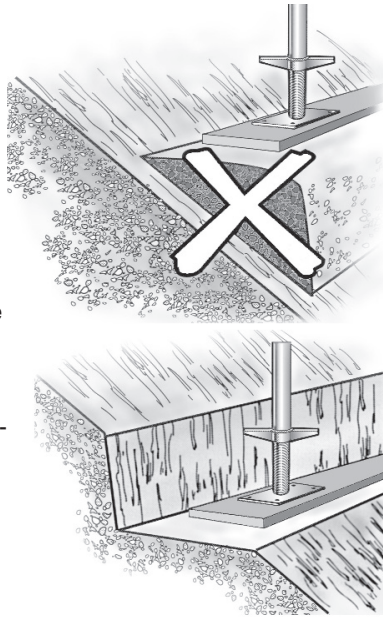


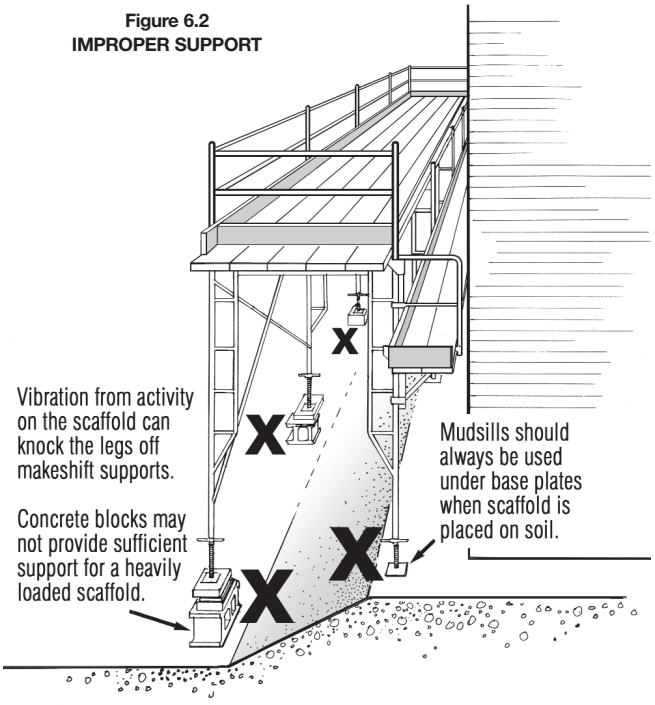
Figure 6.1
MUDSILL ON SLOPING GROUND

Floors are usually adequate to support scaffold loads of workers, tools, and light materials. As loads become greater, floors, especially the older wooden types, should be examined to ensure that they will support the anticipated loads. In some cases, shoring below the floor and directly under the scaffold legs may be necessary. In other situations, you may need sills that span the floor support structure.

Scaffolds erected on any type of soil should have a mudsill. At minimum the mudsill should be a 48 mm x 248 mm (2" x 10") plank (full size) and should be continuous under at least two consecutive supports. The scaffold feet should rest centrally on the mudsill and the sill should, where possible, project at least 300 mm (1 foot) beyond the scaffold foot at the ends. Mudsills may be placed either along the length or across the width of the frames.

Do not use blocking or packing such as bricks, short pieces of lumber, or other scrap materials under scaffold feet or under mudsills (Figure 6.2). If the scaffold is subjected to heavy loading, bricks or blocks can break. Vibration can cause blocking to move or shift, leaving a scaffold leg unsupported. In such conditions the scaffold can topple when heavy loads are applied.

Figure 6.2
IMPROPER SUPPORT



Take particular care when erecting scaffolds on frozen ground. Thawing soil is often water-soaked, resulting in considerable loss of bearing capacity. You must take thawing into account when tarps or other covers will be placed around a scaffold and the enclosure will be heated.

If the scaffold is inside a building, preparing the foundation may mean

- clearing away debris or construction materials and equipment stored in the way
- using sills or placing shoring under old wooden floors.

For a scaffold on the outside of a building, preparing the foundation may include

- replacing mud and soft ground with gravel or crushed stone
- levelling and compacting loose backfill
- stabilizing or protecting embankments
- providing protection against erosion from rain or thawing
- using mudsills.

Foundation preparation is important with any scaffold. It is especially important when scaffolds will be heavily loaded, as in masonry work. Differential settlement may damage scaffold components even if no serious incident or collapse occurs.

6.1.2 Inspection

Scaffold materials should be inspected before use for

- damage to structural components
- damage to hooks on manufactured platforms
- splits, knots, and dry rot in planks
- delamination in laminated veneer lumber planks
- presence of all necessary components for the job
- compatibility of components.

Structural components which are bent, damaged, or severely rusted should not be used. Similarly, platforms with damaged hooks should not be used until properly repaired. Planks showing damage should be discarded and removed from the site so that they cannot be used for platform material.

6.1.3 Location

Before erecting a scaffold, check the location for

- ground conditions
- overhead wires
- obstructions
- variation in surface elevation
- tie-in locations and methods.

Checking the location thoroughly beforehand will eliminate many of the problems that develop during erection and will allow erection to proceed smoothly, efficiently, and safely.

6.1.4 Base Plates

Base plates and adjustable screw jacks should be used whether the scaffold is outside on rough ground or indoors on a smooth level surface. Base plates should be centred on the width of the sill and nailed securely after the first tier has been erected. Sills may run either across the width or along the length of the scaffold depending on grade conditions and other factors. Generally, bearing capacity will be increased by running sills longitudinally because the sill has more contact with the ground.

6.1.5 Plumb

When the first tier of scaffold has been erected it should be checked for plumb, alignment, and level. Where necessary, adjustments can be made using the screw jacks.

Settlement or slight variations in the fit of the components may require additional adjustments as tiers are added to the scaffold tower. Braces should fit easily if the scaffold tower is level. If braces do not fit easily it is an indication that the scaffold is out of plumb or out of alignment.

6.1.6 Hoisting Materials

Where scaffolds will be more than three frames high, a well wheel or "gin" wheel and a hoist arm or davit will make the hoisting of materials easier during erection (Figure 6.3).

While materials can be pulled up by rope without these devices, the well wheel and hoist arm allow the hoisting to be done by workers on the ground. This is much safer and eliminates the risk of workers falling from the scaffold platform as they pull materials up by rope. Loads lifted by a well wheel should normally be no more than 50 kg (100 lb.) unless special structural provisions are made.

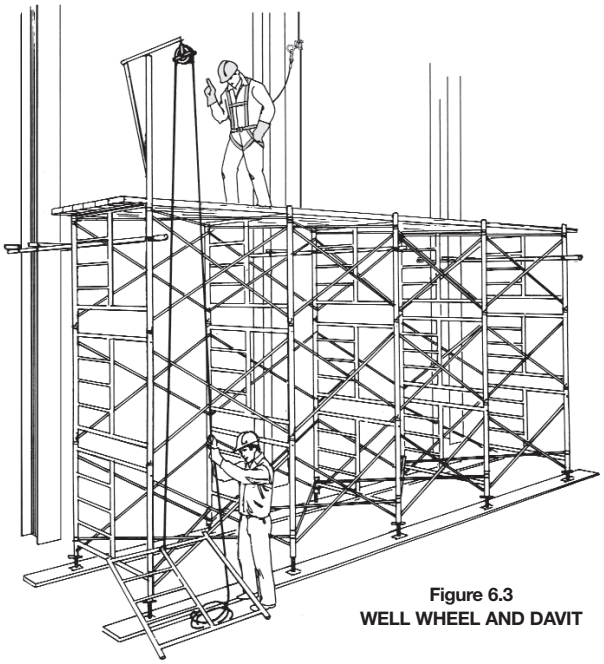


Figure 6.3
WELL WHEEL AND DAVIT

The use of forklifts or other mechanical means of hoisting scaffold materials has become more common particularly in masonry applications. The use of this type of equipment greatly reduces the potential for overexertion injuries due to lifting and pulling. However, extra precaution must be taken to prevent powerline contact and other potential hazards such as overloading.

6.1.7 Tie-ins

Scaffolds must be tied in to a structure or otherwise stabilized —in accordance with manufacturer's instructions and the Construction Regulation—as erection progresses. Leaving such items as tie-ins or positive connections until the scaffold is completely erected will not save time if it results in an accident or injury. Moreover, in most jurisdictions it is prohibited. For further information on tie-in requirements, see Section 7.6.

6.1.8 Fall Protection in Scaffold Erection

Providing practical fall protection for workers erecting and dismantling scaffold and shoring has been challenging for the construction industry.

In Ontario, Section 26 of the Construction Regulation requires that workers erecting, using, or dismantling scaffolds must be protected from falling by using guardrails, travel restraint, fall-restricting systems, or fall-arrest systems.

For fall protection while workers are using a scaffold as a work platform, the safest solution is guardrails, provided they can be erected safely. Workers involved in erecting or dismantling scaffolds face a different challenge. Erecting guardrails and using fall-arrest equipment requires specialized procedures since normally there is nothing above the erector on which to anchor the fall protection system. For suggestions, see IHSA's *Scaffolds and Frame Shoring Towers: Fall Protection*, which you can download from www.ihsa.ca.

In all cases, ensure that procedures comply with the regulations. You must use engineered design and procedures when required, and competent workers must review the installed scaffold before use. Pay special care and attention to anchorages.

A competent person must give adequate oral and written instructions to all workers using fall protection systems. Like all scaffolds, this equipment must be used under the supervision of a competent person.

6.2 ERECTING FRAME SCAFFOLDS

Frame scaffolds are the most common types of scaffolds used in Ontario. Too often they are erected by people who are inexperienced and do not know or recognize the potential hazards. Erectors must be aware of the potential dangers not only to themselves but also to the end user of the scaffold.

6.2.1 Fittings and Accessories

People are sometimes reluctant to install all the parts, fittings, and accessories required for a properly built frame scaffold. This poor practice continues because parts are frequently lost or otherwise not available at the site. Other times, it is due to haste, lack of training, or carelessness.

Always use base plates with adjustable screw jacks. They allow for minor adjustments to keep the scaffold plumb and level. Base plates usually have holes so you can nail them to mudsills. This is good practice and should be done as soon as the first tier is erected and plumbed with base plates centred on the sills.

You must brace in the vertical plane on both sides of every frame. Bracing in the horizontal plane should be done at the joint of every third tier of frames starting with the first tier. Horizontal bracing should coincide with the point at which the scaffold is tied to the building. Horizontal bracing is needed to maintain scaffold stability and full load-carrying capacity. The use of horizontal bracing on the first tier helps to square up the scaffold before nailing base plates to mudsills.

Every scaffold manufacturer provides coupling devices to connect scaffold frames together vertically. Figure 6.4 illustrates various types. Erectors often ignore these devices, believing that the bearing weight of the scaffold and its load will keep the frame above firmly connected to the frame below. This will probably hold true until the scaffold moves or sways. Then the joint may pull apart, causing a scaffold collapse. Coupling devices should always be used and installed properly on every leg of the scaffold, at every joint, as assembly proceeds.

If wheels or castors are used they should be securely attached to the scaffold and be equipped with brakes. Failure to attach wheels or castors properly to the frame has been the cause of many serious accidents and fatalities involving rolling scaffolds. Wheels or castors must have brakes which are well maintained and easily applied.

Scaffolds should always have guardrails. Unfortunately, people frequently leave them out, especially on scaffolds of low to moderate height. Workers have been seriously injured as a result.

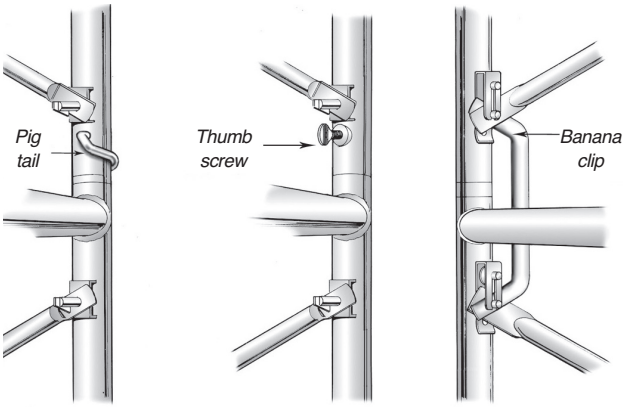


Figure 6.4
COUPLING DEVICES

6.2.2 Braces

Once you have fitted the adjustable base plates on the frames, you must then attach the braces for each tower span. The braces should slide into place easily. If force is required, either the braces are bent or damaged or the frames are out of plumb or alignment.

Secure braces at each end. The erection crew must ensure that self-locking devices move freely and have fallen into place. Rust or slight damage can prevent some of these devices from working properly and they then require force to secure them in position. Maintain moving parts in good condition to prevent this situation from developing.

6.2.3 Platform Erection

Ensure that parts and fittings are in place and secure before placing platform components on a scaffold tier.

When proceeding with the next tier, workers should use platform sections or planks from the previous tier, leaving behind either one platform section or two planks. While this requires more material it speeds up erection because workers have platforms to stand on when erecting or dismantling the platform above. At heights above 3 metres (10 feet), all workers involved in the erection or dismantling of scaffolds must be protected by a guardrail or by other means of fall protection.

Frequently, low scaffolds one or two frames in height are not fully decked in. This can lead to accidents and serious injury. Many lost-time injuries occur each year in Ontario because platforms are inadequately decked.

6.2.4 Ladders

Where frames are not equipped with ladder rungs, ladders should be installed as the erection of each tier proceeds. Injuries involving scaffolds frequently occur when workers are climbing up or down the scaffold. Providing proper ladders will help prevent such injuries. See Section 5.3 for more information on ladders.

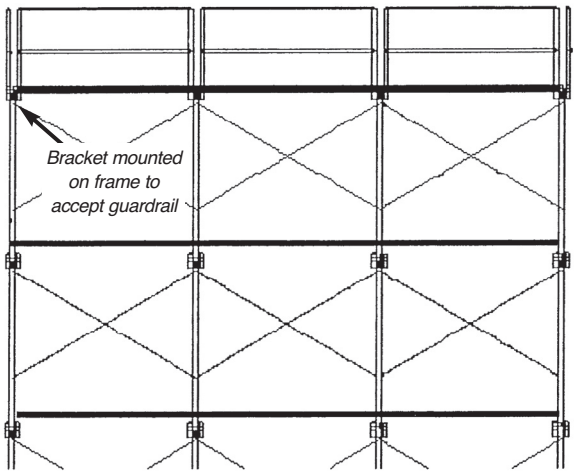
6.2.5 Guardrails

Guardrails must be installed at each working level as the scaffold is erected and also at the top level of the scaffold. This is recommended for all scaffolds regardless of height. Although you do not require guardrails until scaffolds are 2.4 metres (8 feet) high, a considerable number of severe injuries and even fatalities are due to falls from lower scaffolds.

Some manufacturers have recently introduced temporary guardrails workers can use when erecting scaffolds. A guardrail can be set in position from the previous level and can provide a protected work platform for the worker to install the next level of components. Each type of guardrail has a unique design and system of attachment to the scaffold.

Figure 6.5 shows one example of an "advanced guardrail" with the platform fully enclosed. The guardrail is positioned on a bracket which is mounted from below on the outside of the scaffold, and does not interfere with the placement of subsequent frames and braces. As the scaffold goes up the guardrail may be raised as well, or left in position to form the permanent guardrail. The erector must use another fall protection method—permanent guardrails or a full body harness with a lanyard attached to the scaffold—while moving either the platforms or the temporary guardrail.

Figure 6.5
ADVANCED TEMPORARY GUARDRAIL



6.3 ERECTING TUBE-and-CLAMP SCAFFOLDS

Most of the general rules that apply to frame scaffolding also apply to tube-and-clamp scaffolding. The requirements for mudsills, platforms, and guardrails are exactly the same for both types.

The most important difference between the two is the additional degree of skill and knowledge necessary to erect tube-and-clamp scaffolds safely and efficiently. Tube-and-clamp scaffolds should not be erected by an unskilled or inexperienced crew. Basic terms are identified in Figure 6.6.

6.3.1 General Requirements

Tube-and-clamp scaffolds are erected plumb and level like frame scaffolds but the erection system is quite different.

The scaffold must start with a set of ledgers and transoms immediately above the base plates. This is necessary to hold the base plates in their proper position. The typical erection sequence for a simple tower is shown in Figure 6.6. Each vertical and horizontal member should be checked with a spirit level as erection proceeds.

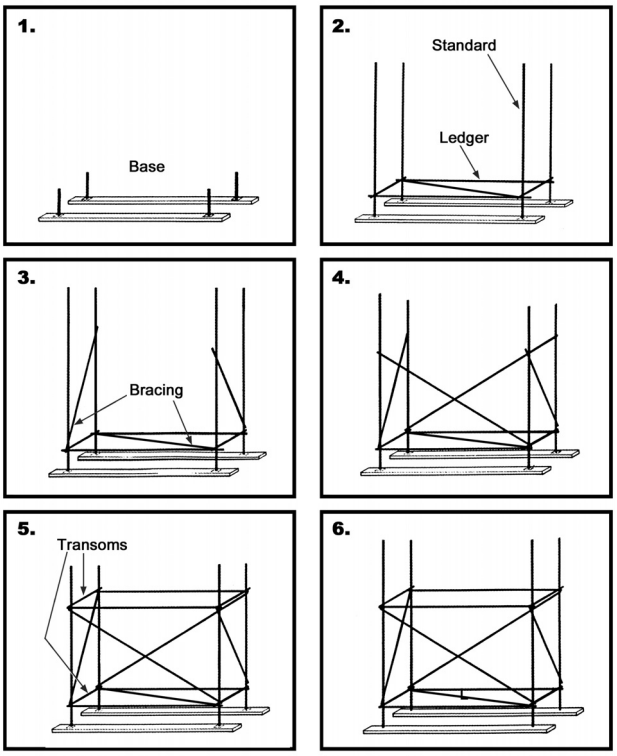


Figure 6.6
ERECTION OF TUBE-AND-CLAMP SCAFFOLD

6.3.2 Materials and Components

The tubing normally used for tube-and-clamp scaffolding in Ontario is schedule 40, 1.9" OD (1½ ID) aluminum pipe manufactured of either 6061 or 6063 alloys.

Clamps are usually made of steel and have a variety of configurations. Depending on the manufacturer, clamps can be fastened using wedges, bolts, or other methods. The following types are used.

- **Right-Angle Clamp**—a clamp used for connecting tubes at right angles. They maintain the right-angled orientation providing rigidity to the structure.
- **End-to-End Clamp**—an externally applied clamp to connect two tubes end-to-end.
- **Swivel Clamp**—a clamp used to connect two tubes when right-angle clamps cannot be used. They usually connect bracing.
- **Parallel Clamp**—a clamp used for lap jointing two tubes together. It can be used to connect short guardrail posts to the standards or legs of frame scaffolds.
- **Concrete Tie Clamp**—a clamp used to connect a tube to concrete or other surfaces using a bolt or concrete anchor.

These and other devices are shown in Figure 6.8 depicting a typical tube-and-clamp scaffold.

Before using clamps, check them carefully for damage to wedges or threads on bolts and distortion of the clamp body.

6.3.3 Spacing of Standards

The spacing of standards depends on the load-carrying requirements of the scaffold. Wherever possible, tube-and-clamp scaffolding should have bay and elevation spacing of about 2 metres (6'-6") longitudinally and vertically. This allows for the front sway bracing to be located at approximately 45° to the horizontal. It also facilitates the use of 5-metre (16-foot) planks with adequate overhang. The width of these platforms can vary but is usually approximately 1 metre (3 feet). This spacing allows the aluminum tubing specified earlier to carry normal construction loads adequately. An advantage of tube-and-clamp scaffolding is that the platform height can be easily adjusted to the most appropriate level for the work being done.

6.3.4 Ledgers and Transoms

Ledgers should be connected to standards using right-angle clamps. These clamps maintain a rigid 90° angle between members.

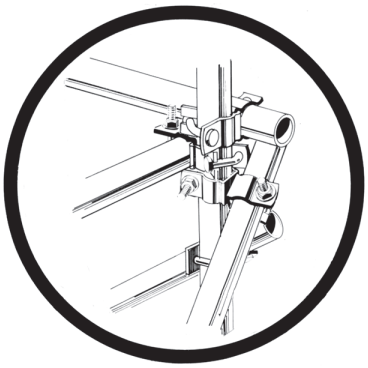
Transoms should be placed above the ledgers and both should be maintained in a horizontal position by levelling with a spirit level. Transoms may be connected to either standards or ledgers by using right-angle clamps.

6.3.5 Joints in Standards and Ledgers

Joints in standards and ledgers should be made with end-to-end clamps. These joints should be as close to the node points as the clamp arrangements will allow. Joints in vertically-adjacent ledgers should not occur in the same bay but should be staggered to provide rigidity.

A node point is the point at which the ledger-to-standard, transom-to-standard, and bracing-to-standard connections come together. An example of a node point is shown in Figure 4.7 and below.

Node point



6.3.6 Intermediate Transoms

You should install intermediate transoms when the scaffold will be supporting heavy loads. You can also use them to avoid lapping planks and the tripping hazard that comes with it.

6.3.7 Tie-ins

Tie-ins are required with tube-and-clamp scaffolding. They should be located at every second node vertically and every third standard horizontally. The tie-in tube should be connected to both standards or both ledgers, near the standard to provide rigidity. Connections should be made with right-angle clamps. Tie-ins should be capable of withstanding both tension (pull) and compression (push) forces (Figure 6.8).

6.3.8 Bracing

Internal bracing (Figure 6.8) is connected standard-to-standard using swivel clamps. It should be clamped as close to the node as possible. Internal bracing should normally be placed at every third standard. The location should coincide with tie-in points. You should also install bracing for tube-and-clamp scaffolding as erection progresses.

Face sway bracing should be installed to the full height of the scaffold. It may be located in a single bay or extend across several bays (Figure 6.7). Where the bracing is located in single bays it should be in the end bays and at least in every fourth bay longitudinally. In practice, it becomes difficult to get bracing close enough to the node points if it extends more than four bays in width (see ends of bracing in Figure 6.7).

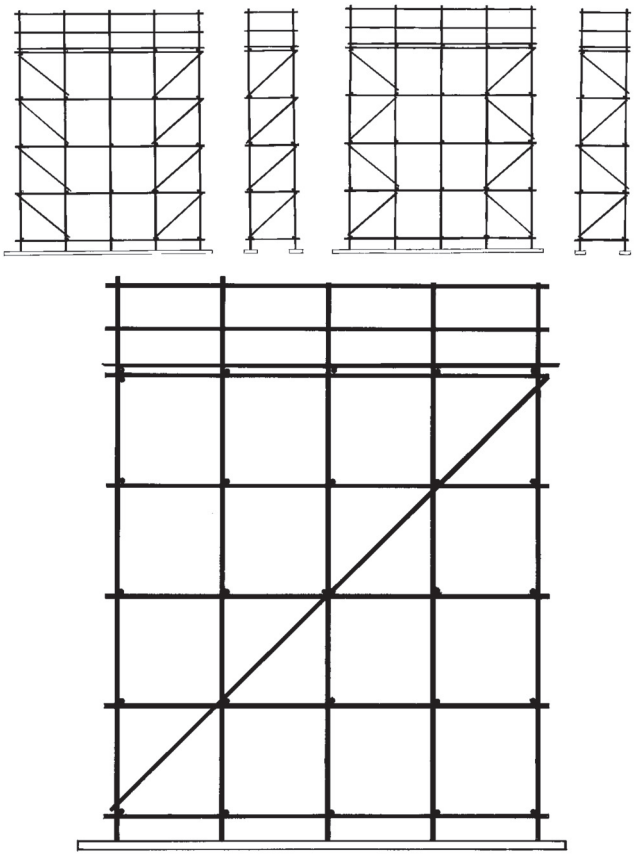
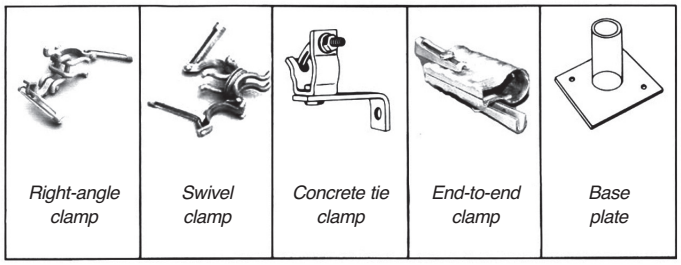


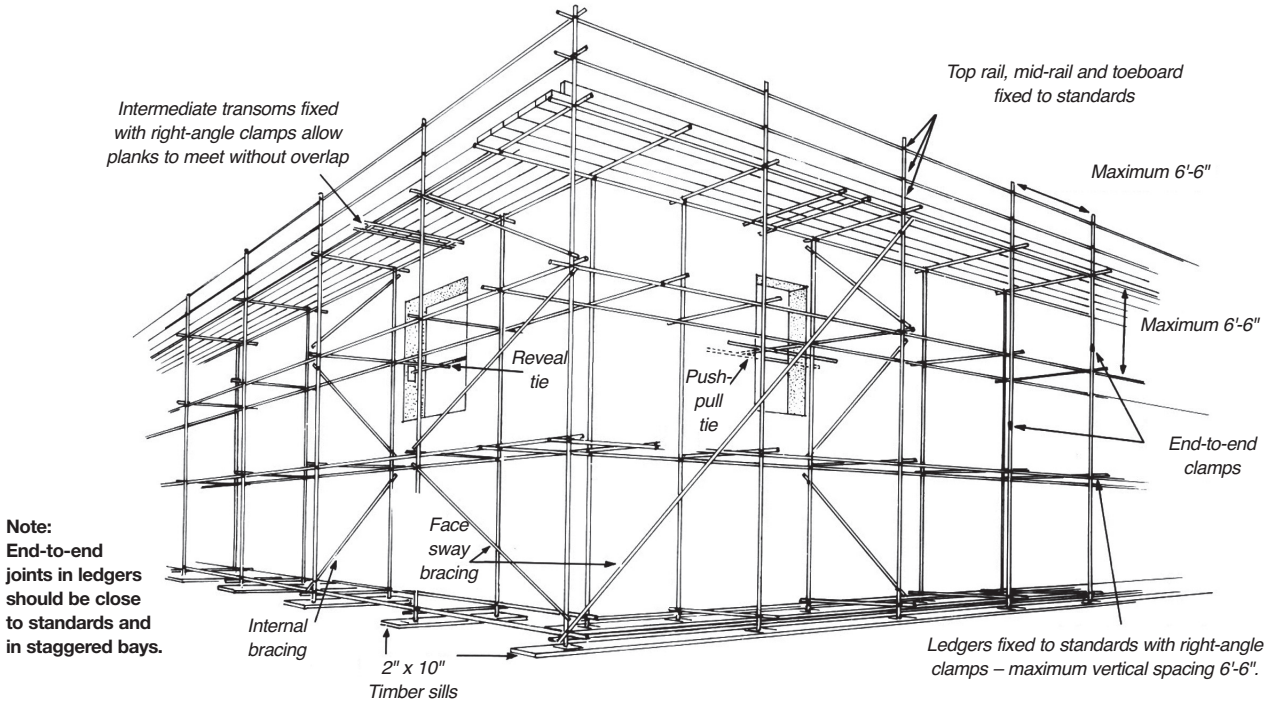
Figure 6.7
TUBE-AND-CLAMP BRACING

6.3.9 Drawings and Inspections

We strongly recommend that a sketch or drawing be prepared before erecting tube-and-clamp scaffolding. It is important that you place the standard to accommodate the anticipated loads adequately. Bracing must also be designed to provide stability and to transfer horizontal loads to tie-in points.

Figure 6.8
COMPLETED TUBE-AND-CLAMP SCAFFOLD





Where the platform will be more than 10 metres (33 feet) high or where unusual structures such as cantilevered platforms are involved, a professional engineer must design the scaffold. A professional engineer or a competent worker must inspect the scaffold before it is used to ensure that it is erected in accordance with the design drawings.

6.4 ERECTION of SYSTEMS SCAFFOLDS

Erection of systems scaffold is very similar to that of tube-and-clamp scaffold. The requirements for mudsills, platforms, and guardrails are the same as is the requirement for being built level and plumb. The main differences are the method of connecting individual members together and the fact that all the members are of a fixed length. As with tube-and-clamp scaffolds, all systems scaffolds above 10 metres (33 feet) must be designed by a professional engineer.

6.4.1 Components

Standards come in a variety of lengths and have a variety of built-in connection points at equal distances along their length. These connectors are normally between 450 and 500 mm (18 and 21 inches) apart depending on the manufacturer. Typical connections are shown in Figure 6.9, although others are available. An end-to-end connection, normally a spigot, is formed at one end to facilitate extension of the standard.

Starter Collars are short standards with one set of system rings or rosettes attached. They are convenient to use because they allow one person to put the first set of transoms and ledgers in place easily (Figure 6.10).

Ledgers or Runners for each system are available in varying lengths and have built-in connection devices for connecting to the standards. The connection is secured by wedging, bolting, or by other methods.

Transoms or Bearers are made wide enough for four or five planks. They normally have end connections similar to those of ledgers and connect directly to the standard. Normally transoms have a lip or groove—particular to the individual manufacturer—designed to accommodate the platform.

Braces are made in set lengths to fit the scaffold being constructed, with connections at both ends to fit directly onto the connection point on the standard.

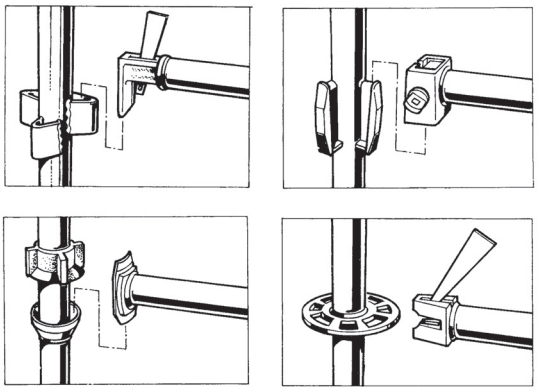


Figure 6.9
TYPICAL SYSTEMS SCAFFOLD CONNECTORS

Platform boards (also called staging) come in a variety of lengths and widths. They fit directly into the transoms and can be secured to prevent wind uplift. To facilitate climbing, some platforms have trap doors with built-in drop-down ladders.

6.4.2 Erection Procedure

The foundation for systems scaffolds should be prepared in the same way as other types of scaffolding, ensuring a firm level base, and using mudsills, base plates, and adjustable screw jacks.

The base plates should be laid out in what you estimate is the correct location. We recommend starter collars since they allow scaffolds to be laid out level and square.

The first level of transoms and ledgers should be placed on the starter collars and be levelled using the screw jacks.

When the scaffold is square and level you should tighten the connections and nail the base plates to the mudsills.

At this point set up an erection platform for installing the standards for the next lift. You now install the second level ledgers and transoms as well as the deck.

You must install ledger bracing at the ends of all system scaffolds and at intervals according to the manufacturers' recommendations. Each brace will be the correct length for the span being braced and should be connected to the attachment point on the standard.

You must install face or sway bracing according to manufacturers' instructions. Again, attachment points are set on the standards, and the braces come in specific lengths for the span of the scaffold being constructed. Normally, every third bay is braced for sway.

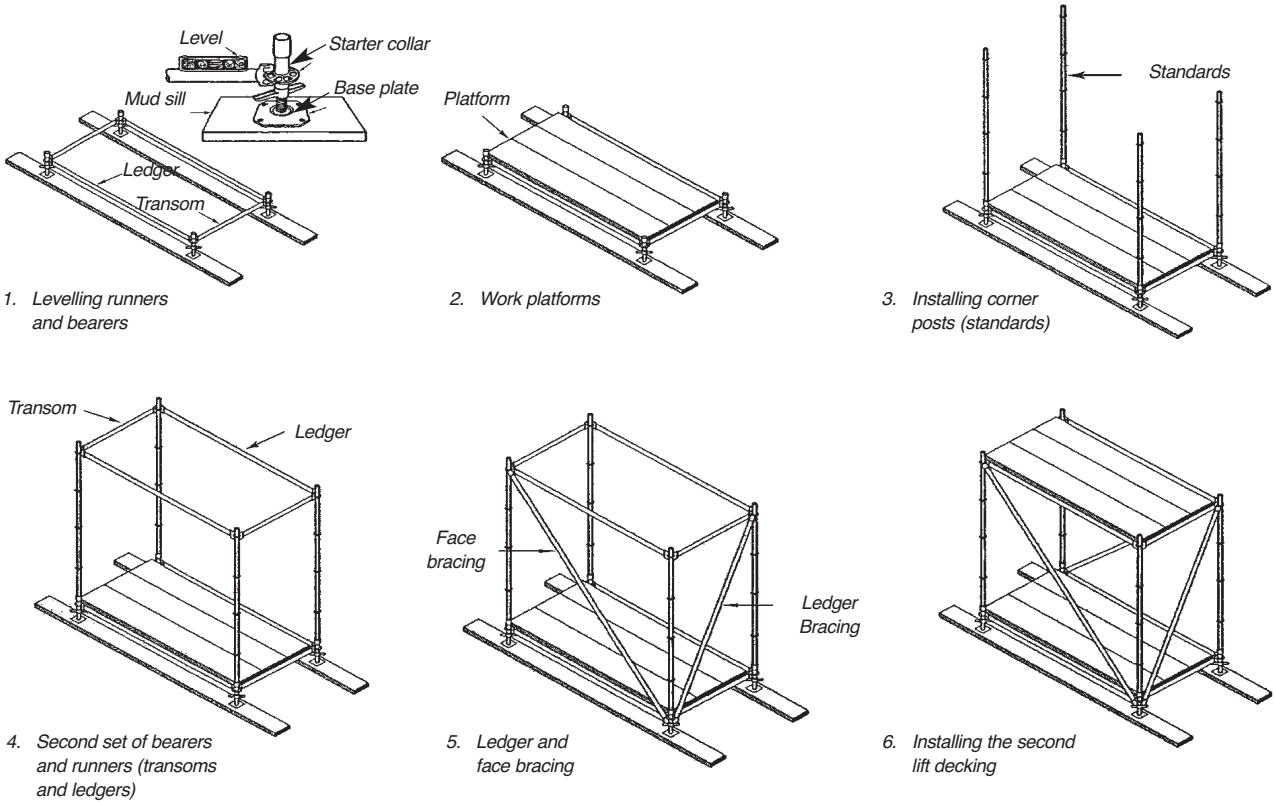
Figure 6.10 outlines the typical erection procedure for systems scaffold.

6.4.3 Tie-ins

Systems scaffolds must be tied in to structures using the 3-to-1 rule as with other scaffolds. Some manufacturers have special adjustable ties which connect directly into the standards, while others use a tube-and-clamp method to tie in to the structure. Anchors attached to the structure are the same as in frame or tube-and-clamp scaffolds.

6.4.4 Guardrails

Generally, guardrails are installed at all working levels. These guardrail components come in modular lengths and are made from lighter materials than the ledgers. They attach directly to the connection points on the standards.



1. *Levelling runners and bearers*
2. *Work platforms*
3. *Installing corner posts (standards)*
4. *Second set of bearers and runners (transoms and ledgers)*
5. *Ledger and face bracing*
6. *Installing the second lift decking*

Figure 6.10
ERECTION SEQUENCE OF TYPICAL SYSTEMS SCAFFOLD

Certain manufacturers have developed advanced guardrail systems that can be installed for a level above the erector, providing fall protection for the worker accessing the next level.

The example shown in Figure 6.11 consists of a "T" shaped temporary guardrail which is attached to the permanent guardrails on the level underneath. When mounted, it extends the required distance past the deck above to form a guardrail. The erector can then work safely without being tied off and install the next level of standards, ledgers, and transoms.

6.5 DISMANTLING

Dismantling frame scaffolds is essentially erection in reverse. Each tier should be completely dismantled and the material lowered to the ground before beginning to dismantle the next tier.

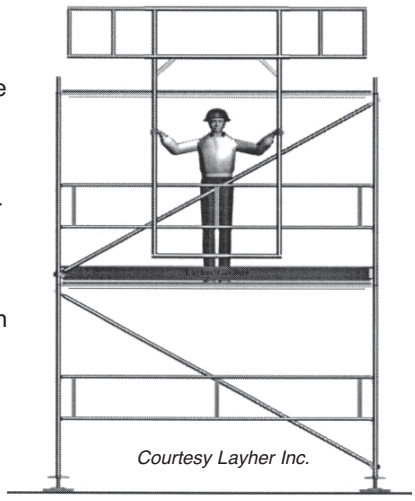
If platform sections or planks have been left at each level during erection, as suggested above, it should be relatively easy to lower platform materials from above and deck in the current working platform completely. Extra platform material can be lowered to the ground. Using this procedure, workers will be operating most of the time from a fully decked-in platform. This makes for easier removal of braces and frames.

Dismantled materials should be lowered using a well wheel and hoist arm or by mechanical means. Dropping materials not only causes damage and waste, but also endangers workers below—and is illegal in most jurisdictions.

When scaffolds have been in the same location for a long time, pins and other components frequently rust, braces become bent, and materials such as mortar or paint often build up on the scaffold parts. All of these can prevent components from separating easily. Removing jammed or rusted scaffold components can be very hazardous. Tugging or pulling on stuck components can cause you to lose your balance and fall. Workers should wear a full body harness and lanyard tied off to a scaffold frame or lifeline before attempting to loosen stuck or jammed parts.

Dismantling tube-and-clamp and systems scaffolding must proceed in reverse order to erection. Each tier should be completely dismantled as far as connections will allow before you begin dismantling the lower tier. You must dismantle them this way because the bracing for tube-and-clamp scaffold is not located in each bay as it is for frame scaffolding. The span or spans with front sway bracing should be the last to be dismantled on each tier.

Figure 6.11
ONE STYLE OF ADVANCED GUARDRAIL SYSTEM



Courtesy Layher Inc.

7 SCAFFOLD STABILITY

7.1 Three-to-One Rule

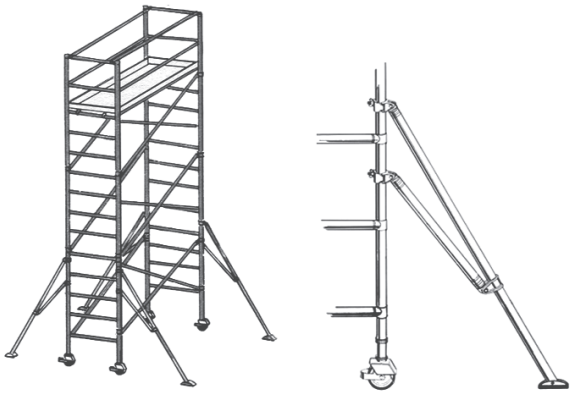
The ratio of height to least lateral dimension must not exceed 3 to 1 unless the scaffold is

- tied to a structure, as discussed in Section 7.6
- equipped with outrigger stabilizers (Figure 7.1) to maintain the ratio of 3 to 1
- equipped with suitable guy wires.

7.2 Outrigger Stabilizers

Scaffold manufacturers usually make outrigger stabilizers that can be attached to their equipment (Figure 7.1).

Figure 7.1
OUTRIGGER STABILIZERS



Rolling scaffold with outrigger stabilizers

Adjustable outrigger stabilizers

With devices of this type, ensure that the outrigger is adjusted so that vibration or dynamic loads on the platform will not move the stabilizer. Where stabilizers with castors are used the castors must rest firmly on a solid surface, with the brakes applied, and with the stabilizer secured in the extended position before workers use the platform (Figure 7.2). Many of these stabilizers fold up to allow movement through smaller openings and around obstructions (Figure 7.2).

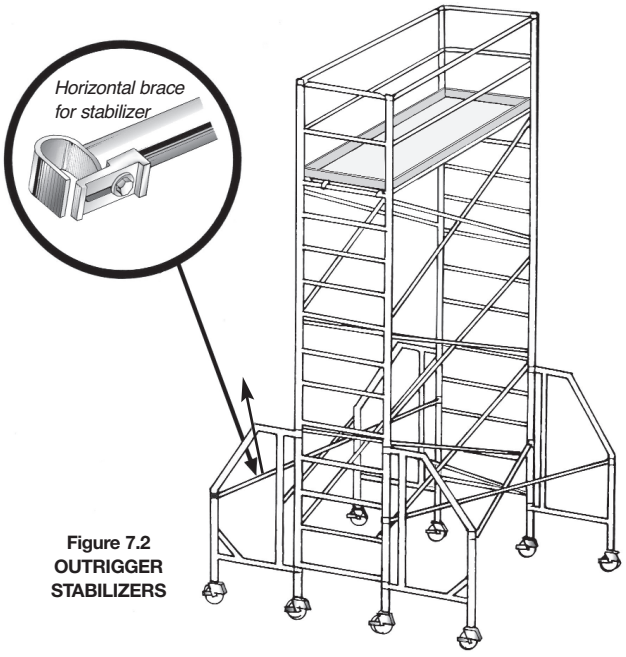


Figure 7.2
OUTRIGGER STABILIZERS

7.3 Limitations to the Three-to-One Rule

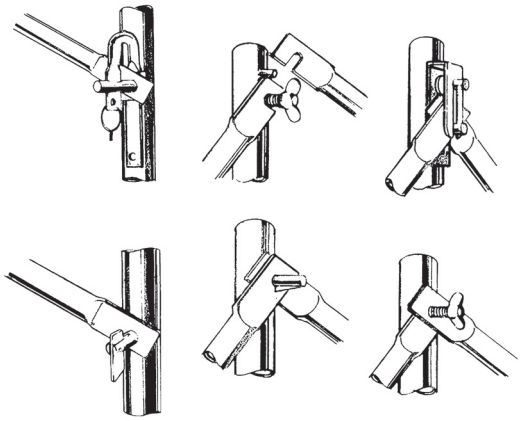
The 3-to-1 rule applies only to the extent that outriggers are extended symmetrically about the scaffold tower. If the outriggers are extended only on one side, you prevent toppling only in that direction.

7.4 Damage

Most bracing systems for tubular frame scaffolds are manufactured from light materials and are easily damaged.

Do not use braces with kinks, bends, or deformations. Such damage can weaken them significantly. The ends of braces are frequently damaged by dropping them on concrete or other hard surfaces during dismantling. Ends of braces are also frequently bent by forcing them onto the locking pin during erection. Constant bending can cause the ends to crack. You should inspect them before use and discard braces with cracked ends. You should maintain the locking device onto which the brace fits in good condition. It should move freely to accept and release the brace. Common securing devices are shown in Figure 7.3.

Figure 7.3
SECURING DEVICES FOR FRAME SCAFFOLD BRACES



7.5 Installation Problems and Symptoms

Ensure that bracing is secured in place. Otherwise, scaffold movement can dislodge the braces and reduce the stability of the scaffold. These devices must secure the braces in place but they must operate freely so that it is easy to erect and dismantle the scaffold. Many times a worker has lost balance and fallen when trying to release a jammed or rusted drop hook while dismantling a scaffold.

You should completely deck platforms used to install bracing. Trying to work from a platform one or two planks wide often results in a fall. In addition, it leads to greater damage to the ends of scaffold braces because they bend when they are not kept close to proper alignment during installation and removal.

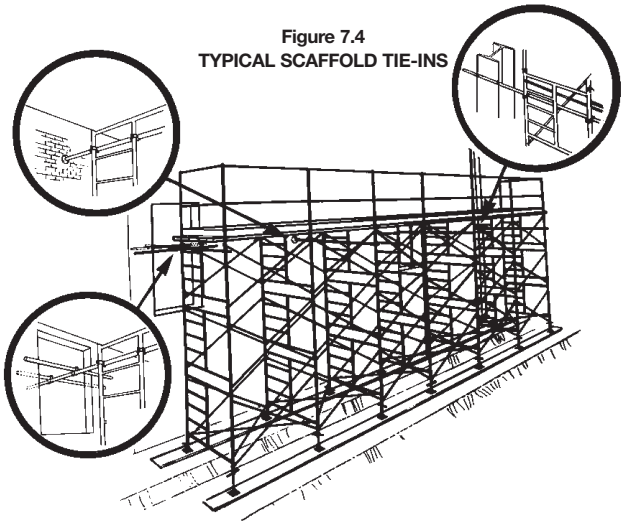
If a brace does not easily drop onto pins something is wrong. The brace may simply be bent and should be discarded. Often, however, it means the scaffold is twisted and out of plumb. Braces should not be forced or hammered onto the pin. The condition causing this difficulty should be corrected so that the brace slides onto the pin easily. Adjusting screw jacks slightly will often solve this problem. However, you need to take care to ensure the scaffold is not adjusted out of plumb.

7.6 Tie-in Requirements

Scaffolds which exceed the 3-to-1 rule of height to least lateral dimension must be tied in to a building or structure. Tie-ins should be applied at every third frame vertically second frame horizontally for tubular frame scaffolds. Tie-ins for tube-and-clamp scaffolds should be applied at every second node vertically and every third standard horizontally.

These tie-ins must be capable of sustaining lateral loads in both tension (pull) and compression (push). Examples are shown in Figure 7.4.

Figure 7.4
TYPICAL SCAFFOLD TIE-INS



Wind loads can affect tie-ins and bracing. These loads vary not only with speed but also with the exposure of the location and the height and shape of structures where the scaffold is erected. In addition, scaffolds which are going to be enclosed for winter construction or sandblasting will be subjected to significantly greater wind loads. If severe winds are expected it is recommended that a professional engineer be consulted for tie-in requirements

8 PLATFORMS

Before you select the platform material, you need to assess the weight of the workers, tools, and materials to be supported. You must also take into consideration the spans being used in the scaffold.

8.1 Typical Loads and Requirements

Minimum platform capacities vary from jurisdiction to jurisdiction. In Ontario, the minimum platform capacity is a uniformly distributed load of 2.4 kn/m^2 (50 lb./sq. ft.) for construction-related work. This is usually sufficient for workers, their tools and equipment, as well as a moderate amount of light materials. It is not sufficient for heavy loads such as those used in masonry construction.

For masonry construction where the scaffold will support large pallets of concrete blocks, minimum capacity should be at least a uniformly distributed load of 7.2 kn/m^2 (150 lb./sq. ft.). This means that scaffolds with spans of 2.1 metres (7 feet) should be at least double-planked. Aluminum/plywood platforms should also have a layer of scaffold planks on top.

Table 8.1

Maximum loads on planks for scaffold platforms 5 feet in width

Layers of Planks		5'-0"			7'-0"		
UNIFORM LOAD PER SQUARE FOOT	150 lbs.	No. 1				No. 1	
	100 lbs.	No. 1			SEL STR	No. 1	
	75 lbs.	No. 1			No. 1		
	50 lbs.	No. 1			No. 1		
4'X4' PALLET LOADS (POUNDS)	4000	SEL STR	No. 1			SEL STR	No. 1
	2900	No. 1				No. 1	
	2430	No. 1			SEL STR	No. 1	
	1760	No. 1			No. 1		
	1520	No. 1			No. 1		

Notes

1. Planks are **spruce-pine-fir species group (SPF)**.
2. Planks are at least $1\frac{7}{8}$" thick and at least $9\frac{3}{4}$" wide.
3. Grade is either number one (No. 1) or select structural (SEL STR).
4. Allowable stresses conform with CSA Standard CAN3-086-1984 “Engineering Design in Wood.”
5. No stress increases are included for load sharing or load duration.
6. Scaffold platforms are 5' wide and fully decked in.
7. Loads indicated are **maximum** for grade and loading conditions. Shaded areas indicate that **no** SPF grades are capable of carrying the loads.

For weights of construction materials and allowable load-carrying capacities of planks at various spans, consult Table 8.1 and Table 9.1.

8.2 Aluminum/Plywood Platform Panels

Most manufacturers make their heavy-duty platforms capable of supporting a uniformly distributed load of 3.6 kn/m^2 (75 lb./sq. ft.) together with a concentrated load of 227 kg (500 lb.) spread over an area near the centre of the span. The load-carrying capacity of these platforms varies to some extent.

It is recommended that the rated load-carrying capacity be obtained from the supplier and marked on the platform panel if the manufacturer has not provided such information on the equipment already. The light-duty platforms available with much less capacity are not suitable for construction.

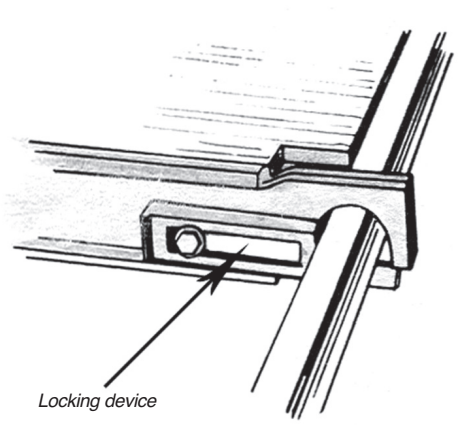


Figure 8.1
SECURING ALUMINUM/PLYWOOD PLATFORMS

The advantage of aluminum/plywood platform panels is that they are light and durable. Worn-out plywood can easily be replaced. However, they are expensive and the hooks on most models can be damaged if dropped from the scaffold repeatedly during dismantling. Check the platform hooks and fastening hardware regularly for looseness, cracking, and distortion. When used outdoors, these platforms should be secured to the scaffold frames using wind locks. Otherwise, when left unloaded, they can be blown off the scaffold by strong winds.

8.3 Laminated Veneer Lumber

This material is really a special type of exterior plywood with laminations oriented longitudinally rather than in two directions. The wood is usually spruce or Douglas fir, although other structural species can be used. The material is manufactured in large sheets of various thicknesses that can be sawn to the sizes required.

The use of laminated veneer lumber as a scaffold platform material is increasing. The strength varies from manufacturer to manufacturer depending on method of fabrication and species of wood used. Users of the material should ask suppliers to furnish rated working loads for the scaffold spans on which the lumber will be used. In general, the material will be stronger than sawn lumber scaffold planks of similar size and species. The strength is also more uniform than sawn lumber.

Like all lumber and plywood, laminated veneer lumber is subject to deterioration from weathering and rot. It must therefore be inspected periodically. Sections showing delamination, cracks, serious damage to several layers of lamination, fungi, or blisters should be discarded.

8.4 Sawn Lumber Planks

Rough sawn planks 48 mm x 248 mm (2 inches by 10 inches) or larger have been the standard scaffold platform material for many years. They are also the least expensive of the common platform materials. **Dressed lumber should never be used for scaffold platforms.**

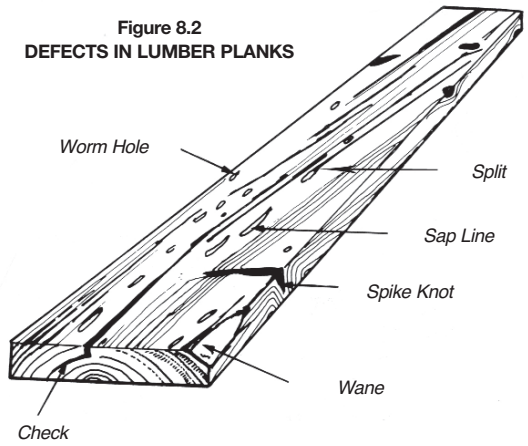
The proper use of planks on a scaffold or other work platform is governed by the Construction Regulation under Ontario's *Occupational Health and Safety Act*. The regulation specifies that wooden planks used on a scaffold must

- be number 1 grade spruce
- bear a legible stamp or be permanently identified as being number 1 grade spruce
- be at least 48 mm by 248 mm ($1\frac{7}{8}$" x $9\frac{3}{4}$")
- be arranged so their span does not exceed 2.1 metres (7 feet)
- overhang their supports by no less than 150 mm (6") and no more than 300 mm (12")
- be laid tightly side by side across the full width of the scaffold at the working level
- be cleated or otherwise secured against slipping
- be capable of carrying any load likely to be applied and as a minimum be capable of carrying 2.4 kilonewtons per square metre (50lb./sq. ft).

It is recommended that planks should meet or exceed the requirements for select structural grades of the species group used, which should be either spruce-pine-fir (SPF) or Douglas fir. Although the SPF group has less strength, it is usually lighter and therefore easier to handle than Douglas fir. Table 8.1 provides maximum loads based on unit stresses from Canadian Standards Association Standard 086.1-1994 "Engineering Design in Wood" for Number 1 and select structural SPF plank platforms. Sawn lumber planks must be stamped by the manufacturer identifying them as scaffold planks.

Since wood planks deteriorate they must be regraded and culled periodically. For most situations, visual grading is recommended. Scaffold planks must be inspected regularly because they deteriorate with use and age, and are subject to damage. Figure 8.2 illustrates defects to look for when inspecting planks. Cull out planks with large knots in the edge, spike knots, checks, wanes, worm holes, and steeply sloping grain patterns. Planks with these defects should not be used as scaffold material and should be destroyed. Scaffold planks can also be weakened by dry rot. It is not easy to notice this condition in its early stages, especially if the exterior of the planks is weathered. Planks substantially infected with dry rot are usually lighter than sound planks of similar size and species. For this reason do not use planks which feel lighter than normal.

Figure 8.2
DEFECTS IN LUMBER PLANKS



8.5 Reinforcing Wood Planks

Wood planks may be reinforced with metal nailer strips or plates. Research conducted by the Construction Safety Association of Ontario (now IHSA) has indicated that the strength of weaker planks may be increased considerably by this technique but it should only be used to increase the strength of planks that are of the proper grade. Do not use this as a method of upgrading inferior grades for scaffold use.

The advantages of strengthening planks by this method are twofold:

- planks are not as likely to be cut up or used for purposes other than scaffold planks
- you have additional assurance that poorer quality planks undetected in the grading process will not break prematurely causing an accident.

WARNING: Nailer plates should not be placed over the portion of the plank resting on the scaffold support—unless cleats are used to prevent the plank from sliding—since there is little friction between the bearing surfaces.

Take care when handling planks reinforced in this way since sharp edges can cut your hands.

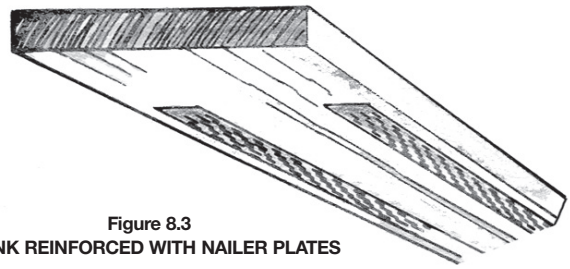


Figure 8.3
PLANK REINFORCED WITH NAILER PLATES

8.6 Securing Platforms to the Frame

Be sure to secure platforms against sliding or movement. Workers frequently fall from platforms because they did not first secure the platform materials. Aluminum/plywood combination platforms have hooks that prevent longitudinal movement but will slide sideways on the scaffold unless the platform is fully decked in.

Sawn lumber planks should be cleated on at least one end to prevent longitudinal movement (Figure 8.4). You can also prevent movement by wiring a plank (Figure 8.6). Unless you carefully apply it, the wire can present a tripping hazard on the platform. Again, the platform should be fully decked in to prevent sideways movement.

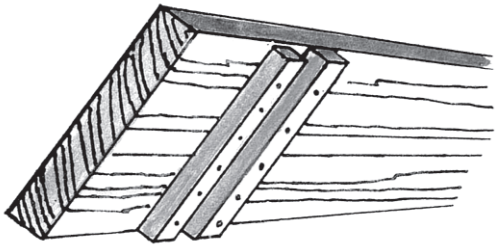
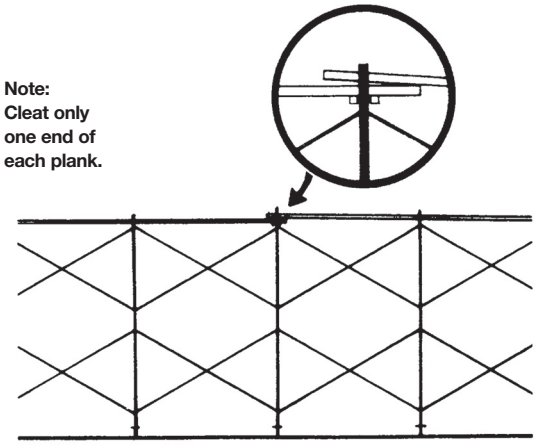


Figure 8.4
PLANK CLEATED TO PREVENT SLIDING

If you have overlapping planks, the cleated end should be resting on the scaffold support. Be aware that the overlapped section presents a tripping hazard (Figure 8.5).

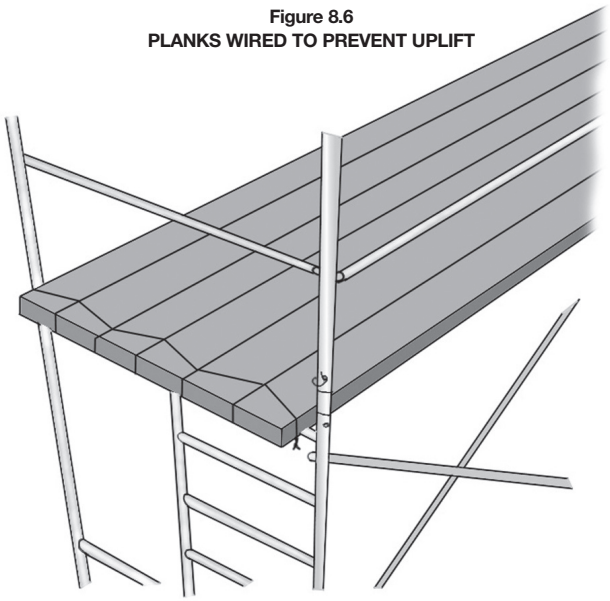
Figure 8.5
OVERLAPPING PLANKS FOR MULTI-SPAN TOWERS



8.7 Wind Uplift

Wind can lift light platform materials from the scaffold if they are not secured. When you anticipate severe wind conditions or when you are using high scaffolds, you should secure platform materials such as aluminum or plywood panels to the scaffold. With some types of platform panels you can do this with wire or nails. Others have a sliding locking device (Figure 8.1). These locking devices, however, can be easily damaged and are often difficult to apply and release.

Figure 8.6
PLANKS WIRED TO PREVENT UPLIFT



9 PROPER USE OF SCAFFOLDS

Much of this chapter deals with the erection and dismantling of various types of scaffolds. Frequently, the end user of the scaffold is not the person who erects it. In order for scaffolds to provide efficient access to work areas they must be used properly by all workers.

9.1 Ladders and Climbing

We discussed ladder access in Section 5.3. The ladder must be properly erected with rails projecting 1 metre (3 feet) above the platform of the scaffold. You should clear debris, extension cords, and tools away from areas around the top and bottom of ladders. Store materials away from these locations.

Falls often happen when workers are getting on or off the ladder at the platform level. Both hands must be free to hold guardrails or ladder rails. Do not carry tools or materials by hand when climbing ladders. Wear a tool belt and pouch and move material up or down by rope.

You should always place portable straight ladders with an adequate slope and secure them to the scaffold structure (Figure 5.5).

Always use three-point contact (Figure 9.1) when climbing ladders. This means using two hands and one foot, or two feet and one hand, to maintain contact with the ladder at all times. Always face the ladder when climbing and always keep your centre of gravity between the two ladder rails.

For more information, refer to the Ladders chapter of this manual.

9.2 Guardrails Missing or Removed

There may be situations where scaffolds must be used without guardrails. If the scaffold is more than one frame or tier in height and there are no guardrails, personnel on the platform must tie off with a full body harness and

Figure 9.1
THREE-POINT CONTACT



Note: Vertical ladders above 3 metres in height must have a safety cage beginning 2.2 metres above the ground or platform. The cage is omitted here for clarity.

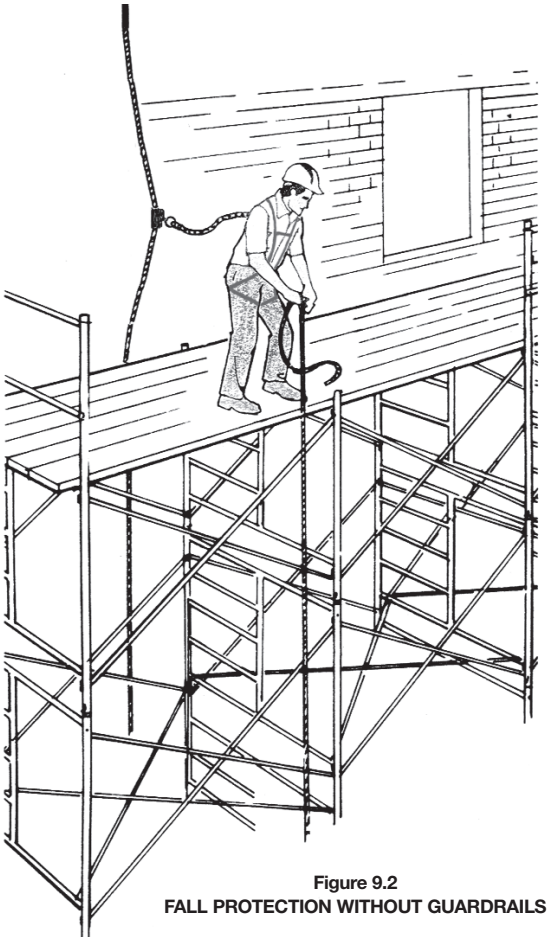


Figure 9.2
FALL PROTECTION WITHOUT GUARDRAILS

lanyard (Figure 9.2). Many falls and serious injuries occur when workers use platforms without guardrails. Any worker who removes a guardrail for any reason must replace it when the task is completed.

9.3 Standing on Objects Above the Platform

People working from the platform should have both feet on the platform. Standing on a barrel, box, stepladder, guardrail, or other object to gain extra height is extremely dangerous and is illegal in most jurisdictions, including Ontario. You should know the required height of the scaffold before erecting it, so you can obtain all the required material, including half frames when necessary.

9.4 Overloading

Overloading scaffold platforms in the masonry trades is one of the most frequent violations of good scaffold practice. Placing full pallets of bricks or concrete blocks on a single layer of 48 mm x 254 mm (2" x 10") scaffold planks is, in most cases, overloading the platform. You may have to double plank decks to support pallets of masonry materials. Place the pallets over the supports wherever possible. In addition, inspect planks used to support masonry materials for damage or for deterioration regularly and often. Table 8.1 indicates the load-carrying capacities of various grades of plank. Table 9.1 lists the approximate weights of common building materials. Bear in mind that overloading may affect stability as well as load-carrying capacity.

Differential settlement is often a problem when you apply heavy loads to scaffolds resting on uncompacted soils. A scaffold tower 9 metres (30 feet) high that settles 25 millimetres (1 inch) on one side can move 150 millimetres (6 inches) at the top. Settlement puts stress on braces, tie-ins, and frame joints. Place heavy loads symmetrically on the platform to ensure that soil settlement is uniform.

Finally, the scaffold structure must be capable of carrying the load that you will apply. Both light-duty and heavy-duty frames are available on the market. Do not use light-duty frames where you have heavy loads. If you do not know the load-carrying capacity of the frames, consult the manufacturer or supplier. The load-carrying capacity of frames usually varies with the height of the towers.

9.5 Debris on Scaffold Decks

Scaffold decks are small, narrow, and confined. Store tools and materials in an orderly fashion. Do not allow debris and waste materials to collect on the platform. Put them in a container or remove them from the platform immediately. Set up a plan for dealing with waste materials. Simply throwing garbage off the scaffold is extremely dangerous—don't do it. If work on the scaffold is likely to result in debris falling, such as in masonry work, then cordon off the scaffold to prevent workers from entering the area.

Waste pieces of lumber, pipe, wire, miscellaneous metal, and small tools are tripping hazards which have caused

Figure 9.3
USING SCAFFOLDS AROUND HAZARDOUS MATERIAL

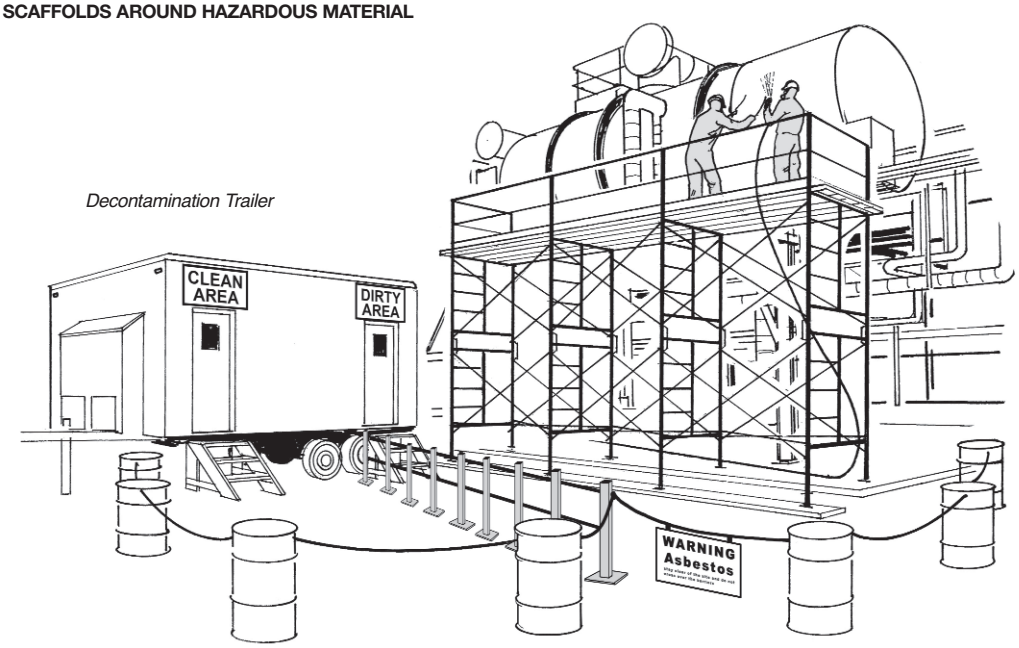


Table 9.1

APPROXIMATE WEIGHTS OF BUILDING MATERIALS

Material	Metric Unit Weight	Imperial Unit Weight
Aluminum	2643 kg/cu m	165 lb/cu ft
Iron (Wrought)	7769 kg/cu m	485 lb/cu ft
Steel	7849 kg/cu m	490 lb/cu ft
Nickel	8730 kg/cu m	545 lb/cu ft
Glass (plate)	2563 kg/cu m	160 lb/cu ft
Lumber (dry)		
Cedar (white)	352 kg/cu m	22 lb/cu ft
Douglas Fir	513 kg/cu m	32 lb/cu ft
Maple	689 kg/cu m	43 lb/cu ft
Red Oak	657 kg/cu m	41 lb/cu ft
Spruce	433 kg/cu m	27 lb/cu ft
Concrete	2403 kg/cu m	150 lb/cu ft
Granite	2803 kg/cu m	175 lb/cu ft
Brick	1922 – 2243 kg/cu m	120 – 140 lb/cu ft
Limestone, Marble	2643 kg/cu m	165 lb/cu ft
Sandstone	2082 kg/cu m	130 lb/cu ft
Steel Pipe (standard)		
1" I.D.	2.49 kg/m	1.68 lb/ft
2" I.D.	5.43 kg/m	3.65 lb/ft
3" I.D.	11.27 kg/m	7.58 lb/ft
4" I.D.	16.05 kg/m	10.79 lb/ft
Copper Pipe		
1" I.D.	2.71 kg/m	1.82 lb/ft
2" I.D.	6.28 kg/m	4.22 lb/ft
3" I.D.	13.02 kg/m	8.75 lb/ft
4" I.D.	19.20 kg/m	12.90 lb/ft
Aluminum Pipe (standard)		
1" I.D.	0.86 kg/m	0.58 lb/ft
1-1/2" I.D.	2.40 kg/m	1.61 lb/ft
2" I.D.	3.08 kg/m	2.07 lb/ft
3" I.D.	4.57 kg/m	3.07 lb/ft
Drywall (1/2" thick)	10.25 kg/m^2	2.10 lb/ft^2

many serious falls from scaffolds. You need an orderly work area to work safely on scaffolds.

9.6 Exposure to Hazardous Material

Frequently, scaffolds are erected for work involving hazardous substances: e.g., refurbishing structures painted with lead-based paint or removing asbestos. If you are sandblasting painted surfaces for instance, lead can accumulate on planks and other components. Workers carrying out these activities must use appropriate personal protective equipment. The scaffold worker who has to dismantle the scaffold can also be at risk from the lead residue. Under these conditions you should do the following.

1. Clean components that are likely to be contaminated by lead dust, preferably by washing with a hose before dismantling begins.
2. Cap scaffolding frames and standards as the scaffold is being erected to prevent lead dust from accumulating inside and being subsequently released during the dismantling process.
3. If it is not possible to wash down the scaffolding before dismantling, then scaffold workers should wear properly fitting N100 filtering facepiece respirators while dismantling. The scaffold should then be washed before it is removed from the site.
4. Proper attention to personal hygiene is critical when dealing with lead. Workers must be instructed not to eat, drink, or smoke without washing their hands. A sign or notice indicating this should be conspicuous.
5. Workers should be provided with separate “clean” and “dirty” areas. Use the dirty area for changing out of contaminated clothing and the clean area for changing into uncontaminated clothing and eating (Figure 9.3). Washing facilities with clean water, soap, and individual towels should separate the two areas.
6. Scaffold workers should inform their physician if they are exposed to lead. The physician may want to monitor the level of lead in the person’s blood to see if it is within normal parameters.

22 ELEVATING WORK PLATFORMS

Basic Types

There are two basic types of elevating work platforms—boom and scissor. Both types come in

- *on-slab models* for use on smooth hard surfaces such as concrete or pavement
- *rough-terrain models* for use on firm level surfaces such as graded and compacted soil or gravel.

Both types share three major components: base, lifting mechanism, and platform assembly.

Scissor-Type Machines

These are raised and lowered by hydraulic pistons and an expanding scissor mechanism. Platforms are available in various configurations with different capabilities for extension and movement. Some have extendable platforms or platforms that can rotate. Extendable platforms should be retracted before raising or lowering the device. Typical machines are illustrated in Figure 1.1.

On-slab units

- not designed for uneven or sloping ground
- normally have solid rubber tires
- generally powered by rechargeable DC battery
- some powered by internal combustion engine, either gasoline or propane
- most have “pothole protection”—a metal plate lowered close to the ground to afford some protection against inadvertent movement into depressions or debris.

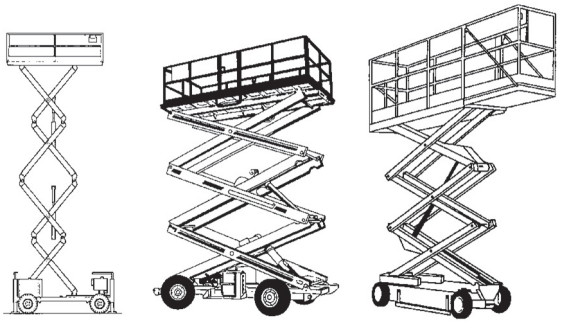


Figure 1.1: Scissor-type powered platforms

Rough-terrain units

- similar in design to on-slab machines
- built to handle rigorous off-slab challenges
- normally have wider wheel bases, larger wheels, and pneumatic tires
- some fitted with outriggers for extra stability
- usually powered by internal combustion engines, gasoline, diesel, or propane
- DC units also available but not common
- lifting mechanism is hydraulic.

Scissor-type machines range in capacity from 500 to several thousand pounds. They are available with platform heights often reaching 15 metres (50 feet) and beyond.

> Scissor-type machines must be set up on stable level ground, even with outriggers deployed. A slight imbalance or instability is amplified when the machine is raised.

Figure 1.2 shows one example of controls. Although fixed to the platform, the controls are moveable from one side of the platform to the other. This enables the operator to see the path of travel.

The controls must be oriented correctly so that the operator does not inadvertently move the machine in the wrong direction. Many machines have colour-coded directional arrows on the chassis to aid the operator in moving the machine.

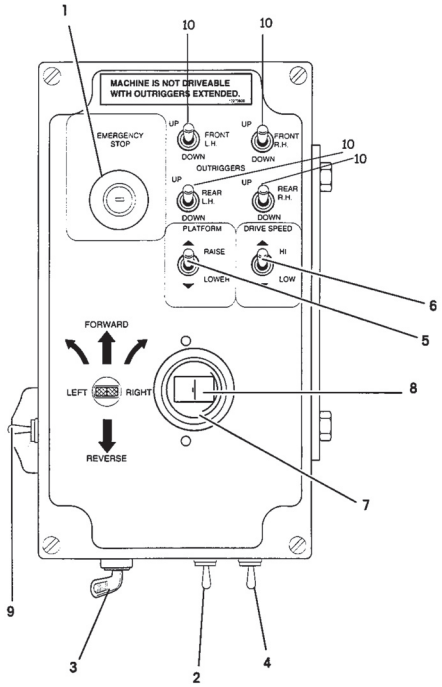


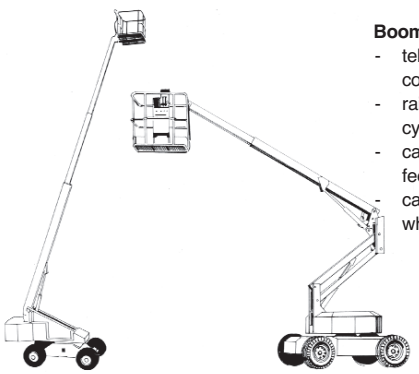
Figure 1.2: Example of controls on scissor-type platforms

Controls

1. Emergency stop button
2. Choke
3. Stop/start switch
4. Run/idle switch
5. Lift up/down switch
6. Drive high range/low range switch
7. Forward/reverse joystick
8. Left/right steer switch
9. Traversing deck out/in switch
10. Outriggers up/down switch

Self-Propelled Boom-Supported Platforms

- normally fitted with rough-terrain undercarriages
- some smaller on-slab units
- platforms have lifting capacity of about 227 kg (500 pounds) or two workers
- lack capacity of scissor-type machines; not intended for lifting materials
- usually powered by an internal combustion engine, gasoline, diesel, or propane.



Booms

- telescopic, articulating, or combination of both
- raised and extended by hydraulic cylinders
- can reach up to 45 metres (150 feet)
- can extend well beyond the wheelbase.

Figure 1.3: Boom-type powered platforms

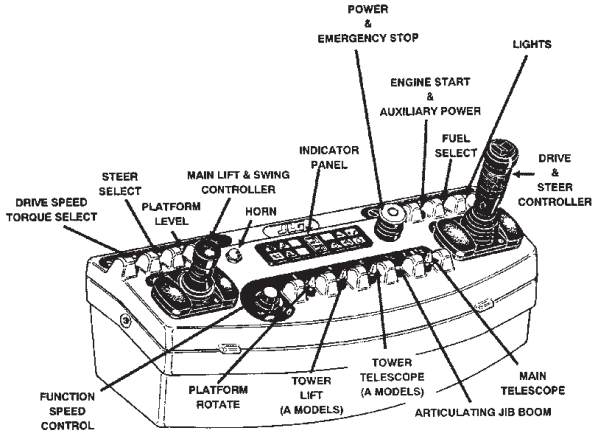


Figure 1.4: Example of boom-machine controls

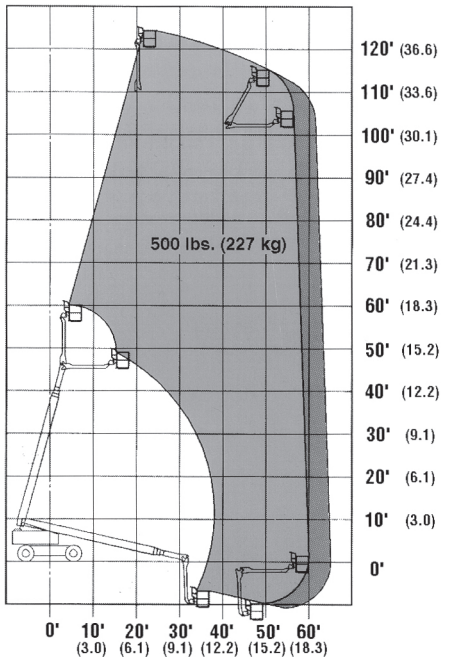


Figure 1.5: Reach chart for a 120-foot (36-metre) machine

Figure 1.4 shows one example of controls for a boom machine. Although controls are fixed in position, the operator may become disoriented by machine rotation and must remain aware of the direction of movement. Many machines have colour-coded directional arrows to help the operator move the machine in the right direction.

As with mobile cranes, stability decreases with length of boom and boom angle as the centre of gravity moves in relation to the platform position. The machine will overturn if the centre of gravity moves outside the machine's base.

Machines come with load charts that show safe operating configurations. Machines with booms long enough to cause overturning at low boom angles are required to have radius-limiting interlocks to prevent operation in unstable configurations.

The reach chart shown in Figure 1.5 indicates the safe operating configurations for a machine with 36 metres (120 feet) of reach operating on a level surface.

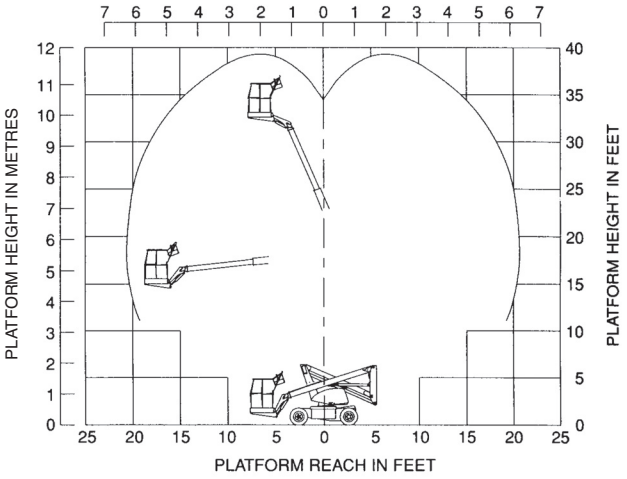


Figure 1.6: Reach diagram for a 10-metre articulating boom platform

The reach diagram in Figure 1.6 shows the safe operating envelope for a 10-metre boom machine.

Notice that the machine does not achieve its maximum height directly overhead. Nor does it achieve its maximum reach at ground level.

Users must be familiar with the operating range of the individual make and model they are using. This knowledge is essential in order to position the machine correctly and reach the work location safely.

Non-Self-Propelled or Push-Arounds

As the name indicates, these units are not self-propelled and must be transported from one location to another with an independent power source or manually in the case of the smaller devices.

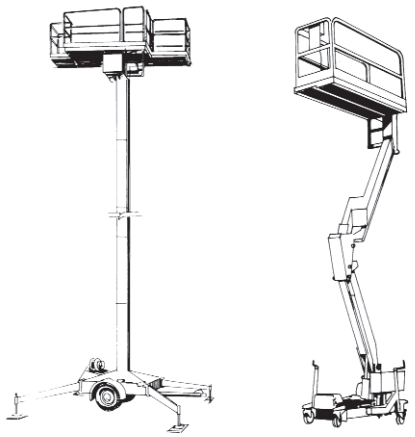


Figure 1.7: Push-around powered platforms

The machines are intended primarily for use on smooth, level, hard surfaces or on-slab conditions. Some trailer-mounted units are available.

Many of these devices can fold up to pass through a standard door and can be transported by pick-up truck. As a result they are suitable for maintenance or renovation work.

Push-Arounds

- Raising mechanism normally powered by gasoline or propane engine or by electric motors, either AC or DC
- normally raised and lowered by hydraulic cylinders
- platform capacities vary from 300 to 1000 pounds or more but are generally less than 500 pounds
- as platform is raised, risk of overturning increases
- extra care required when operating at maximum height.

Selection

Elevating work platforms are designed for different uses. It is essential to select the right machine for the job.

Typical Mistakes

- using an on-slab machine on rough terrain
- using a unit undersized with respect to height, reach, and lifting capacity
- extending the platform with planks, ladders, or other devices because the machine can't reach the required height
- failing to assess the job needs before starting and using the wrong machine or not ordering the right machine to do the job.

Factors to Consider

Capacity – Does the machine have the lifting capacity, the reach, and the height to complete the task?

Surface conditions – Are the surface conditions hard or soft, sloped or level? Will the ground have an effect on the type of machine selected?

Platform size and configuration – Do you need a regular or extendable platform? Is rotation required? Are there space restrictions to consider?

Mobility – Is a boom type better suited than a scissor lift to the task at hand?

Material to be lifted – Will the machine be able to lift the size and weight of material required for the job?

Access – Will the machine be able to travel around the workplace safely? Are there obstructions or depressions that will restrict the use of certain machines?

Operator skill or training – Are the people on site competent to operate the machine? If a propane-powered engine is used, has the operator received propane training?

Work environment – If the work is to be done indoors or in a poorly ventilated area, will an electrically powered machine be required?

Basic Hazards

The following are some basic hazards.

Machine tipping or overturning
Many factors cause instability—sudden stops, depressions, drop-offs, overreaching, overloading, etc. Overturning and tipping result in many fatalities and injuries.

Overriding safety features
Disarming features such as the tilt or level warning and the deadman switch can prevent operators from knowing when they are in a dangerous situation. Overriding the deadman switch has resulted in a fatality; so has malfunction of the tilt warning.

Overhead powerlines
Working near overhead wires can result in electrocution. This can happen when using any type of machine.

Makeshift extensions
When the machine can't reach the working height desired, don't compensate by using scaffold planks, ladders, blocks of wood, or other makeshift arrangements. Such practices lead to falls and machine instability.

Overloading the platform
EWPs overloaded or loaded unevenly can become unstable and fail. Boom-type machines are especially sensitive to overloading. Always stay within the operating range specified by the manufacturer.

Failure to cordon off
- EWPs have been struck by other construction equipment or oncoming traffic when the work area is not properly marked or cordoned off.
- Workers can be injured if they inadvertently enter an unmarked area and are struck by falling material, tools, or debris.
- In unmarked areas, workers can be injured by swinging booms and pinched by scissor mechanisms.

Accidental contact
Moving the machine or platform may cause contact with workers or with obstacles. Use a designated signaller on the ground to guide the operator when the path of travel isn't clear or access is tight.

Improper maintenance or modifications
EWPs should be maintained by competent workers in accordance with manufacturer's instructions. No modifications should be made to the machine without the manufacturer's approval.

Improper blocking during maintenance
Failing to block, or improperly blocking the machine, boom, or platform can cause serious crushing injuries and property damage.

Improper access
Don't access the platform by climbing the scissors or the boom. Don't use extension ladders to gain access. Ladders exert lateral loads on the platform that can cause overturning. For the safest access, lower the machine completely.

Moving with platform raised
Lower the platform before moving the machine unless 1) the machine is designed to move with platform raised and 2) the supporting surface is smooth and level. Slight dips and drops are amplified when the platform is raised and can cause the machine to overturn.

Improper refuelling
Workers must be competent to exchange propane cylinders or handle liquid fuels or batteries. Cautions are also required to prevent spills and sparks.

Pinch points
Clothing, fingers, and hands can get caught in scissor mechanisms. As platforms are raised, machines may sway. Workers can be pinched between guardrails and the structure. Position the platform so that work takes place above guardrail height.

Regulations and Responsibilities

The construction regulation (Ontario Regulation 213/91) includes the following requirements:

- Elevating work platforms must be engineered and tested to meet the relevant standard for that equipment [section 144(1)(a)]. Standards include
  - CSA B354.1: non-self-propelled elevating work platforms
  - CSA B354.2: self-propelled elevating work platforms
  - CSA B354.4: boom-type elevating work platforms.
- The devices must be checked each day before use by a trained worker [section 144(3)(b)].
- The owner or supplier must keep a log of all inspections, tests, repairs, modifications, and maintenance [section 145(2)].
- The log must be kept up to date and include names and signatures of persons who performed inspections and other work [section 145(3)].
- A maintenance and inspection tag must be attached near the operator's station and include the date of the last maintenance and inspection and the name and signature of the person who performed the work [section 146].
- Workers must be given oral and written instruction before using the platform for the first time. Instruction must include items to be checked daily before use [section 147].
- All workers on the platform must wear a full-body harness or a safety belt attached to the platform while the platform is being moved [section 148(e)].

The health and safety responsibilities of all parties on a construction site are outlined in the "green book"—the *Occupational Health and Safety Act and Regulations for Construction Projects*.

Because elevating work platforms are often rented from an equipment supplier, there is confusion as to the responsibilities of the parties involved. Generally, the responsibilities can be summarized in the following way.

The owner or supplier must ensure that the machine

- is in good condition
- complies with regulations
- is maintained in good condition
- conforms to the appropriate CSA Standard
- includes the correct load rating charts if required.

The employer and supervisor on the project must

- ensure that the operator is competent
- ensure that the machine has the correct load rating capacity for the job
- maintain the equipment and all its protective devices
- maintain a log book for each platform
- ensure that workers use appropriate personal protective equipment
- keep the manufacturer's operating manual on site
- train workers on each class of equipment being used.

The worker or operator of the equipment must

- receive adequate training to be fully competent
- only operate the machine when competent
- operate the machine in a safe manner and as prescribed by the manufacturer and the company's health and safety policy
- inspect the equipment daily before use
- perform function tests before use
- report any defects to the supervisor
- read, understand, and obey the manufacturer's safety rules, including the operating manual and warning decals.

When a defect is reported to the supervisor, the equipment must be taken out of service until the repairs are completed and the equipment is inspected and approved for use.

Stability and Tipping

In general, EWPs are well manufactured and are safe to use within their specific limitations. As with any equipment or tool, there are do's and don'ts to follow.

One of the most dangerous hazards in operating EWPs is tipping over. This can be caused by one or several of the following factors:

- sudden movement of the unit or parts of the unit when elevated
- sudden stopping when elevated
- overloading or uneven loading of the platform
- travelling or operating on a slope or uneven terrain
- changing the weight distribution of the machine by adding attachments not approved by the manufacturer
- holes or drop-offs in the floor surface causing one wheel to drop suddenly
- operating the equipment in windy conditions.

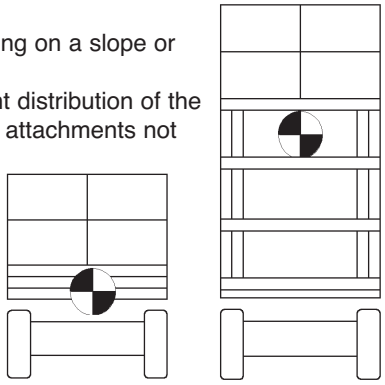


Figure 4.1 Centre of gravity on scissor lifts

It is important that users understand what makes a platform stable and what causes it to overturn. To understand stability, one must understand the concept of centre of gravity, tipping axis (or tipping point), and forces that shift the centre of gravity.

Stability is resistance against tipping over. Stability depends on the location of the centre of gravity in relation to the tipping axis.

Centre of Gravity

Every object has a centre of gravity. It is the point where the object's weight would be evenly distributed or balanced. If a support is placed under that point, the object would be perfectly balanced.

The centre of gravity is usually located where the mass is mostly concentrated. However, the location doesn't always remain the same. Any action that changes the machine's configuration—such as raising the platform, extending the boom, or travelling on a slope—can change the location of the centre of gravity.

Figure 4.1 shows how raising a scissor-type platform affects the centre of gravity.

Tipping Axis and Area of Stability

When an EWP turns over, it tips around an axis or point. This is called the tipping axis or tipping point. EWPs typically have four tipping axes – front, back, left, and right.

Each EWP has its own area of stability. This varies from platform to platform and from model to model. In most cases, the area of stability is bound by the four tipping axes (or the four tires or outriggers). The platform is stable as long as the centre of gravity remains inside the area of stability. This is the key to safe operation.

Figure 4.2 shows how lowering the boom angle affects the centre of gravity. In this example the centre of gravity moves towards the platform but remains inside the area of stability.

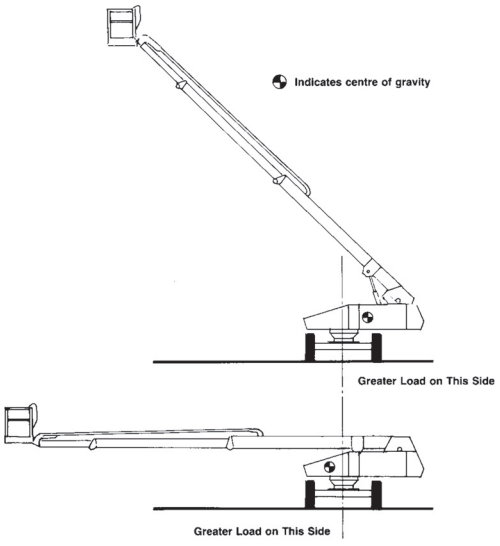


Figure 4.2: Centre of gravity for a boom-supported machine

When the centre of gravity shifts beyond the area of stability, the machine will tip over. Some factors that can cause a shift beyond the stability area are overloading, moving on excessively sloped ground, a sudden drop of one wheel, and shock loading.

Raising the platform also raises the EWP's centre of gravity. When a scissor lift is situated on a slope, and the platform is raised, the platform's centre of gravity will move toward the tipping axis. If the centre of gravity moves beyond the tipping axis, the platform will overturn.

Boom-supported EWPs work in the same way. When the boom is extended outward, the centre of gravity moves outwards towards the tipping axis. The EWP will overturn if the boom is extended such that the centre of gravity moves beyond the axis. Boom-type machines have an interlocking system that prevents the machine from moving into an unstable configuration.

Factors Affecting Stability

Dynamic Forces

Dynamic forces are forces generated by movement or change of movement. For example, applying the brakes suddenly or travelling too fast around corners can cause instability – as in a car or van. Sudden stops while raising or lowering the platform can also cause instability.

Travelling

Travelling the platform over rough or uneven ground can also cause instability. Figure 4.3 shows how a tire dropping 100 mm can cause the boom to sway 600 mm. It is important to lower the platform fully or to retract telescoping sections while travelling, particularly on uneven surfaces.

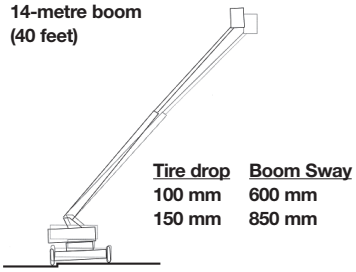


Figure 4.3: Effect of uneven ground on boom sway

Equipment Inspection

All components which bear directly on the safe operation of the EWP and can change from day to day must be inspected daily. Inspection is mostly visual – done in a quick but thorough manner.

Users must check the operator's manual for a complete list of pre-operational checks.

Minimum Requirements

Before climbing into the platform, check

- ✓ Tires for proper pressure and wheels for loose or missing lug nuts
- ✓ Steer cylinder, linkage, and tie rods for loose or missing parts, damage, and leaks
- ✓ Hydraulic hoses, lift cylinder(s), and connections for leaks or loose connections (e.g., a small pool of hydraulic fluid)
- ✓ Fuel supply – adequate fuel, filler cap in place, no damage, leaks, or spills

- ✓ Hydraulic oil for leaks and fluid level, battery for fluid level and state of charge
- ✓ Proper connection of all quick-disconnect hoses
- ✓ Structural components for damage, broken parts, cracks in welds, including scissor arms, outrigger arms, and pads
- ✓ Ladder or steps for damage and debris (ladder must be firmly secured to the platform and relatively free of grease, mud and dirt)
- ✓ Beacon and warning lights for missing and defective lenses or caps
- ✓ Ground controls (manual and powered)—including emergency stop switch and platform lower/lift switch—for proper function and damaged and missing control sticks/switches
- ✓ Decals and warning signs to make sure they're clean, legible, and conspicuous.

On the platform, check

- ✓ Platform assembly for loose and missing parts, missing or loose lock pins and bolts
- ✓ Platform floor for structural damage, holes, or cracked welds and any dirt, grease, or oil that can create a hazard
- ✓ Operator's manual to make sure it's in place
- ✓ Extendable platform deck for ease of extension/retraction and proper function of locking position of platform
- ✓ Guardrails to make sure they're in place
- ✓ Access gate for ease of movement, missing parts, latch, and locking capabilities
- ✓ All fall protection anchorage points
- ✓ All control mechanisms for broken or missing parts
- ✓ All emergency controls for proper function—stopping, descending, master OFF switch
- ✓ All safety devices such as tilt and motion alarms for malfunction
- ✓ Swivels for freedom of rotation
- ✓ Scissors for smooth movement up and down
- ✓ Brakes for stopping capabilities
- ✓ Horn for proper function.

Manuals, Signs, and Decals

Section 144(8) of the construction regulation (Ontario Regulation 213/91) specifies the signs that are required on an EWP.

Signs clearly visible to the operator at the controls must indicate

- the rated working load
- all limiting operating conditions, including the use of outriggers, stabilizers, and extendable axles
- the specific firm level surface conditions required for use in the elevated position
- such warnings as may be specified by the manufacturer
- other than for a boom-type elevating work platform, the direction of machine movement for each operating control
- the name and number of the National Standards of Canada standard to which the platform was designed
- the name and address of the owner.

In addition to the above, the CSA standards for EWPs require the following signs:

- the make, model, serial number, and manufacturer's name and address
- the maximum platform height
- the maximum travel height, if not equal to the maximum platform height
- the nominal voltage rating of the batteries, if battery-powered
- a warning to study the operating manual before using the equipment
- a notice outlining the required inspections
- diagrams or description of the various configurations in which the platform can be used
- the capacity in each configuration
- a statement as to whether or not the platform is insulated
- warnings against replacing, without the manufacturer's consent, components critical to the machine's stability—for example, batteries or ballasted tires with lighter weight components (the minimum weights of such components must be specified).

Many of these signs are vital to the operation of the machine and the protection of workers. All signs and decals must be kept clear of dust and grease so they can be easily read. Torn or damaged signs must be replaced. A typical warning sign is shown in Figure 5.1.



Figure 5.1

CSA standards also require that the manufacturer provide a manual containing the following information:

- description, specifications, and capacities of the platform
- the operating pressure of the hydraulic or pneumatic system that is part of the work platform
- instructions regarding operation and maintenance, including recommended daily, weekly, and monthly inspection checklists
- information on replacement parts.

The manual must be stored on the platform in a weather-proof storage container.

Safe Practices

Specific Requirements

For the specific EWP they will use, operators must be familiar with

- the manufacturer's operating manual
- the manufacturer's warning and caution signs on the machine
- the location of all emergency controls and emergency procedures
- the daily maintenance checks to perform.

General Guidelines

- Always check for overhead powerlines before moving the machine or operating the platform. You must observe the minimum permitted distances from overhead powerlines (see table, next column). When equipment operates within reach of (and could therefore encroach on) the minimum distance from a powerline, make arrangements with the owner of the utility to have the powerline de-energized. Otherwise, the constructor is required to have written procedures in place to prevent equipment from encroaching on the minimum distance. Copies of the procedures must be available for every employer on the project. See section 188 of the Construction Regulation for further requirements.
- Allow for movement or sway of the lines as well as the platform. Be aware of overhanging tools or equipment.

Voltage Rating of Powerline	*Minimum Distance*
750 to 150,000 volts	3 metres (10 feet)
150,001 to 250,000 volts	4.5 metres (15 feet)
over 250,000 volts	6 metres (20 feet)

- Wear a full-body harness and tie off to a designated tie-off point while the machine is moving.
- Do not leave the machine unattended without locking it or otherwise preventing unauthorized use.
- Don't load the platform above its rated working load (RWL).
- Make sure that all controls are clearly labeled with action and direction.
- Keep guardrails in good condition and ensure that the gate is securely closed before moving the platform.
- Shut off power and insert the required blocking before maintenance or servicing.
- Deploy stabilizers or outriggers according to the manufacturer's instructions.
- Don't remove guardrails while the platform is raised.
- Position the boom in the direction of travel unless the manufacturer specifies differently.
- Keep ground personnel away from the machine and out from under the platform.
- Don't access the platform by walking on the boom.
- Don't try to push or move the machine by telescoping the boom.
- Do not use the machine as a ground for welding.
- Don't use a boom-supported platform as a crane.
- Don't operate the equipment in windy conditions. For safe wind speeds refer to the operator's manual for the specific make and model you are using.
- Do not place the boom or platform against any structure to steady either the platform or the structure.
- Secure loads and tools on the platform so that machine movement won't dislodge them.
- Make sure that extension cords are long enough for the full platform height and won't get pinched or severed by the scissor mechanism.
- Use three-point contact and proper climbing techniques when mounting or dismounting from the machine (Figure 6.1).

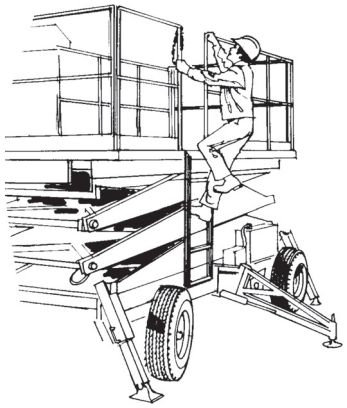


Figure 6.1: Three-point contact

Never operate equipment on which you have not been trained or which you are not comfortable operating. The safety of you and others on site depends on the competent, knowledgeable operation of equipment.

Work Area Inspection

Before operating the EWP, check the work area for

- ✓ drop-offs or holes in the ground
- ✓ slopes
- ✓ bumps or floor obstructions
- ✓ debris
- ✓ overhead obstructions
- ✓ overhead wires, powerlines, or other electrical conductors
- ✓ hazardous atmospheres
- ✓ adequate operating surface—ground or floor
- ✓ sufficient ground or floor support to withstand all forces imposed by the platform in every operating configuration
- ✓ wind and weather conditions.

24 RIGGING

Tradespeople who are not professional riggers must nonetheless rig loads at times on the job. Carpenters, for instance, are often involved not only in handling but in hoisting and landing material. When in doubt about rigging, consult your supervisor. Information in this chapter covers only the basics of rigging.

Inspection

Use this checklist to inspect rigging components regularly and before each lift.

Manila Rope

Manila rope is not recommended for construction use and is illegal for lifelines and lanyards.

Dusty residue when twisted open	Wear from inside out. Overloading. If extensive, replace rope.
Broken strands, fraying, spongy texture	Replace rope.
Wet	Strength could be reduced.
Frozen	Thaw and dry at room temperature.
Mildew, dry rot	Replace rope.
Dry and brittle	Do not oil. Wash with cold water and hang in coils to dry.

Polypropylene and Nylon Rope

Chalky exterior appearance	Overexposed to sunlight (UV) rays. Possibly left unprotected outside. Do not use. Discard.
Dusty residue when twisted open	Worn from inside out. If extensive, replace.
Frayed exterior	Abraded by sharp edges. Strength could be reduced.
Broken strands	Destroy and discard.
Cold or frozen	Thaw, dry at room temperature before use.
Size reduction	Usually indicates overloading and excessive wear. Use caution. Reduce capacity accordingly.

Wire Rope (Figure 87)

Rusty, lack of lubrication	Apply light, clean oil. Do not use engine oil.
Excessive outside wear	Used over rough surfaces, with misaligned or wrong sheave sizes. Reduce load capacity according to wear. If outside diameter wire is more than 1/3 worn away, the rope must be replaced.
Broken wires	Up to six allowed in one rope lay, OR three in one strand in one rope lay, with no more than one at an attached fitting. Otherwise, destroy and replace rope.
Crushed, jammed, or flattened strands	Replace rope.
Bulges in rope	Replace, especially non-rotating types.
Gaps between strands	Replace rope.
Core protrusion	Replace rope.
Heat damage, torch burns, or electric arc strikes	Replace rope.
Frozen rope	Do not use. Avoid sudden loading of cold rope.
Kinks, bird-caging	Replace rope. Destroy defective rope.

Polypropylene and Nylon Web Slings

Chalky exterior appearance	Overexposed to sunlight (UV) rays. Should be checked by manufacturer.
Frayed exterior	Could have been shock-loaded or abraded. Inspect very carefully for signs of damage.
Breaks, tears, or patches	Destroy. Do not use.
Frozen	Thaw and dry at room temperature before use.
Oil-contaminated	Destroy.

Wire Rope Slings

Broken wires	Up to six allowed in one rope lay or three in one strand in one rope lay with no more than one at an attached fitting. Otherwise, destroy and replace rope.
Kinks, bird-caging	Replace and destroy.
Crushed and jammed strands	Replace and destroy.
Core protrusion	Replace and destroy.
Bulges in rope	Replace and destroy.
Gaps between strands	Replace and destroy.
Wire rope clips	Check proper installation and tightness before each lift. Remember, wire rope stretches when loaded, which may cause clips to loosen.
Attached fittings	Check for broken wires. Replace and destroy if one or more are broken.
Frozen	Do not use. Avoid sudden loading of cold ropes to prevent failure.

Sharp bends	Avoid sharp corners. Use pads such as old carpet, rubber hose, or soft wood to prevent damage.

Chain Slings

Use only alloy steel for overhead lifting.

Elongated or stretched links	Return to manufacturer for repair.
Failure to hang straight	Return to manufacturer for repair.
Bent, twisted, or cracked links	Return to manufacturer for repair.
Gouges, chips, or scores	Ground out and reduce capacity according to amount of material removed.

Chain repairs are best left to the manufacturer. Chain beyond repair should be cut with torch into short pieces.

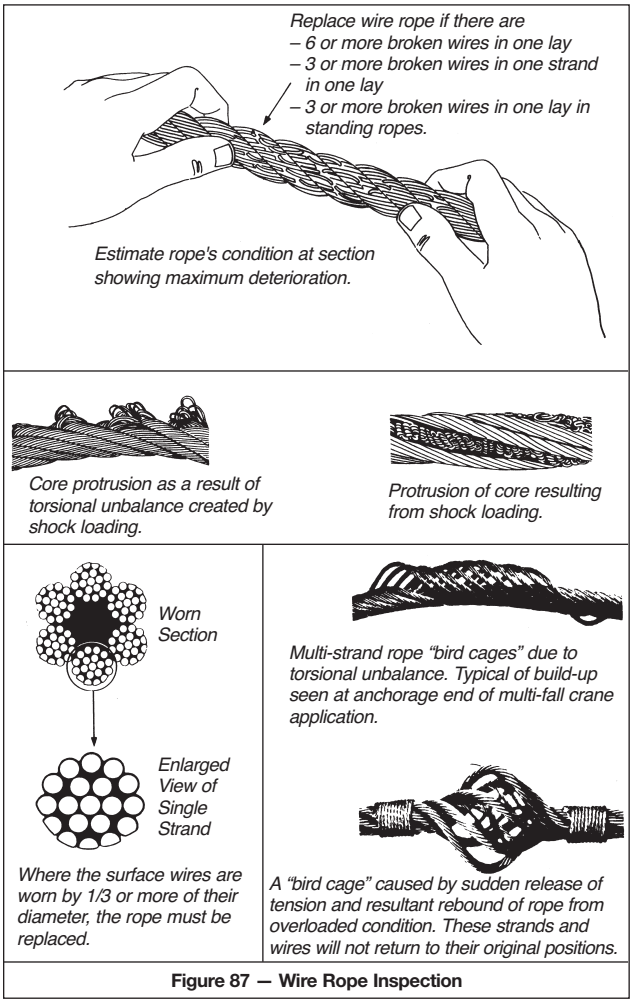


Figure 87 — Wire Rope Inspection

Hardware

Know what hardware to use, how to use it, and how its working load limits (WLLs) compare with the rope or chain used with it.

All fittings must be of adequate strength for the application. Only forged alloy steel load-rated hardware should be used for overhead lifting. Load-rated hardware is stamped with its WLL (Figure 88).



Figure 88

Inspect hardware regularly and before each lift. Telltale signs include
– wear
– cracks
– severe corrosion
– deformation/bends
– mismatched parts
– obvious damage.

Any of these signs indicates a weakened component that should be replaced for safety. Figure 89 shows what to check for on a hook.

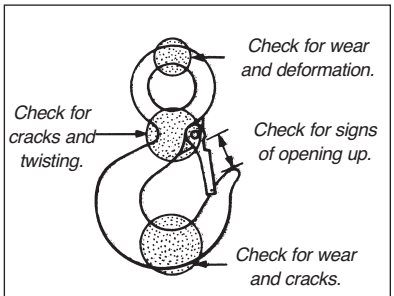
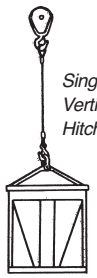


Figure 89
Hook Inspection Areas

Sling Configurations

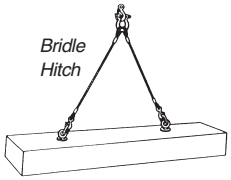
The term "sling" includes a wide variety of configurations for all fibre ropes, wire ropes, chains, and webs. The most commonly used types in construction are explained here.



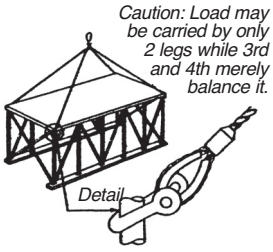
Single Vertical Hitch

The total weight of the load is carried by a single leg. This configuration must not be used for lifting loose material, long material, or anything difficult to balance. This hitch provides absolutely no control over the load because it permits rotation.

Bridle Hitch

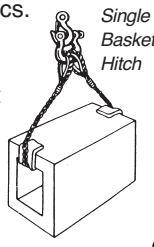


Two, three, or four single hitches can be used together to form a bridle hitch. They provide excellent stability when the load is distributed equally among the legs, when the hook is directly over the centre of gravity of the load, and the load is raised level. The leg length may need adjustment with turnbuckles to distribute the load.



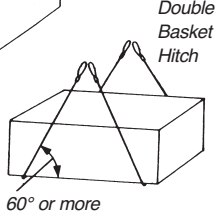
Single Basket Hitch

This hitch is ideal for loads with inherent stabilizing characteristics. The load is automatically equalized, with each leg supporting half the load. Do not use on loads that are difficult to balance because the load can tilt and slip out of the sling.



Double Basket Hitch

Consists of two single basket hitches passed under the load. The legs of the hitches must be kept far enough apart to provide balance without opening excessive sling angles.



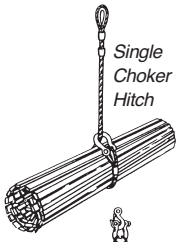
Double Wrap Basket Hitch

A basket hitch that is wrapped completely around the load. This method is excellent for handling loose materials, pipes, rods, or smooth cylindrical loads because the rope or chain exerts a full 360-degree contact with load and tends to draw it together.


Double Wrap Basket Hitch

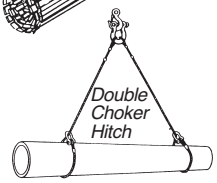
Single Choker Hitch

This forms a noose in the rope and tightens as the load is lifted. It does not provide full contact and must not be used to lift loose bundles or loads difficult to balance.


Single Choker Hitch

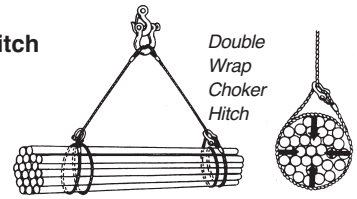
Double Choker Hitch

Consists of two single chokers attached to the load and spread to provide load stability. Does not grip the load completely but can balance the load. Can be used for handling loose bundles.


Double Choker Hitch

Double Wrap Choker Hitch

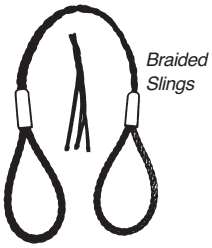
The rope or chain is wrapped completely around the load before being hooked into the vertical part of the sling. Makes full contact with load and tends to draw it together. If the double wrap choker is incorrectly made and the two eyes are placed on the crane hook, the supporting legs of the sling may not be equal in length and the load may be carried by one leg only. Do not run the sling through the hook, permitting an unbalanced load to tip.

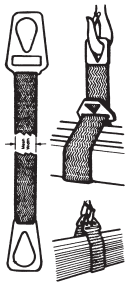

Double Wrap Choker Hitch



Braided Slings

Fabricated from six or eight small diameter ropes braided together to form a single rope that provides a large bearing surface, tremendous strength, and flexibility in all directions. They are very easy to handle and almost impossible to kink. Especially useful for basket hitches where low bearing pressure is desirable or where the bend is extremely sharp.


Braided Slings


Metal Mesh Slings

Metal (Wire or Chain) Mesh Slings

Well adapted for use where loads are abrasive, hot, or tend to cut fabric or wire rope slings.

Chain Slings

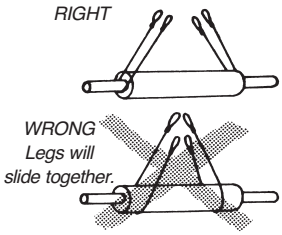
Made for abrasion and high temperature resistance. The only chain suitable for lifting is grade 80 or 100 alloy steel chain. Grade 80 chain is marked with an 8, 80, or 800. Grade 100 is marked with a 10, 100, or 1000. The chain must be embossed with this grade marking every 3 feet or 20 links, whichever is shorter – although some manufacturers mark every link. Chain must be padded on sharp corners to prevent bending stresses.


Chain Slings

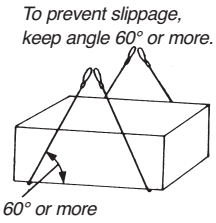
Wire Rope Slings

The use of wire rope slings for lifting materials provides several advantages over other types of slings. While not as strong as chain, it has good flexibility with minimum weight. Outer wires breaking warn of failure and allow time to react. Properly fabricated wire rope slings are very safe for general construction use.

On smooth surfaces, the basket hitch should be snubbed against a step or change of contour to prevent the rope from slipping as the load is applied. The angle between the load and the sling should be approximately 60 degrees or greater to avoid slippage.



On wooden boxes or crates, the rope will dig into the wood sufficiently to prevent slippage. On other rectangular loads, the rope should be protected by guards or load protectors at the edges to prevent kinking.



Loads should not be allowed to turn or slide along the rope during a lift. The sling or the load may become scuffed or damaged. Use a double choker if the load must turn.

Hooking Up

- Avoid sharp bends, pinching, and kinks in rigging equipment. Thimbles should be used at all times in sling eyes.
- Never wrap a wire rope sling completely around a hook. The tight radius will damage the sling.
- Make sure the load is balanced in the hook. Eccentric loading can reduce capacity dangerously.
- Never point-load a hook unless it is designed and rated for such use (Figure 91).
- Never wrap the crane hoist rope around the load. Attach the load to the hook by slings or other rigging devices adequate for the load.
- Avoid bending the eye section of wire rope slings around corners. The bend will weaken the splice or swaging.
- Avoid bending wire rope slings near any attached fitting.
- Understand the effect of sling angle on sling load (Figure 92) and pull angle on beam load (Figure 93).

Rig the load with its centre of gravity directly below the hook to ensure stability. The crane hook should be brought over the load's centre of gravity before the lift is started. Crane hook and load line should be vertical before lifting. Weights of common materials are listed in Tables 7 to 11.

Working Load Limit (WLL): Tons of 2000 lbs

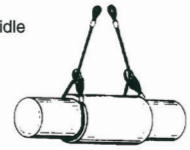
UNI-LOC® 6-strand Wire Rope Slings

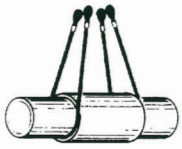
- 6 x 19, 6 x 26, 6 x 25 and 6 x 36 IWRC -

Design Factor = 5

Nom. Rope Dia. Inch	Vertical	Choker	2 Sling Bridle, or single Basket Hitch Sling Angle 60°	45°	30°	Weight of one 10 ft long Std Loop Sling w/o any hardware approx. lbs
1/4	0.65	0.48	1.1	0.91	0.65	1.6
3/8	1.4	1.1	2.5	2.0	1.4	3.5
1/2	2.5	1.9	4.4	3.6	2.5	6.8
5/8	3.9	2.9	6.8	5.5	3.9	10.9
3/4	5.6	4.1	9.7	7.9	5.6	16.5
7/8	7.6	5.6	13	11	7.6	23.5
1	9.8	7.2	17	14	9.8	32.5
1-1/8	12	9.1	21	17	12	41.0
1-1/4	15	11	26	21	15	53.5
1-3/8	18	13	31	25	18	68.5
1-1/2	21	16	37	30	21	85.0
1-3/4	28	21	49	40	28	130.0
2	37	28	63	52	37	178.0
2-1/4	44	35	77	63	44	243.0
2-1/2	54	42	94	77	54	315.0

For Choker Bridle Sling, multiply values by 3/4.





For Double Basket Sling, multiply values by 2.

NOTES: 1) Working Load Limit (WLL) based on **UNI-LOC®** splice only.
2) Values for Chokers valid only if A is greater than 30°.
3) Values based on ropes with a tensile strength of EIPS.
4) Shackles and fittings must be sized to the full WLL of sling.
5) WLL Basket Hitch is based on D/d ratio of 25.

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Figure 91
Point Loading



Capacity Severely Reduced

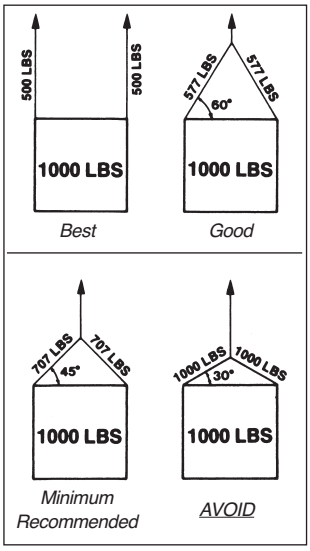
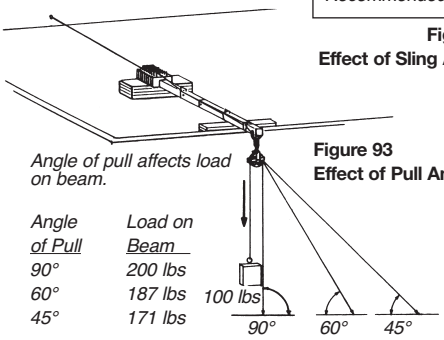


Figure 92
Effect of Sling Angle on Sling Load



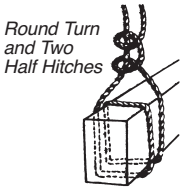
Angle of pull affects load on beam.

Angle of Pull	*Load on Beam*
90°	*200 lbs*
60°	*187 lbs*
45°	*171 lbs*

100 lbs
90° *60°* *45°*

Figure 93
Effect of Pull Angle on Beam Load

Basic Knots and Hitches



Round Turn and Two Half Hitches

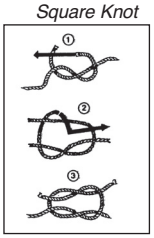
Every worker should be able to tie the basic knots and hitches that are useful in everyday work.

Round Turn and Two Half Hitches

Used to secure loads to be hoisted horizontally. Two are usually required because the load can slide out if lifted vertically.



Timber Hitch and Two Half Hitches

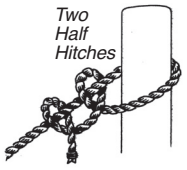


Reef or Square Knot

Timber Hitch and Two Half Hitches

A good way to secure a scaffold plank for hoisting vertically. The timber hitch grips the load.

Reef or Square Knot



Two Half Hitches

Can be used for tying two ropes of the same diameter together. It is unsuitable for wet or slippery ropes and should be used with caution since it unties easily when either free end is jerked. Both live and dead ends of the rope must come out of the loops at the same side.

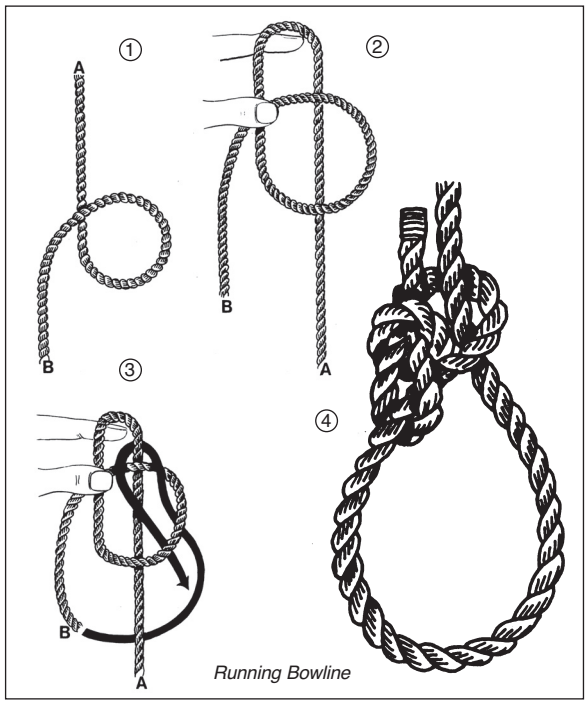
Two Half Hitches

Two half hitches, which can be quickly tied, are reliable and can be put to almost any general use.

Running Bowline

The running bowline is mainly used for hanging objects with ropes of different diameters. The weight of the object determines the tension necessary for the knot to grip.

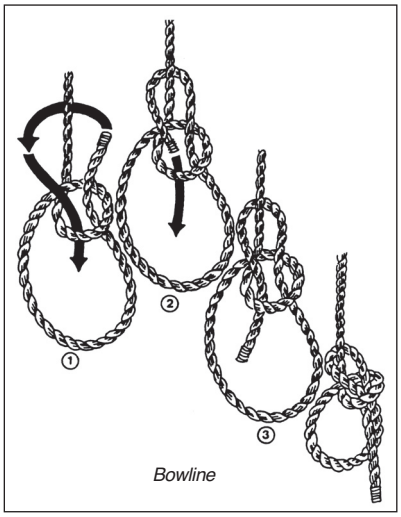
(1) Make an overhand loop with the end of the rope held toward you. (2) Hold the loop with your thumb and fingers and bring the standing part of the rope back so that it lies behind the loop. (3) Take the end of the rope in behind the standing part, bring it up, and feed it through the loop. (4) Pass it behind the standing part at the top of the loop and bring it back down through the loop.



Running Bowline

Bowline

Never jams or slips when properly tied. It is a universal knot if properly tied and untied. Two interlocking bowlines can be used to join two ropes together. Single bowlines can be used for hoisting or hitching directly around a ring or post.



Bowline

Sheet Bend

Can be used for tying ropes of light or medium size.

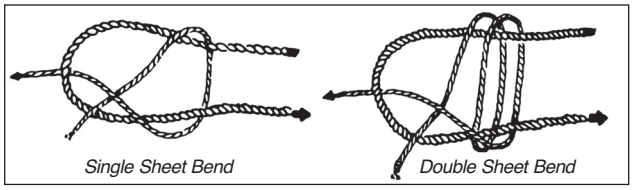

Single Sheet Bend *Double Sheet Bend*

TABLE 7: WEIGHTS OF MATERIALS (Based On Volume)

Material	Approximate Weight Lbs. Per Cubic Foot	Material	Approximate Weight Lbs. Per Cubic Foot
METALS		**TIMBER, AIR-DRY**	
Aluminum	165	Cedar	22
Brass	535	Fir, Douglas, seasoned	34
Bronze	500	Fir, Douglas, seasoned	40
Copper	560	Fir, Douglas, wet	50
Iron	480	Fir, Douglas, glue laminated	34
Lead	710	Hemlock	30
Steel	480	Pine	30
Tin	460	Poplar	30
MASONRY		Spruce	28
Ashlar masonry	140-160	**LIQUIDS**	
Brick masonry, soft	110	Alcohol, pure	49
Brick masonry, common (about		Gasoline	42
3 tons per thousand)	125	Oils	58
Brick masonry, pressed	140	Water	62
Clay tile masonry, average	60	**EARTH**	
Rubble masonry	130-155	Earth, wet	100
Concrete, cinder, taydite	100-110	Earth, dry (about 2050 lbs.)	
Concrete, slag	130	per cu. yd.)	75
Concrete, stone	144	Sand and gravel, wet	120
Concrete, stone, reinforced		Sand and gravel, dry	105
(4050 lbs. per cu. yd.)	150	River sand (about 3240 lbs.	
ICE AND SNOW		per cu. yd.)	120
Ice	56	**VARIOUS BUILDING**	
Snow, dry, fresh fallen	8	**MATERIALS**	
Snow, dry, packed	12-25	Cement, portland, loose	94
Snow, wet	27-40	Cement, portland, set	183
MISCELLANEOUS		Lime, gypsum, loose	53-64
Asphalt	80	Mortar, cement-time, set	103
Tar	75	Crushed rock (about 2565 lbs.	
Glass	160	per cu. yd.)	90-110

Caution: This table contains sample values for the purposes of illustration only. Refer to the manufacturer of the material you're using for precise values.

TABLE 8: DRYWALL WEIGHTS

Non-Fire Rated	8'	10'	12'
1/2"	58 lbs.	72 lbs.	86 lbs.
5/8"	74 lbs.	92 lbs.	110 lbs.
Fire-Rated			
1/2"	64 lbs.	80 lbs.	96 lbs.
5/8"	77 lbs.	96 lbs.	115 lbs.

Caution: This table contains sample values for the purposes of illustration only. Refer to the manufacturer of the material you're using for precise values.

TABLE 9: STEEL STUDS AND TRIMS – WEIGHTS

		Pcs./Bdl.	Lbs. (per 1,000 Lin. Ft.)
STUD SIZE–.018 THICKNESS			
1 5/8	All Lengths	10	290
2 1/2	All Lengths	10	340
3 5/8	All Lengths	10	415
6 (.020)	All Lengths	10	625
TRACK SIZES–.018 THICKNESS			
1 5/8	Regular Leg	10	240
2 1/2	Regular Leg	10	295
3 5/8	Regular Leg	10	365
6 (.020)	Regular Leg	10	570
1 5/8	2 Leg	12	365
2 1/2	2 Leg	6	415
3 5/8	2 Leg	6	470
DRYWALL FURRING CHANNEL			
Electro-Galvanized		10	300
DRYWALL CORNER BEAD			
1 1/4 x 1 1/4		Various	120
RESILIENT CHANNEL			
Electro-Galvanized		20	210
DRYWALL TRIMS			
1/2 Door & Windows L.		20	100
5/8 Door & Window L.		20	100
3/8 Casing Bead J.		20	110
1/2 Casing Bead J.		20	120
5/8 Casing Bead J.		20	130
DRYWALL ANGLE			
1 x 2 Drywall Angle		10	200

Caution: This table contains sample values for the purposes of illustration only. Refer to the manufacturer of the material or equipment you're using for precise values.

TABLE 10: WEIGHTS OF MATERIALS (Based On Surface Area)

Material	Approximate Weight Lbs. Per Square Foot	Material	Approximate Weight Lbs. Per Square Foot
CEILINGS		**FLOORING**	
(Per Inch of Thickness)		(Per Inch of Thickness)	
Plaster board	5	Hardwood	5
Acoustic and fire resistive tile	2	Sheathing	2.5
Plaster, gypsum-sand	8	Plywood, fir	3
Plaster, light aggregate	4	Wood block, treated	4
Plaster, cement sand	12	Concrete, finish or fill	12
ROOFING		Mastic base	12
Three-ply felt and gravel	5.5	Mortar base	10
Five-ply felt and gravel	6.5	Terrazzo	12.5
Three-ply felt, no gravel	3	Tile, vinyl 1/8 inch	1.5
Five-ply felt, no gravel	4	Tile, linoleum 3/16 inch	1
Shingles, wood	2	Tile, cork, per 1/16 inch	0.5
Shingles, asbestos	3	Tile, rubber or asphalt 3/16 inch	2
Shingles, asphalt	2.5	Tile, ceramic or quarry 3/4 inch	11
Shingles, 1/4 inch slate	10	Carpeting	2
Shingles, tile	14	**DECKS AND SLABS**	
PARTITIONS		Steel roof deck 1 1/2" - 14 ga.	5
Steel partitions	4	- 16 ga.	4
Solid 2" gypsum-sand plaster	20	- 18 ga.	3
Solid 2" gypsum-light agg. plaster	12	- 20 ga.	2.5
Metal studs, metal lath, 3/4"		- 22 ga.	2
plaster both sides	18	Steel cellular deck 1 1/2" - 12/12 ga.	11
Metal or wood studs, plaster		- 14/14 ga.	8
board and 1/2" plaster both sides	18	- 16/16 ga.	6.5
Plaster 1/2"	4	- 18/18 ga.	5
Hollow clay tile 2 inch	13	- 20/20 ga.	3.5
3 inch	16	Steel cellular deck 3" - 12/12 ga.	12.5
4 inch	18	- 14/14 ga.	9.5
5 inch	20	- 16/16 ga.	7.5
6 inch	25	- 18/18 ga.	6
Hollow slag concrete block 4 in	24	- 20/20 ga.	4.5
6 in	35	Concrete, reinforced, per inch	12.5
Hollow gypsum block 3 inch	10	Concrete, gypsum, per inch	5
4 inch	13	Concrete, lightweight, per inch	5-10
5 inch	15.5	**MISCELLANEOUS**	
6 inch	16.5	Windows, glass, frame	8
Solid gypsum block 2 inch	9.5	Skylight, glass, frame	12
3 inch	13	Corrugated asbestos 1/4 inch	3.5
MASONRY WALLS		Glass, plate 1/4 inch	3.5
(Per 4 Inch of Thickness)		Glass, common	1.5
Brick	40	Plastic sheet 1/4 inch	1.5
Glass brick	20	Corrugated steel sheet, galv.	
Hollow concrete block	30	- 12 ga.	5.5
Hollow slag concrete block	24	- 14 ga.	4
Hollow cinder concrete block	20	- 16 ga.	3
Hollow haydite block	22	- 18 ga.	2.5
Stone, average	55	- 20 ga.	2
Bearing hollow clay tile	23	- 22 ga.	1.5
		Wood Joists - 16" ctrs. 2 x 12	3.5
		2 x 10	3
		2 x 8	2.5
		Steel plate (per inch of thickness)	40

Caution: This table contains sample values for the purposes of illustration only. Refer to the manufacturer of the material you're using for precise values.

TABLE 11: SUSPENDED CEILING GRID SYSTEMS–WEIGHTS

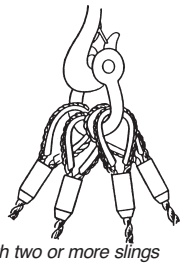
Systems	Qty./Ctn. (Lin. Ft.)	Lbs./Ctn. (Lbs.)
NON-FIRE RATED GRID SYSTEM		
1 1/2 x 144" Main Runner	240	58
1 x 48" Cross Tee	300	55
1 x 24" Cross Tee	150	28
1 x 30" Cross Tee	187.5	35
1 x 20" Cross Tee	125	23
1 x 12" Cross Tee	75	14
FIRE-RATED GRID SYSTEM		
1 1/2 x 144" Main Runner	240	70
1 1/2 x 48" Cross Tee	240	70
1 1/2" x 24" Cross Tee	120	35
WALL MOULDINGS		
Wall Mould 3/4 x 15/16 x 120"	400	49
Reveal Mould 3/4 x 3/4 x 1/2 x 3/4 x 120"	200	36
ACCESSORIES		
Hold-Down Clips (for 5/8" tile)	500 pcs.	3
BASKETWEAVE & CONVENTIONAL 5' x 5' MODULE – NON RATED		
1 1/2 x 120" Main Member	200	49
1 1/2 x 60" Cross Tee	250	61
Wall Mould 3/4 x 15/16 x 120"	400	57
THIN LINE GRID SYSTEM – NON-RATED		
Main Runner 1 1/2 x 144"	300	65
Cross Tee 1 1/2 x 48"	300	65
Cross Tee 1 1/2 x 24"	150	33
Wall Mould 15/16 x 9/16 x 120"	500	62
Reveal Mould 1 x 3/8 x 3/8 x 9/16 x 120"	300	48
Main Runner 1 1/12 x 144"	300	65
Cross Tee 1 1/2 x 48"	300	65
Cross Tee 1 1/2 x 24"	150	33
Wall Mount 15/16 x 9/16 x 120"	500	62

Caution: This table contains sample values for the purposes of illustration only. Refer to the manufacturer of the material or equipment you're using for precise values.

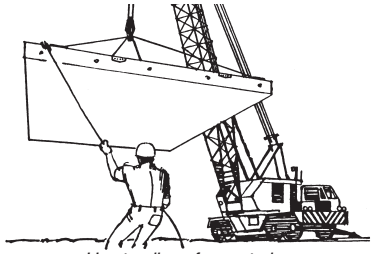
Hand Signals for Hoisting Operations



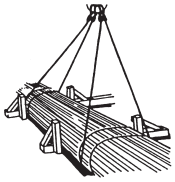
Rigging Safety Tips



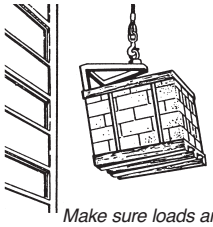
With two or more slings on a hook, use a shackle.



Use tag lines for control.

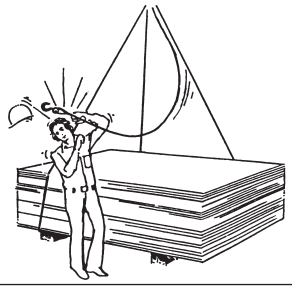


Block loose loads before unhooking.



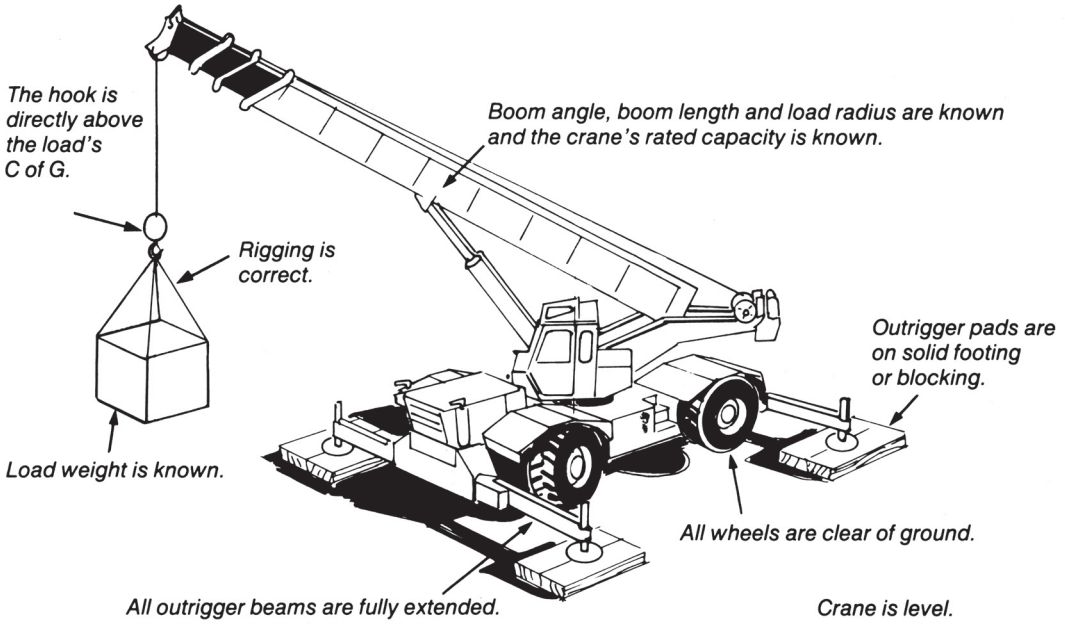
Make sure loads are secure.

Stay back when slings are pulled out from under loads.

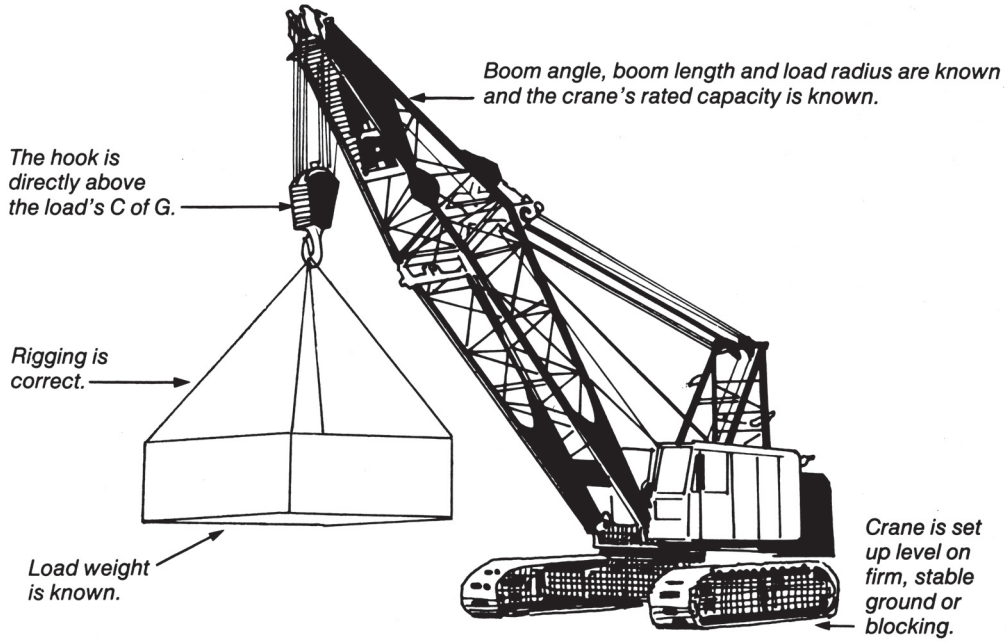


A crane is properly set up for lifting when the following conditions are met.

For Cranes Operating "On Outriggers"



For Crawler-Mounted Cranes or When Lifting "On Rubber"



27 HAND AND POWER TOOLS

Employers are responsible for maintaining in good repair any tools and equipment supplied to workers. Workers must use tools and equipment properly and report any defects to supervisors.

The Construction Regulation (O.Reg. 213/91) requires that tools and equipment be used according to manufacturers' operating manuals, that operating manuals for tools and equipment rated at more than 10 horsepower be kept readily available on the project, and that tools and equipment be inspected regularly.

Our finest tools are our **hands**. Too often they are damaged by tool accidents. Hands can be caught in machines, crushed by objects, or cut by sharp-edged tools such as chisels, knives, and saws. Hands can also be damaged by being burned, fractured, or sprained unless you stay alert.

Eyes are highly susceptible to injury from tool use but eye injuries are almost always preventable. Use the guards and personal protective equipment which we all know are needed but sometimes tend to overlook.

Noise is a hazard inherent in construction. Tools and the working environment can both be noisy, particularly for construction trades operating in plants and mills. Exposure to excessive noise can impair hearing. Prolonged excessive exposure can result in permanent damage to the hearing and eventually deafness. Hearing protection should be worn whenever there is a risk of excessive exposure.

Common Causes of Accidents

Typical causes of hand and power tool accidents include the following:

- using the wrong tool for the job
- tools falling from overhead
- sharp tools carried in pockets
- using cheaters on tool handles
- excessive vibration
- using tools with mushroomed heads
- failure to support or clamp work in position
- carrying tools by hand up or down ladders
- using damaged electrical cords or end connectors
- failure to use ground fault circuit interrupters (GFCIs), especially outdoors.

Safe Practices

Basic hazard awareness and common sense can prevent serious injuries with hand and power tools. As a general rule follow the safe practices listed below.

1) **Always wear eye protection.** There is always the risk of flying particles and dust with hand and power tools. Appropriate eye protection is essential and must be worn by the user and others nearby. For eye protection see the Personal Protective Equipment chapter in this manual.
2) **Use the right tool for the job.** Using a screwdriver as a chisel, using a cheater on a wrench handle, or using pliers instead of a proper wrench are typical examples of the mistakes which commonly lead to accidents and injuries.
3) **Use tools as recommended by the manufacturer.** For example, don't use cheaters on handles. This will exert greater forces on the tool than it was designed for and is likely to cause breakage and possible injury.
4) **Damaged or broken tools should be removed from service.** Chisels with mushroomed heads, hammers with cracked or loose handles, wrenches with worn jaws, damaged extension cords, and ungrounded tools are all unsafe and should be removed from service and be either repaired or destroyed.
5) **Maintain tools in safe operating condition.**

   Prevent mushrooming. Tools which are struck by hammers, such as chisels or punches, should have the head ground periodically to prevent mushrooming. See Figure 21.1

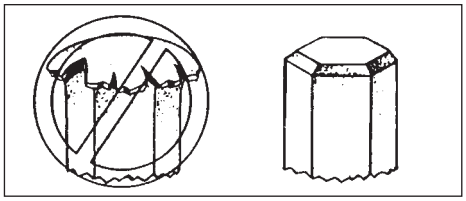


Figure 21.1

   Keep handles secure and safe. Don't rely on friction tape to secure split handles or to prevent handles from splitting. Check wedges and handles frequently. Be sure heads are wedged tightly on handles. Keep handles smooth and free of rough or jagged surfaces. Replace handles that are split, chipped, or that cannot be refitted securely.

   Keep hand tool cutting edges sharp. Sharp tools make work easier, improve the accuracy of your work, save time, require less effort, and are safer than dull tools.
6) **Never climb ladders with tools in your hand.** Tool holders and pouches (Figure 21.2) free the hands while workers are climbing or working on ladders, scaffolding, and other areas where access may be difficult. When carrying tools up or down from elevated places, put them in substantial bags or boxes and raise and lower them with strong ropes.

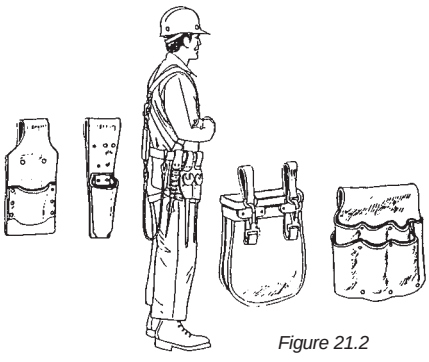


Figure 21.2

7) **Spark-resistant tools** (non-ferrous tools) are recommended where flammable materials or explosive dusts or vapours might be present. These tools, such as brass or copper hammers or mallets, should still be used with caution; remember, they may not guarantee safety in all explosive situations such

as in the presence of gasoline vapours. It is always safer to eliminate the hazard by ensuring a safe atmosphere through isolation, ventilation, or purging.

8) **Protect the cutting edges of tools when carrying them**. Carry them in such a way that they won't be a hazard to yourself and others. Carry pointed or sharp-edged tools in pouches or holsters.
9) **Keep your hand tools clean.** Protect them against damage caused by corrosion. Wipe off accumulated dirt and grease. Dip the tools occasionally in cleaning fluids or solvents and wipe them clean.
10) **Lubricate** adjustable and other moving parts to prevent wear and misalignment.
11) **When swinging a tool,** be absolutely sure that no one else is within range or can come within range of the swing or be struck by flying material.
12) **Falling tools** are a dangerous hazard for workers below. Keep track of tools, especially when working at heights on scaffolds or other access equipment. An unnoticed file or chipping hammer, if accidentally kicked off the work platform, is a deadly missile as well as a tripping hazard for you. **If practical, tie tools off when working at heights.**
13) **Hearing protection** should be worn whenever there is a chance of excessive noise exposure. Noise from tools and equipment is an inherent hazard in construction. Exposure to excessive noise can impair hearing. Prolonged excessive exposure can result in permanent damage to hearing and eventually deafness. Although the tools being used are only one of several possible sources of noise, efforts should be made to provide the least noisy power tools that will still do the job.

Inspection and Repair

Tools should be inspected by a person qualified through training and experience to determine the safe condition of the tool.

Worn or damaged tools should be tagged *"DEFECTIVE – DO NOT USE"* and returned to the shop for repair or replacement.

Regular inspection of all tools is necessary and should cover tool maintenance and service as outlined in the operator's manual. Observing proper handling and storage of tools should also be a part of the inspection process. Responsibility for inspection is usually left to the supervisor. However, tools should be checked by those who use them daily.

Hand tools that get the heaviest use and abuse, such as chisels, hammers, and wrenches, should be inspected frequently and regularly.

To maintain and repair tools properly requires the right facilities and equipment. A good workbench, repair tools, vises, and good lighting are necessities. Only persons skilled in the repair of tools should be allowed to do the repairs. Otherwise tools should be sent out to a qualified repair depot.

Redressing Tools

Follow the tool manufacturer's recommendations to repair, shape, or maintain tools.

When redressing the cutting edge on a tool, ensure that the tool is supported firmly. Use only a hand file or whetstone—not a grinding wheel. **(If a grinder is used, it can destroy the temper of the cutting edge.)** Be sure to restore the original contour of the cutting edge.

Cold chisels, for example, are hardened on the cutting edge. Use only a hand file or whetstone for redressing. Be sure to restore the cutting edge to its original shape and angle of approximately 70 degrees (Figure 21.3).

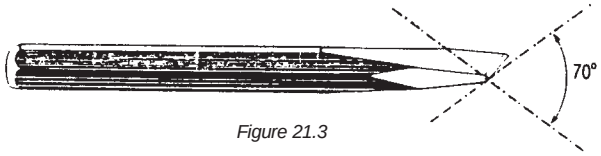


Figure 21.3

Handles

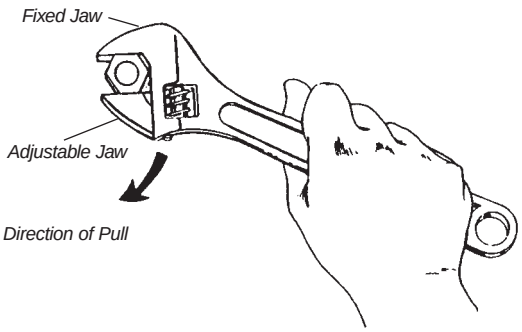
Hand tools such as hammers and sledgehammers should have handles of straight-grained hickory, ash, or maple and be free from slivers. It is important to ensure that handles are attached and properly fitted to tools by an experienced person. Poorly fitted handles can be very dangerous and make the tool difficult to control.

Constant inspection is necessary for handles. Even though they are received in good condition, handles can loosen with use and shrinkage. In some cases, tapping the wedges may take up the shrinkage. In other cases the head of the tool can be driven back on the handle and the wedges reset and any protruding piece of the handle cut off.

Most wooden handles will need replacement eventually. A replacement handle should be of correct specifications for a tight fit and be properly wedged.

Safety Tip

Whenever possible, **pull** on an adjustable wrench. Do not push. Force should be exerted on the fixed rather than the adjustable jaw.



Hand Tools

Use

The **misuse** of hand tools is a common cause of injury in construction. In many cases, the injury results because it is assumed that everyone knows how to use most common hand tools. This is not the case.

It is the responsibility of the supervisor and employer to ensure that workers are trained in the safe and proper use of hand tools. This section is intended to provide an overview of hazards and safe practices in selecting and using hand tools.

Hammers, Sledges, and Mauls

Hammers are made in various shapes and sizes for specific jobs. They should be selected and used only for the purpose intended.

Ballpeen hammers

These come in a variety of weights up to 3 pounds. Ballpeen hammers are designed for striking cold chisels and punches and for riveting, shaping, and straightening metal (Figure 21.4).

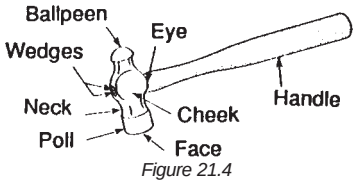


Figure 21.4
Standard ballpeen hammer

Sledges

All patterns of this heavy-duty striking tool have a crowned face with bevelled edges. Sledges are forged from high-carbon or alloy steel and are heat-treated. The types most commonly used are:

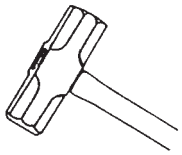


Figure 21.5
Double or maul-faced sledge

Double-face — head weights from 4 to 20 pounds and handle lengths from 15 to 36 inches. The 8-pound sledge is heavy enough for most boilermakers' work, although heavier sledges may be required for fairing tank seams or for driving wedges on heavy plate work. The 4-pound maul or sledge is a favourite with fitters and is often carried on their belts. With a shorter handle (10 to 12 inches) permitting heavy blows with a limited swing, its weight makes it ideal for driving in full pins for lining up shelf plates (Figure 21.5).

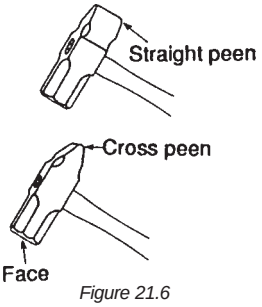


Figure 21.6
Straight and cross-peen sledges

Straight or crosspeen sledges — head weights are from 2 to 16 lbs. and handle lengths from 14 to 36 inches. These peens are used for shaping (fullering) and bending metal (Figure 21.6).

Chipping hammers — come in a variety of styles and handles and are designed for chipping slag off welds or burned edges. These hammers have long, slender or tapered points or edges and can be resharpened many times.

Other types of hammers — are used when required by the tradesperson. They include carpenter's or claw hammers for nailing; various soft-faced mallets, when a steel head might damage the work; and brass or copper heads, when non-sparking tools are required.

Basic rules for safe hammer use

- Always wear eye protection.
- Make sure the handle is tight. Never use a hammer with a loose or damaged handle.
- Always strike the work surface squarely with the hammer face. Avoid glancing blows.
- Hold the hammer with wrist straight and hand tightly wrapped around the handle.
- Look behind and above before swinging the hammer.
- Never use a hammer to strike another hammer.
- Discard any hammer with dents, cracks, chips, or mushrooming. Redressing is not recommended.
- When striking another tool (chisel, punch, wedge, etc.), the striking face of the hammer should have a diameter at least 1/2 inch (1 cm. +) larger than the struck face of the tool.
- Never weld or reheat-treat a hammer.

Struck or Hammered Tools

These include chisels, punches, drift pins, and wedges. General safety measures for their use include:

1) Always wear eye protection. If other people are close by, put up a screen or shield to protect them from flying chips.
2) Strike the tool squarely and in the centre, as called for by the crow or beveled-face design. Off-centre blows can misdirect the tool and increase the rate of wear on the head.
3) Never use a tool with a mushroomed or chipped head. Remove it from service and destroy or repair it.
4) Keep cutting edges sharp. A dull edge increases labour and decreases tool durability. Failures can be caused by dullness.

Cold chisels have a cutting edge that will cut, shape, or remove metal which is softer than the cutting edge. Such metals include cast iron, wrought iron, mild steel, bronze, and copper. The hardened cutting edge should be kept sharp at a 60- to 70-degree angle. The selection of chisel is determined by the material to be cut and the size and depth of cut. The most commonly used type is the **flat chisel**. It is used to cut rivets, split nuts, chip castings, cut thin plate, remove burn slag and weld spatter, and cut off small rods and wire. Other varieties of cold chisels include: **cape** – for keyways, grooves, square corners; **half round** and **round nose** – for round grooves and to chip inside corners; and **diamond point** – for V-grooves to remove tubes from sheets

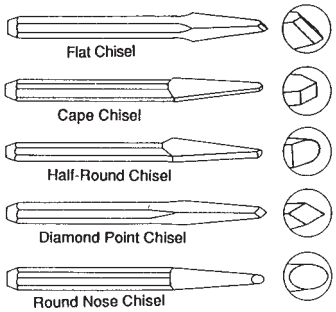


Figure 21.7
Metal cutting chisel types

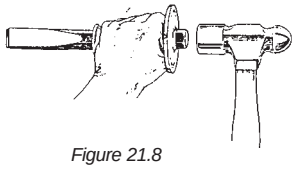


Figure 21.8

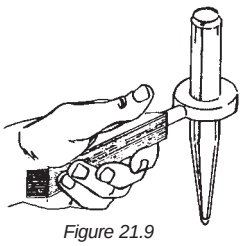


Figure 21.9

and for chipping tack welds and square corners. See Figure 21.7.

A sponge rubber pad forced down over the chisel provides a protective cushion that reduces shock for the hand, but a protective guard such as the one shown in Figure 21.8 is more effective.

Bull chisels held by one worker and struck by another require the use of tongs or a chisel holder to guide the chisel so that the user will not be injured (Figure 21.9).

Punches and Pins

- Select punches or pins heavy enough for the work.
- Avoid jamming tapered parts of punches in openings.
- Avoid bending or breaking pins.
- Make sure pins or punches are held firmly in position before hitting them, especially on rounded surfaces.

Hand punches have a variety of configurations for various purposes. When using punches, hold them at right angles to the work surface to prevent side-slipping. Be sure to strike the punch squarely with the hammer to prevent its slipping off and hitting fingers. Figure 21.9a shows some types. In addition, there are blacksmith-type punches (not shown), mounted on hammer style handles; a tapered round point, for drifting and aligning; and a straight punch for backing out bolts, rivets, and pins.

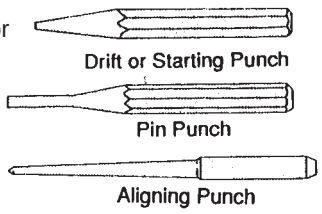


Figure 21.9a
Types of Punches

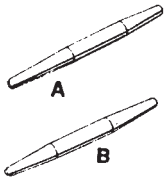


Figure 21.10
Drift Pins: A Standard; B Barrel

Drift pins are used to align holes in metal. They come in two types: **standard** and **barrel** (Figure 21.10).

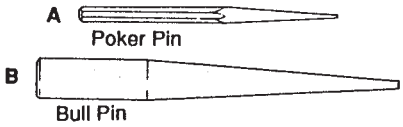


Figure 21.11
Special Boilermaker Pins
A: Poker and B: Bull

There are also special pins used largely by boilermakers (Figure 21.11) for heavy-duty steel plate. These include the **poker pin**, a large diameter punch for aligning holes in steel plate; and the **bull pin**, a heavy-duty pin used in the fit-up of steel plate. They are inserted into holes in fit-up clamps (welded temporarily to the side of the plates) to align the plates for welding.

Cutting Hand tools

Bolt Cutters

Bolt cutters (Figure 21.12) typically come in lengths of 18" to 36" with the larger ones able to cut mild-steel bolts and rods up to 1/2" diameter, as well other materials such as wire rope. With these tools, observe the following.

- Wear eye protection.
- Keep fingers clear of jaws and hinges.
- Cut ends can fly and cause injury. Try wrapping burlap or a rag around the jaws while cutting.
- Keep jaws at right angles to material. Don't pry or twist — chips can break off and fly, causing injury or damaging the blade.

Snips

Snips (Figure 21.13) are generally used to cut light-gauge galvanized sheet metal, copper sheet, and tin. Flying metal particles are always a hazard. Safety glasses or a face shield should be worn to protect against eye injury.



Figure 21.12 Bolt Cutter

Always be sure to select the right size and type of snips for the job. Don't cut wire with snips — use wire cutters.

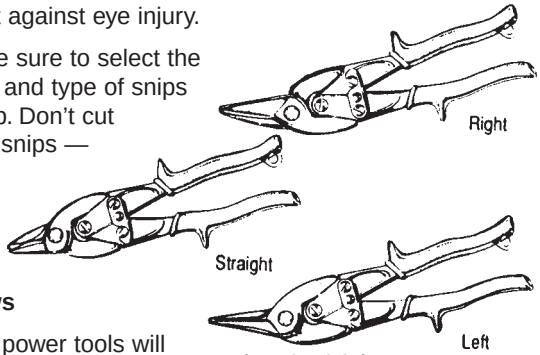


Figure 21.13 Snips

Hacksaws

Although power tools will be used whenever possible, hacksaws deserve mention. They fill a gap by cutting metal too heavy for snips or bolt cutters. The main danger from hacksaws is hand injury due to blade breakage. To prevent this danger:

- install and keep the blade taut but not too tight
- make sure that the material is held firmly in a vise or by other devices such as clamps.

Files

There are three standard American-pattern metal file cuts as shown in Figure 21.14.

Make sure that a handle is installed on a file before use. This will prevent the chance of an uncovered tang being jammed into your hand. A firmly attached handle will also improve control of the tool.

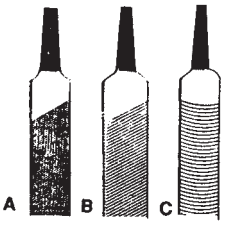


Figure 21.14 Metal file cuts: A) single cut, B) double cut, C) curved cut

Taps and Dies

- Keep taps and dies clean and well oiled when not in use.
- Store taps and dies so that they don't contact each other or other tools. For long term storage coat them with rust preventive compound and store in a dry place.
- Don't attempt to sharpen taps or dies. Precise cutting is required to maintain the correct thread-cutting characteristics and chamfer. This work must only be done by experienced personnel.
- Don't use diestocks or tapwrenches as hammers or prybars.

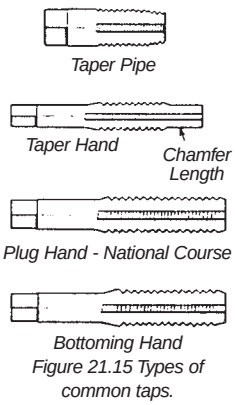


Figure 21.15 Types of common taps.

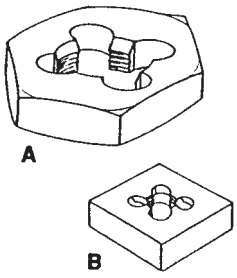


Figure 21.16
Types of solid dies:
A) rethreading; B) square pipe

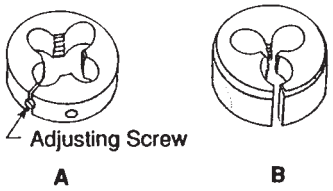


Figure 21.17
Common adjustable dies:
A) screw adjusting type;
B) open adjusting type

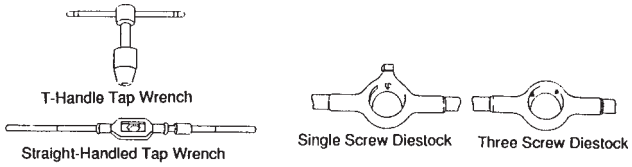
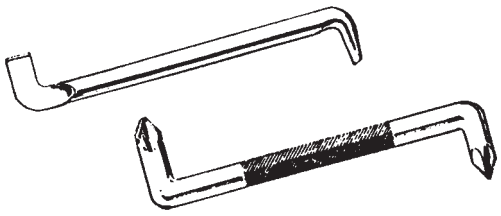


Figure 21.18 Diestock and tap wrenches

Screwdrivers

This is probably the most abused of all tools. It's used as a punch, wedge, pinch bar, and for other jobs for which it was not designed. Broken handles, bent or chipped blades, and twisted tips may cause the screwdriver to slip and cause a serious hand injury.

- Choose a screwdriver with a rectangular handle that fits the shank tightly, with a flange to keep your hand from slipping off the handle.
- Never get any part of your body in front of the screwdriver. Never hold the work in your hand while using a screwdriver. Hold the work in a vise, with a clamp, or at least on a solid surface.
- Keep screwdriver handles clean. A greasy handle can cause an accident.
- When working around electricity, use screwdrivers with a handle insulated with dielectric material. Keep in mind, however, that this insulation is only a secondary method of protection. Always be sure electrical power is off before beginning work.
- Don't use screwdrivers as chisels, hammers, prybars or for any purpose other than to turn screws.
- Be sure to use the right screwdriver for the screw being turned. The blade must fit the screw type, be in good condition, and seat solidly in the screw slot(s).
- Use an offset screwdriver in close quarters where a conventional screwdriver won't fit.



Holding Tools

Wrenches

There are hazards with all types of wrenches: the wrench may slip off the work, the workpiece may suddenly turn free, the wrench or workpiece may break. The user should always be braced to maintain balance and keep from being injured in case the wrench slips. Always inspect a wrench for flaws, damaged parts, or wear that can cause it to slip and damage fasteners.

There is a correct wrench for every job. If the wrench is too big, it may not grip securely. Overtorquing can cause slippage and damage of the wrench or fastener, including the stripping of threads. Where possible, use penetrating oil to loosen tight nuts and bolts.

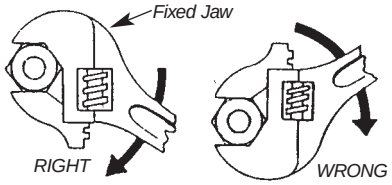


Figure 21.19

- Always grip the wrench so it will not cause injury if it slips.
- Use the correct type of jaw to avoid slippage. Box wrenches are safer than open-end wrenches since they are less likely to slip. Solid open-end wrenches of the correct size are generally more secure than an adjustable wrench, especially on hard-to-turn items.

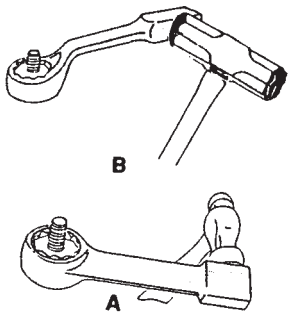


Figure 21.20 Hammer wrenches
(A) offset hammer wrench
(B) straight hammer wrench

- Discard any damaged box or open-end wrench. Don't attempt to repair a wrench with rounded or damaged points on the box end or worn or spread jaws on the open end.
- Face the adjustable wrench forward and turn it so pressure is against the fixed jaw (Figure 21.19).
- Always **pull** on a wrench whenever possible. Do not push.
- **Never overload a wrench by using a pipe extension on the handle or by striking the handle with a hammer.** This can weaken the metal of the wrench and cause the tool to break. Heavy-duty box wrenches with extra long handles and "hammer" or striking-face wrenches are available for these jobs. The striking-face wrenches with 12-point box opening are designed for striking with a ballpeen or sledge hammer. Both offset and straight styles are available but the straight type should be used when possible.

Spud wrenches are specialized tools with a fixed or box end. The other end is long and tapered, giving extra leverage. It can be used to align holes and pry steel plates. These are also available in an offset (or structural) style for clearing obstructions.

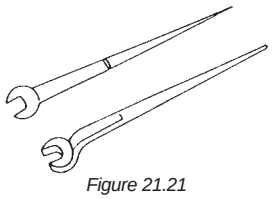


Figure 21.21
Typical spud wrenches

Socket Wrenches

Socket wrench sets come in many types and sizes of socket. Drivers include ratchet, universal, and speeder, along with many extensions and adapters. Be careful when adapting down in size not to overtorque a smaller socket and fastener with a larger driver.

Always use the correct size of socket and make sure it fits snugly. An oversize or sloppy fit can cause slippage and injury as well as wear to both the socket and the fastener.

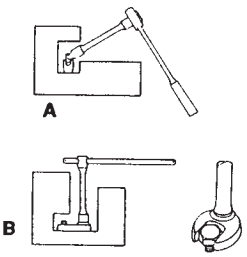
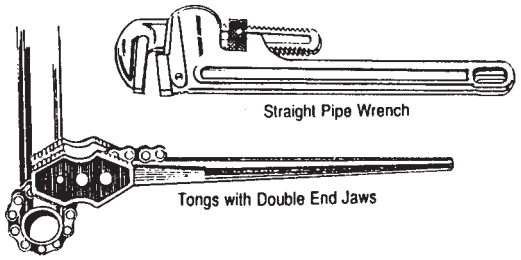


Figure 21.22 Useful socket items:
A) Universal socket
B) crowfoot attachment

Never use "hand" sockets on a power drive or impact wrench. Hand sockets are normally brightly finished while power and impact sockets have a dull finish and usually thicker walls.

Two useful socket items are illustrated in Figure 21.22 — a universal joint with an extension and a crowfoot attachment. They allow access into otherwise inaccessible locations.

Pipe wrenches have been the cause of serious injuries when used on overhead jobs. Wrenches can slip on pipes or fittings, causing the worker to lose balance and fall. Pipe wrenches, whether straight or chain tong, should have sharp jaws and be kept clean to prevent slipping.

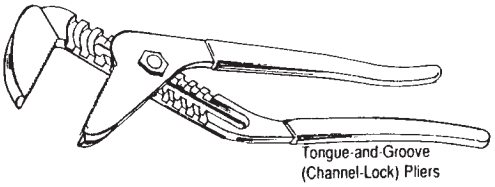


Pliers

Considered a general purpose tool, pliers are frequently misused. Pliers are meant for gripping and cutting operations and are **not** to be used as a wrench because their jaws are moveable and may slip.

Basic safety rules

- Choose pliers with enough space between the handles to prevent pinching of the palm or fingers.
- Select pliers that have a grip span of 6 cm to 9 cm (2-1/2"–3-1/2").
- **Pull** on pliers — do not push.
- Side cutting pliers may cause injuries when ends of wire are cut and fragments fly into a worker's eye. Eye protection should be worn when using side cutters.
- Always cut at right angles. Never rock from side to side against the cutting edges.
- Pliers used for electrical work should be insulated. Power must still be shut off first. Remember — cushion grips on handles are for comfort only and are not intended to protect against electrical shock.
- Never expose pliers to excessive heat; this may draw the temper and ruin the tool.



- Don't use pliers as hammers — they might crack, break, or be nicked.
- Don't use cheaters to extend the handles. This can damage or spring the tool, or slip and cause injury.
- Pliers should not be used to tighten nuts or bolts. Use a wrench.

Locking Wrench Pliers

Sometimes referred to by the trade names vise grips or grip-locks, these can be locked onto a wide variety of objects, leaving the hands free for other work. They are useful as a clamp, a speed wrench, or as a portable vise. Standard types of locking wrench pliers are shown in Figure 21.23 while Figure 21.24 displays speciality styles.

- Don't use them to replace wrenches since they can damage fittings or fasteners.
- Don't hammer or use cheaters to increase force to tighten jaws or to cut wire or bolts.
- Don't expose to heat from torches or contact with welding electrodes.
- Severe vibration can cause release of the jaws accidentally; wire or tape them shut when necessary.
- Never clamp them or attempt to use as a step or climbing device.

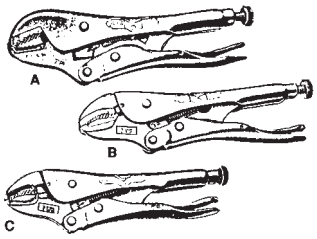


Figure 21.23 Locking wrench pliers with A) straight jaws; B) curved jaws; and C) curved jaws with wire cutters

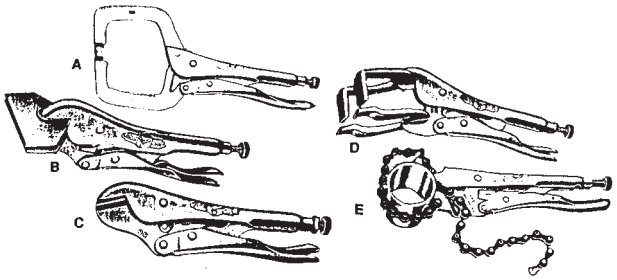


Figure 21.24 Some special locking wrench pliers: A) C-clamp; B) sheet metal clamp; C) pinch off tool; D) welding clamp; and E) chain clamp

Clamps

Clamps are another useful holding tool and the C-clamp (Figure 21.25) is the most widely used style. C-clamps, like other tools, require some maintenance; lubricate periodically, keep threads clean and free of rust, and make sure the swivel head rotates freely.

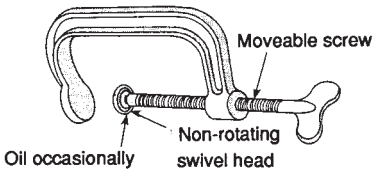


Figure 21.25 Typical C-clamp

For larger clamping jobs there are bar clamps and pipe clamps, which offer a reach limited only by the pipe length used.

The following points should be considered when using clamps.

- Choose a clamp size suited to the job; too small and the clamp can be overloaded and bend or break the body; too large and it can be an obstruction.
- Overextending the screw can bend it.

- Don't use wrenches on the screws unless the clamp is designed for this service, with a bolt head to withstand wrench tightening.
- For welding, use clamps with a shielded thread (Figure 21.26) to prevent damage to the threads from spatter.

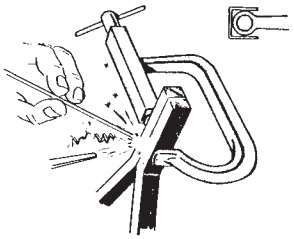


Figure 21.26 Welding C-clamp

Vises

The types of vises likely to be used by the various trades are shown in Figure 21.27. The most commonly used is the "bench" vise which can come with a fixed or swivel base. They are also available with or without pipe holding jaws. Bench vises are usually bolt-mounted to a bench but clamp-on models are also available for lighter duty.

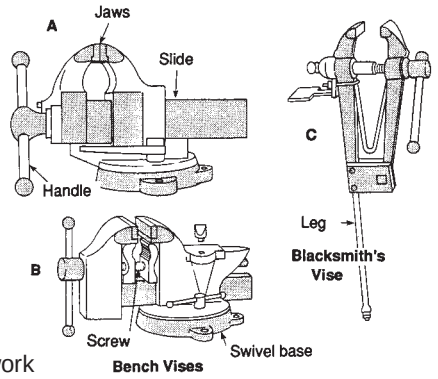


Figure 21.27

The blacksmith's vise is useful for work which must be pounced; it is secured to a bench and braced by the long leg attached to a solid base on the floor.

Pipe vises are also useful to various trades. The yoke-type pipe vise usually has capacity up to about 8 cm. (3 in.). The chain-type vise has a larger diameter capability as well as being useful for irregular shapes.

Safe use

- Mount vise securely.
- Keep work close to jaws.
- Keep vise cleaned, oiled.
- Support extra-long work.
- Prop very heavy work in vise with wood blocks to prevent it from falling and causing injury.
- Don't open jaws beyond their capacity; the moveable jaw may fall, causing injury or damage.

Pipe Tools

Pipe wrenches have been the cause of serious injuries when used on overhead jobs. Wrenches can slip on pipes or fittings, causing the worker to lose balance and fall. Pipe wrenches, whether straight or chain tong, should have sharp jaws and be kept clean to prevent slipping (Figure 21.28).

- The adjusting nut of the pipe wrench should be inspected frequently for cracks. A cracked nut may break under strain, causing a failure of the wrench and serious injury.
- Use a wrench the right length and size for the job. A wrench that is too small will not provide enough leverage or proper grip. A wrench that is too big is more apt to slip on the work.
- Face the pipe wrench forward. Turn the wrench so that pressure is against the heel jaw.
- Never use a "cheater" to extend the length of a wrench handle and provide more leverage. The cheater may strain the wrench or the work to the breaking point.

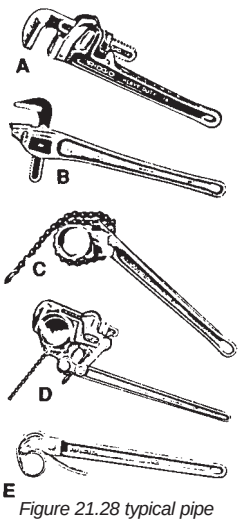


Figure 21.28 typical pipe wrenches: A) Straight, B) Offset, C) Heavy-duty chain wrench, D) Compound leverage wrench, and E) Strap Wrench

Pipe Vises

Pipe vises have been discussed briefly; however, another configuration is the portable tristand equipped with either a chain vise or yoke vise (Figure 21.29).

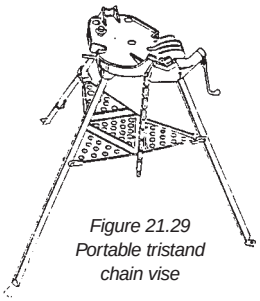


Figure 21.29 Portable tristand chain vise

- Mount the vise securely to prevent slipping or tipping over. Most tripod stands are equipped with a ceiling brace screw.
- Keep work close to the jaws of the vise.
- Support extra-long work.
- Keep the vise, especially the jaws, clean and oiled.

Pipe and tube cutters

The most common pipe and tube cutters have an alloy steel cutting wheel and two adjustable rollers. The hand units usually come in two sizes, up to 2" and 2" to 4". Usually larger tubes and pipes are cut with power cutters. Hand cutters for tubes up to 12" are available in hinged design as shown in Figure 21.30(b).

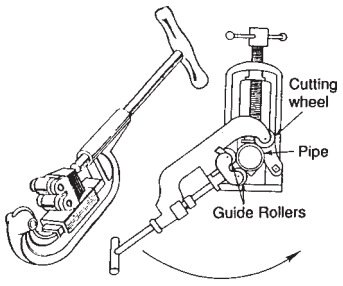


Fig. 21.30 (a): Cutting pipe or tube

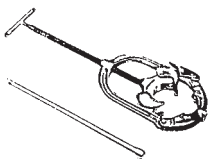


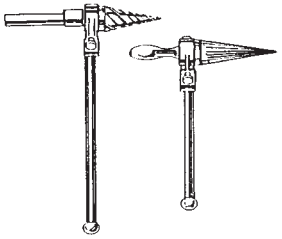
Fig. 21.30 (b): Hinged large tube cutter

In any case, it is important not to force too much pressure on the cutting wheel as it may shatter and cause dangerous fragments to fly off.

When setting up to cut, make sure to check the cutting wheel for nicks and make sure to keep the cutter perpendicular to the tube or pipe to ensure accurate tracking.

Reamers

Reamers (Figure 21.31) are used to remove the burr that results from cutting pipe with roller pipe cutters. Be careful when using this tool with a power vise. There is always the potential for the reamer to dig into the pipe and twist the tool out of the worker's hands.



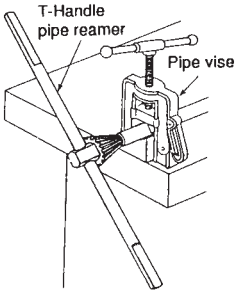


Figure 21.31 Using reamer to remove burrs from pipe or tube.

Power Tools

Basic Safety

Power tools used in construction are driven by gasoline, electricity, compressed air (pneumatic), hydraulic pressure, and explosive powder. Regardless of the source of power, these tools present hazards similar to and, because of their speed, often greater than hand tools. Typical injuries include cuts, burns, strains, and sprains. Causes of injuries include electric shock, flying particles and dust in the eye, falls, explosive atmospheres, and falling tools. These are all acute injuries produced by sudden trauma and are identified immediately with the event.

Chronic injuries must also be guarded against; such as musculoskeletal conditions like carpal tunnel syndrome or Raynaud's syndrome – white finger disease. These conditions can develop more subtly and prevention can involve awareness of a variety of precautions including tool selection, work schedules, and work practices.

Always wear eye protection. Flying particles and dust are always problems with power tools.

Wear hearing protection whenever there is chance of excessive noise exposure. Exposure to excessive noise can impair hearing and prolonged exposure can result in permanent damage to the hearing and eventually deafness.

Always disconnect the power on a portable power tool before changing or adjusting accessories such as drill bits and saw blades.

Never operate a power tool with the guard removed or improperly adjusted.

Power tools should not be left where there is a chance that the cord or hose may be pulled, causing the tool to fall. Cords and hoses left on the floor in high traffic areas may also create a tripping hazard. Cords or hoses that must cross access routes or roadways should be suspended above the ground or protected by wooden planks.

General Guidelines

- Whenever possible, select tools with large handles relative to the tool body, to reduce vibration.
- Select tool handles covered with cork, rubber, or plastic bonded to steel to reduce vibration.
- Use tools with two handles to make holding and manipulation easier.
- Always refer to the operator's manual before using a tool the first time.
- Choose tools with a trigger strip rather than a trigger button. This spreads force over a greater area, reducing muscle fatigue (Fig. 21.32).
- Make sure there's adequate lighting for safe tool use.

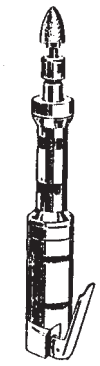


Figure 21.32

Inspection and Repair

Frequent inspection of power tools is essential to keep hazards from developing. Inspection will also help to identify operating defects and possibly avoid costly breakdowns.

A regular schedule for inspection — daily, weekly, or monthly depending on requirements — will help to ensure that all power tools are in safe operating condition. Defective tools should be removed from service, tagged, and be either repaired or replaced.

Workers should be trained to inspect the tools they use and to report defects to their supervisor. The extent of the inspection and the responsibility for maintenance or repairs must be clearly communicated so there is no misunderstanding. Workers should not carry out makeshift repairs.

Electric Power Tools

Types of injuries with electric tools include:

- major shocks that may cause a fatality
- electric flash burns
- minor shocks that may lead to injury from the tool itself or from resulting falls from ladders or platforms
- eye injuries from flying chips and cuttings
- gashes, cuts, and puncture wounds.

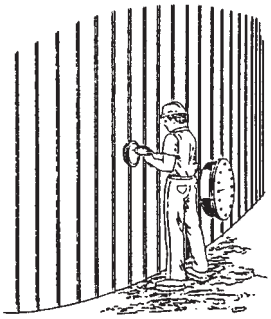


Figure 21.33

The potential for current to flow through a worker from a faulty tool is determined in part by working conditions. Wet or damp conditions can reduce resistance and can greatly increase the chance of current flow and injury from electric shock (Figure 21.33)

Grounding of electric power tools and the use of **ground fault circuit interrupters (GFCIs)** will protect the worker under most circumstances. GFCIs are required by law (Construction Regulation, section 195) wherever portable power tools are used outdoors or in wet conditions (Figure 21.34). GFCIs detect current leaking to ground from an electric tool or cord and shut off power before injury or damage can occur.

Double-insulated tools provide reliable shock protection without third-wire grounding. Tools with this type of protection are permanently marked DOUBLE INSULATION or DOUBLE-INSULATED. These tools have

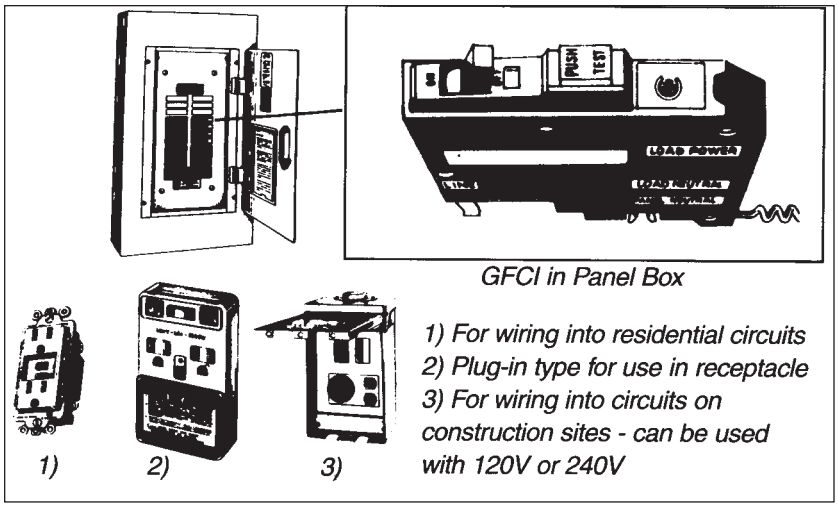


Figure 21.34

been tested and listed by Underwriters Laboratories and will carry the UL symbol. Many manufacturers are also carrying the symbol as shown in Figure 21.35 to identify double insulation.

On a double-insulated electric tool, an internal layer of protective insulation completely isolates the electrical components from the outer housing. Therefore, the third wire or ground wire is not needed.



Double Insulated
Figure 21.35

- All tools should be tested regularly for effective grounding with a continuity tester (Figure 21.36).
- Tools should have deadfront plugs (Figure 21.37).
- Make sure the casings of double-insulated tools are not cracked or broken and are free of moisture, oil, and grease.

Multimeters

Multimeters are used for testing circuits. Multimeters designed to meet the International Electro-technical Commission (IEC) 101 and Category (CAT) III standards, when properly operated, offer an acceptable level of protection recognized by the electrical industry in applications under 750 volts. CAT III devices afford more protection from high transient voltage spikes than do CAT II and CAT I designs.

Look for proof of independent testing, such as the CSA International (Canadian Standards Association) logo, along with CAT III on the equipment. Test levels should also be rated at the same or greater category and voltage than the multimeter.

For guidelines on standards, selection, and use, refer to the Electrical Hazards chapter in this manual.

Electric cords and plugs

- Inspect regularly and make sure they are in good condition.
- Never cut off, bend, or cheat the ground pin on three-prong plugs.
- Use cords fitted with deadfront plugs (Figure 21.37). These present less risk of shock and shortcircuit than open front plugs and prevent strain on current-carrying components when the cord is accidentally pulled.
- Check extension cords and outlets with a circuit-tester (Figure 21.36).
- Don't use extension or tool cords that are defective or have been improperly repaired.
- Don't wire plugs into outlets. Disconnecting will take too long in an emergency.

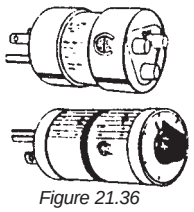


Figure 21.36
Circuit testers

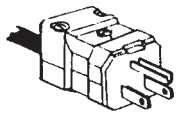


Figure 21.37
Deadfront plug

- Protect cords from traffic.
- Extension cords should be kept clear of sharp objects, heat, oil, and solvents that may damage or soften the outer insulation. Do not use light-duty power cords.

Electric Drills

Portable hand drills come in a variety of types and sizes. Figure 21.39 shows a typical light duty, variable speed drill.

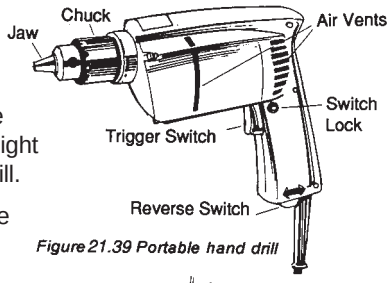


Figure 21.39 Portable hand drill

Electric drills can cause various accidents and injuries, including cuts, gashes, puncture wounds, and eye injuries from flying particles or broken bits. Proper eye protection is essential. Material being drilled should always be clamped or well secured to prevent whipping should the bit bind in the hole (Figure 21.40).

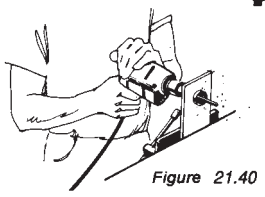


Figure 21.40

Standing on a ladder to drill a hole in a wall or overhead can be hazardous (Figure 21.41) as well as hard on the shoulder. The top and bottom of the ladder must be secure to prevent the ladder from slipping when the operator puts pressure on the drill. Never reach out to either side of the ladder. Overreaching can cause the ladder to slide or tip. When using any power tool from a ladder, never support yourself by holding onto a pipe or other grounded object.

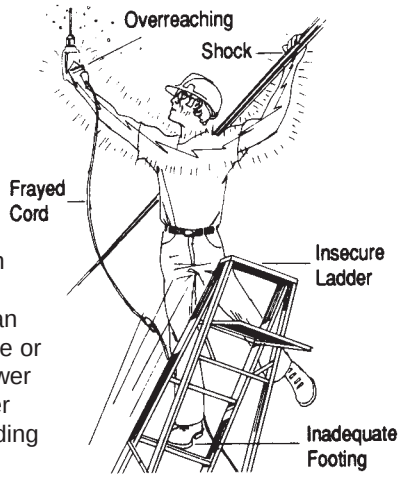


Figure 21.41

Electric current can travel from the hand holding the tool through your heart to the hand holding the pipe. A minor shock can make you lose your balance. A major shock can badly burn or even kill you.

Always be sure that the switch is off before plugging in the drill.

Make sure the shank of the attachment is tight and square in the chuck and running true before starting the drill.

Punch or drill a pilot hole in the work so that the bit won't slip or slide when you start drilling. Align the drill square with the hole — Figure 21.42.

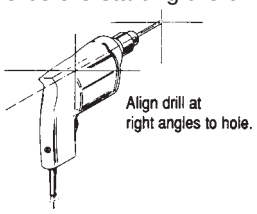


Figure 21.42

Impact or Hammer Drill

Using an impact or hammer drill (Figure 21.43) requires considerable control. Feed the attachment slowly and carefully into the material or the drill may jam and stop suddenly, severely twisting or breaking your arm. When drilling into floors, ceilings, and walls, beware of plumbing — and wiring!

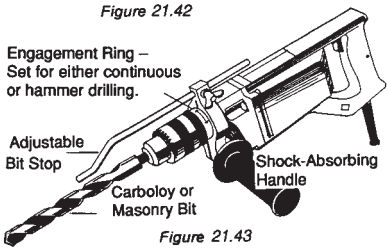


Figure 21.43

Drill Presses

On many jobs, either conventional drill presses or the more mobile electromagnetic drill presses are used. They permit more accurate drilling.

- Make sure no loose hair or loose or torn clothing can be caught in the drill bit and cause serious injury.
- Before doing any drilling on a workpiece on a conventional drill press, make sure the work is securely clamped to the drill table.
- Electromagnetic ("mag") drills are only "attached" if switched on.
- "Mag" drills if "attached" on vertical or overhead ferrous surfaces must also be secured by safety chain in case of power loss.

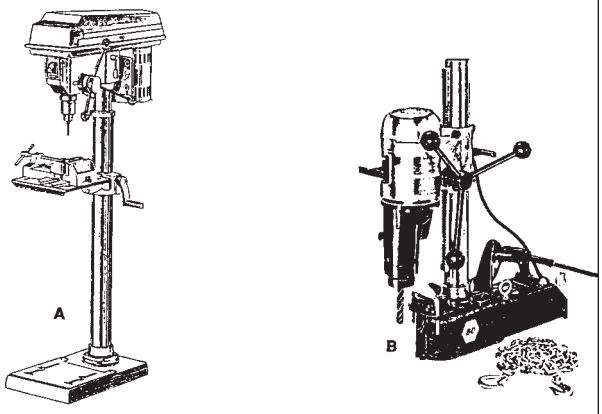


Figure 21.44 Drill Presses A) Conventional B) Electromagnetic

Power Saws

Used on construction sites, power saws of all types are a regular source of injury. Basic safety considerations with any power saw include the following points.

- Wear protective clothing and equipment. Eye protection is essential — a full face shield is recommended because of the potential for flying pieces, not just small particles. Hearing protection should also be worn.
- Where ventilation is inadequate, wear a dust mask for protection against dust. Exposure to dust from cutting metal, concrete, or other materials may cause respiratory problems over time.
- Electric saws operated outside or in wet locations must be protected with a ground fault circuit interrupter (GFCI).
- Never wear loose clothing, neck chains, scarves, or anything else that may get caught in the saw.
- Leave all safety devices and guards in place and properly adjusted on the saw.
- Change and adjust blades with the power OFF. Disconnect the saw from the power source.

Chop saws are becoming more popular among many trades in construction (Figure 21.45). They provide quick, economical cutting of various materials.

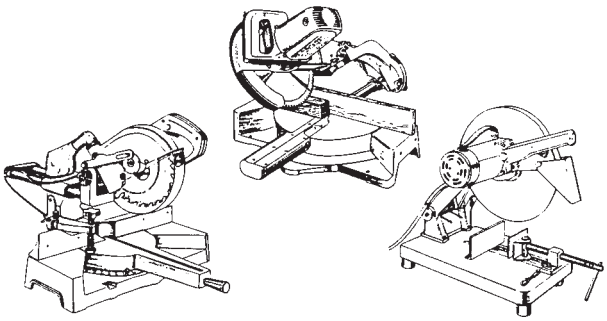


Figure 21.45

As with all power equipment, chop saws pose a serious hazard for the unwary or untrained operator. Most of these saws are equipped with abrasive wheels for quick cutting through metal and other materials.

- Select the proper abrasive cutting wheel for the material being cut. For metals, use aluminum oxide. For masonry, stone, and concrete, use silica carborundum.
- Position material to be cut at 90 degrees to the blade. Support the other end to prevent the blade from binding.
- Do not rush cutting. Let the wheel cut without burning or jamming.
- When cutting is complete, let the blade stop before moving material.
- Keep the saw in good repair with the blade guard in place and working properly. Tighten any loose parts and replace any broken or damaged components.

Quick-cut saws are widely used for cutting sheet metal, light steel angles, and channels as well as aluminum, concrete, and masonry products (Figure 21.46). They are high-powered compared to similar tools. Hazards include high-speed rotation, blade exposure during operation, and exhaust from the internal combustion engine — the usual power source.

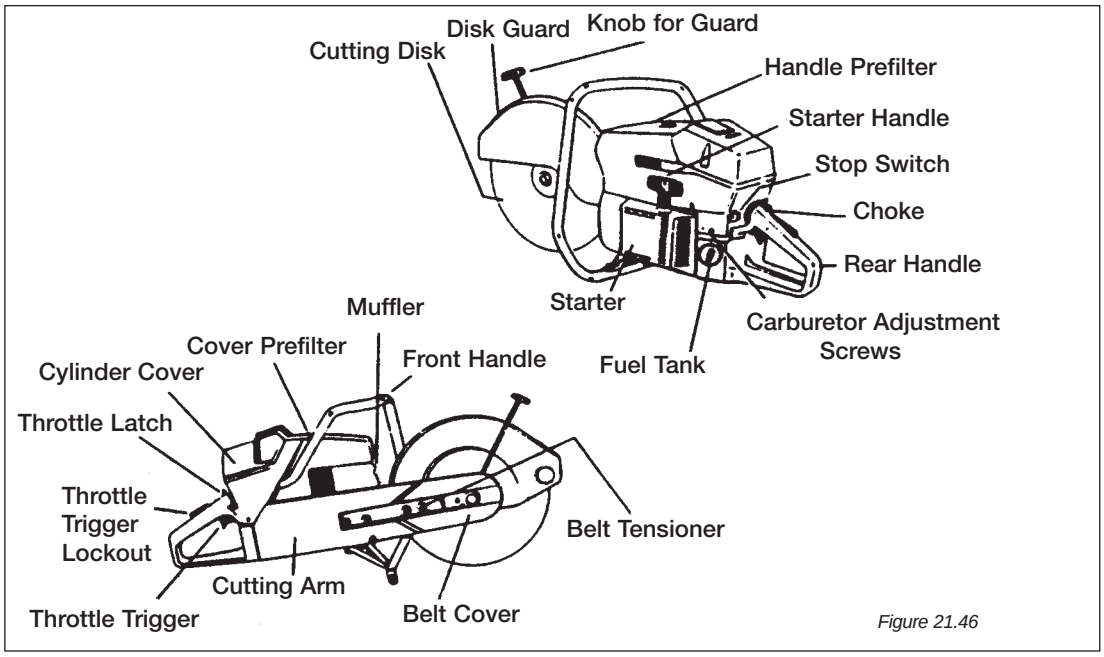


Figure 21.46

Quick-cut saws also create clouds of dust and hot sparks when dry-cutting metal products, especially steel.

Injuries can result from cuts, kickback, exposure to carbon monoxide fumes, dust exposure, burns, flying particles in the eye, and other injuries from flying material when work is not secured for cutting or when blades fly apart.

Hazards with quick-cut saws can be controlled by

- operators trained to use the saws properly and to wear the right protective equipment (full face shield and hearing protection.)
- saws kept in good working condition, equipped with the proper blades or abrasive disks, and used with all guards in place
- work secured to keep it from shifting during cutting.

Operators of quick-cut saws should be instructed in the care, maintenance, and operation of the tool. The operating manual should be kept on the job and read by users. Time spent on instruction will reduce accidents and injuries as well as extend the service life of the saw.

As a minimum, the operator of a quick-cut saw should be instructed in

- care of the saw
- installing disks and blades
- mixing fuel and fuelling the saw
- starting the saw
- supporting and securing the work to be cut
- proper cutting stance and grip
- proper cutting techniques for different material
- respiratory protection against dust
- inspection and storage of abrasive disks.

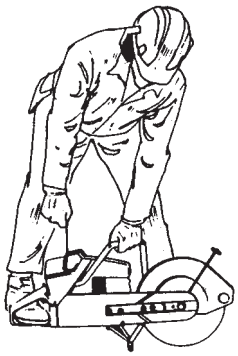


Figure 21.47

In confined areas, make sure that ventilation is adequate. Gasoline-driven saws release carbon monoxide gas — odourless, colourless, and highly toxic.

For safe starting, set one foot on the rear handle, put one hand on the top handle to lift the blade off the surface, and use the other hand to pull the starter cord (Figure 21.47).

Once the saw is running, release the throttle and make sure the engine drops to idle without the disk or blade moving.

Run the engine at full throttle and let the disk or blade run freely to make sure it turns on the arbor without wobbling or vibrating.

The saw is powerful enough to throw material around unless it is securely held and supported. Standing on material to hold it down is not recommended.

Kickback can happen extremely fast and with tremendous power. If the segment of the disk or blade shown in Figure 21.48 contacts the work, the disk or blade starts to climb out of the cut and can throw the saw up and back toward the operator with great force.

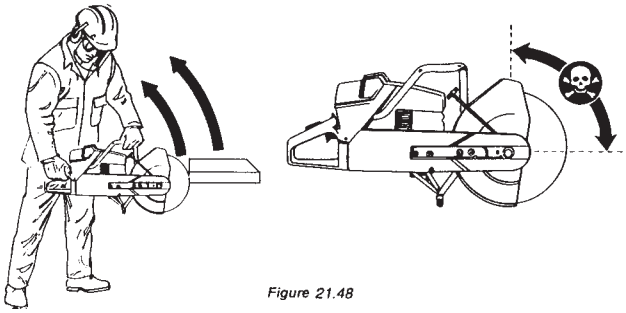


Figure 21.48

Take the following precautions

- Run the saw at full throttle.
- Do not cut above chest height.
- When re-entering a cut, do so without causing the blade or disk to pinch.
- Secure and support material at a comfortable position for cutting. Make sure that material will not move,

shift, or pinch the blade or disk during cutting.
- Keep steady balance and solid footing when making cut.
- Use both hands to control the saw. Maintain a firm grip with thumb and fingers encircling the handles.
- Never let the upper quarter segment of the blade or disk contact the material.
- Select the right blade for the job (Figure 21.49).

Abrasive Disks - Types and Uses

Type	Uses	Materials
Concrete	All-around use, most economical cutting concrete and masonry. Water-cooling is recommended to increase disk life and reduce cost.	Concrete, stone, masonry products, cast iron, aluminum, copper, brass, cables, hard rubber, plastics.
Metal	Primarily for steel, not suited for masonry products. Water-cooling is not recommended with metal abrasive disks.	Steel, steel alloys, other hard metals such as monel and iron.

Figure 21.49

In addition to the protective equipment that is mandatory on construction sites, operators of quick-cut saws should wear snug-fitting clothing, hearing protection, eye and face protection, and heavy-duty leather gloves (Figure 21.50).

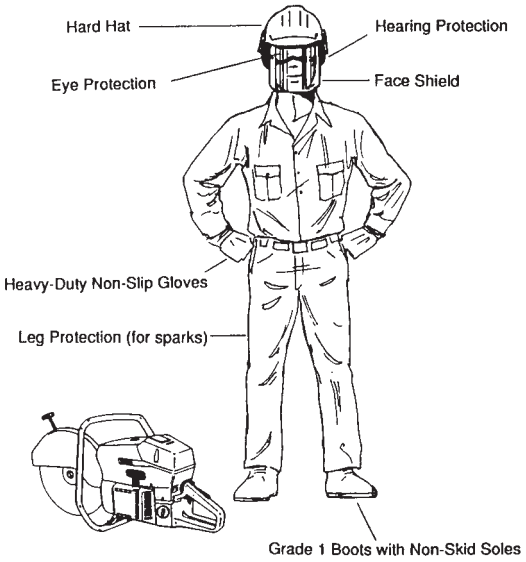


Figure 21.50

For general dust hazards, a half-mask cartridge respirator with NIOSH approval for dust, mist, and fumes should provide adequate protection when properly fitted and worn.

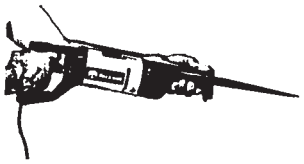


Figure 21.51 - Reciprocating Saw

Power Hacksaws

Power hacksaws come in two types; straight blade (reciprocating saw) and continuous blade (portable band saw) as are shown in Figures 21.51 and 21.52.

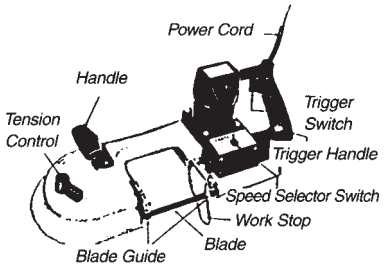


Figure 21.52 - Portable Band Saw

When using a power hacksaw, observe the following.

- Wear eye protection.
- When starting a cut with a hand-held saw, hold it above the work, turn it on, and lower it carefully onto the work (avoid plunge cuts).
- Always start the cut off an edge, never against it.
- Always keep the blade guard in place and the blade sharp.
- Keep hands away from the cutting area.
- Make sure the material being cut is secure to prevent movement.
- Stay clear of end pieces that may fall after being cut off.
- If using the tool as a portable unit, take extreme caution when cutting conduit or pipe blindly. Make sure it doesn't contain electrical wires, gases, or chemicals that could produce a hazard.

Portable Nibblers

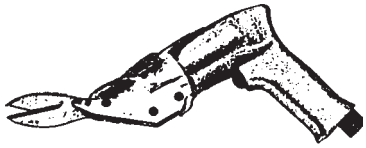


Figure 21.53 - Portable Nibblers

Portable nibblers, or power metal shears, will cut sheet metal up to about 1/4" thick. Either electric or pneumatic, they have one stationary blade and one powerful shearing blade. Stationary tools will cut heavier sheet or plate. Always secure material tightly before cutting and check for clearance under the work. See Figure 21.53.

Portable Grinders

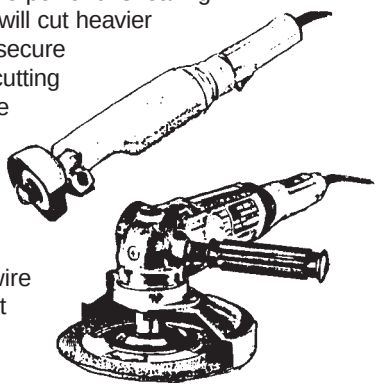


Figure 21.54 Types of portable grinders

Grinding wheels, portable buffers, and wire brushes are a constant source of flying particles and require special caution. The storage, mounting, and operation of grinding wheels calls for thorough training. Figure 21.54 shows types of portable grinders in common use: straight grinders, with stones half an inch wide or more, by 4 to 8 inches in diameter; and angle, or vertical, grinders with abrasive or sanding disks or cup stones.

Safety in using a portable grinder

- Always wear eye protection.
- Ring-test abrasive wheels before use.

Ring Test

- Clean material from wheel.
- Let wheel dry before testing.
- Tap wheel with something non-metallic such as the handle of a screwdriver.
- Tap 1/2" from outside edge.
- Rotate wheel 45 degrees and repeat test.
- A sound, undamaged wheel will give off a clear metallic ring. A cracked wheel will give off a dull sound with little or no ring.

- Never exceed the safe grinding in rpm for a stone or disk, which should be specified on the manufacturer's label. Make sure the maximum rpm of the grinder doesn't exceed the stone speed. Excessive speed can cause disks and stones to disintegrate with the potential for causing a serious injury.
- Always unplug the tool before making grinder/cutter installations.
- Make sure that the grinding wheel is installed according to the manufacturer's instructions. Use the proper hardware (safety flanges, nuts and blotters) as recommended for holding the wheel in position.
- Make sure that safety guards are in place and properly adjusted before operating.
- If you drop a portable grinder or a wheel, inspect it very carefully for damage.
- Wear hearing protection, especially for extended operation. Wear respiratory protection.
- Change disk or stone as recommended by manufacturer. Excessively worn disks and stones can shatter in use.
- Grind only on the face or outer circumference of the grinding wheel unless it is specifically designed for side grinding.
- Gloves, aprons, and foot protection may be advisable for some work, especially if hot sparks are being generated.
- Always stand aside when starting a grinder, especially with a newly mounted wheel. Hold it away from you until the tool has run at operating speed before contacting the work. This can prevent injury from a faulty wheel blowing apart.
- Use light pressure when starting the grinding, especially with a cold wheel — too much pressure on a cold wheel may cause failure.
- Don't wear loose clothing when grinding.
- Do not use grinders in the vicinity of flammable materials.



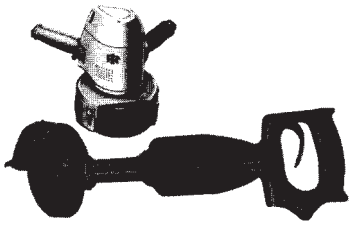
Figure 21.55 – Straight Grinders

Pencil Grinders and Rotary Files

These are normally straight die grinders (some have right-angle drive) which accept compatible cutters (files or burrs) or abrasive grinding points of small diameter, normally under 2 inches. Common types include **pencil grinders** and **rotary files**. These grinders operate at high speeds and must be used with caution. The small-diameter tools run up to about 80,000 rpm and the larger at about 20-30,000 rpm. The files or burrs are sharp and can easily cut you, even when static.

Precautions are similar to those for other grinders, but these tools are often unguarded — an added hazard.

- Use only the accessories recommended by the manufacturer and ensure they are speed-rated at least as high as the no-load RPM on the tool's nameplate. The wrong accessory, if rotated too fast, may shatter during use.
- Use grinding wheels when working with hard materials. Rotary files are used for soft materials such as aluminum, brass, and copper. Using grinding wheels on soft materials can cause build-up and excessively load the wheel, with the possibility of wheel disintegration.
- Never over-tighten the collet; it can damage the collet, cutter or wheel. If the tool doesn't run smoothly, the cutter may be out of balance. Replace it.
- Excessive pressure can bend or break the collet, mandrel, or wheel/cutter. If the grinder runs smoothly without load, but not smoothly under load, too much pressure is being used.
- Maintain a firm grip on all grinding tools. Always keep the tool pointing away from you. Never use a rotary die grinder with the cutter towards you. A slip could cause serious injury.



Angle Grinders

- Use a vise or clamp to hold the workpiece securely. Never hold a small workpiece by hand.

Air-Powered Tools

Many different types of tools are powered by compressed air. They are fast, powerful, and ideal for repetitive tasks such as scaling, chipping, and tube shaping or fitting, as well as a variety of general construction tasks such as breaking concrete or nailing. There are pneumatic equivalents for most electrical tools, including grinders, drills, and impact wrenches. Some pneumatic tools have no electrical equivalent, including needle scalers, rotary impact scalers, and chipping hammers.

Pneumatic tools can operate (when used with a portable compressor) in locations remote from another source of power. Overloading will stall the tool without damaging it; there's no shock hazard; speed control is variable from zero to maximum; and fire and explosion hazards can be reduced in some environments where sparking can be a problem.

Air Compressors

Powered by a combustion engine or electric motor, air compressors supply the air for the tool. Keep the manual with the machine and follow its directions. Check the maintenance and setup requirements and stick to a regular maintenance schedule.

There are basic precautions which must be followed for compressors.

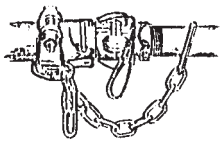
- Inspect before use, check hoses and fittings, and never use a damaged unit.
- Keep the belt guard in place.
- When using a gas or diesel powered unit, make sure there is adequate ventilation and avoid inhaling exhaust gases.
- In cold weather, moisture in the air lines can freeze, reducing the efficiency of the equipment and producing potential hazards. Anti-freeze systems are available in addition to the cold weather precaution given below.

Air hoses should be kept clear of traffic and not present tripping hazards. A hose that is left on the floor should be

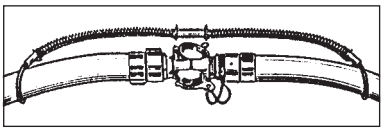
protected against damage by running planks along either side of it. Where possible, suspend hoses over walkways, traffic routes, and work areas, but take care that hoses do not get caught on passing vehicles.

Occasionally workers suffer injuries when compressed air is used to blow dust and dirt from the work area or from clothing. Compressed air can enter the skin and bloodstream with disastrous results. It can also blow particles and dust into the air at high velocity, endangering eyes and lungs. To clean away dust, use a brush or vacuum instead.

Always secure hose connections with wire, safety clips, or chain to prevent whipping, except when automatic couplers are used.



Never kink hose to stop air flow. Turn off the pressure to hoses when the system is not in use.



In cold weather, after the system is shut down and bled, air hoses should be stored overnight in a warm place so that any residual moisture cannot condense and freeze. If hoses are left out, ice can form inside. On startup they may be plugged and ice chips can be fired out of the end of the hose. Injuries have resulted from workers being struck while looking down the plugged line, or being struck by objects used to clear the line. In very cold conditions, a spare set of hoses is a good idea so that one set can always be stored and dry.

Injuries Caused by Compressed Air

Air embolism can lead to death. If compressed air from a hose or nozzle enters even a tiny cut on the skin, it can form a bubble in the bloodstream with possibly fatal results.

Physical damage – compressed air directed at the body can cause injuries, including damage to the eyes and ear drums.

Flying particles can accelerate to well over 70 mph when compressed air is used to blow off dust, metal shavings, or wood chips. These particles carry enough force to penetrate the skin.

Airborne contaminants can include silica and other substances hazardous to the respiratory system.

Pneumatic impact tools

When using air-powered tools, use only the attachments designed for them. For example, with impact wrenches, use only impact sockets and adapters manufactured for this use - they are normally marked, of a dull black colour, 6-point, and of heavier wall construction than hand sockets. Hand sockets, if used, could shatter and cause injury. Always check sockets for wear or damage; sockets in poor condition could also shatter.

When using larger impact wrenches, don't try to work alone; always consider whether you need help. A second worker is often needed for the backup wrench while tightening to avoid injury due to the torque developed by an impact wrench.

Some tools have a high noise level — for instance, impact drills. To prevent hearing loss, always wear hearing protection.

Match the speed rating of any attachments to the tool speed. Too fast or too slow a speed can damage attachments, break off fragments, and cause injury.

Before start-up, check the couplings and fittings, open the control valve momentarily, connect the hose and blow it out by opening the valve momentarily to remove moisture and dirt, then clean the nipple before connecting the tool. Set air pressure according to manufacturer's specifications and open gradually.

Make sure that attachments on pneumatic tools are secured or locked according to manufacturer's instructions.

Pneumatic impact tools require regular inspection by qualified persons. Replace worn-out absorption pads and springs. Too much vibration of the tool can damage nerves in fingers, hands, and other body parts. This is called "White Finger disease" or Raynaud's Syndrome.

Grinders

For information on the hazards and safe use of pneumatic grinders, refer back to the section on electric grinders. Apart from the different hazards connected with their power sources, air- and electric-powered grinders present the same basic problems.

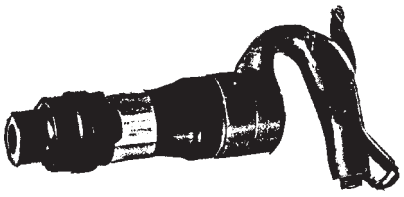


Figure 21.56 Pneumatic chipping hammer

Chipping hammers and chisels

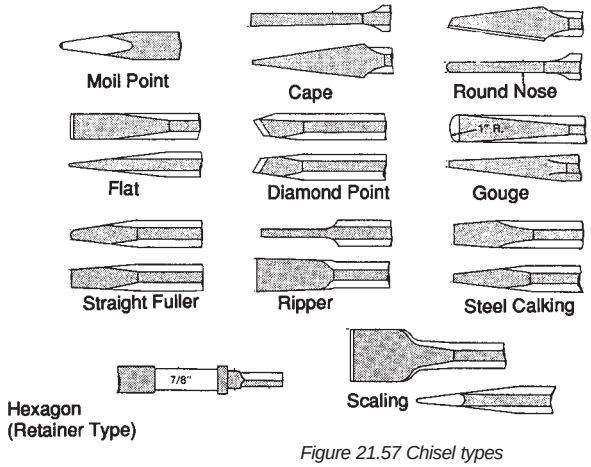


Figure 21.57 Chisel types

Chipping hammers, or chippers (Figure 21.56), are versatile tools for a number of uses with a variety of chisel tips available for attachment (Figure 21.57).

Safe practices for chippers include the following.

- Always wear eye protection when using a chipping hammer; make sure anybody else in the immediate area also has eye protection.

- When working, never point the chipper so that anybody might be hit by an accidentally ejected bit.
- Toward the end of a cut, ease off on the throttle lever to decrease the intensity of the blows to reduce the possibility of a chip or the tool flying.
- If the hammer has to be laid down, remove the attachment to prevent it from being accidentally ejected if the tool is unintentionally started.

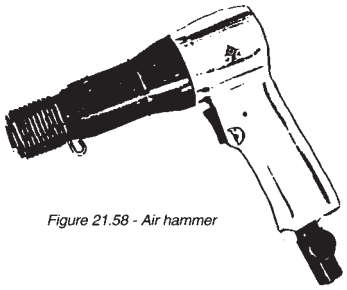


Figure 21.58 - Air hammer

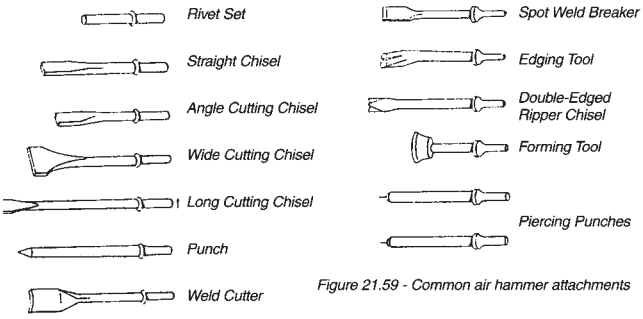
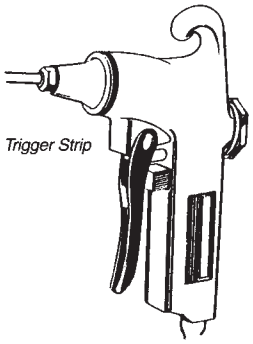
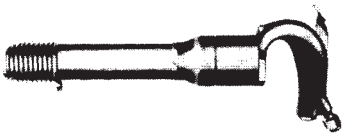


Figure 21.59 - Common air hammer attachments

Air hammers are small multi-purpose tools. Figure 21.59 shows some common air hammer attachments.





Safety Tip

Choose tools with a trigger strip rather than a trigger button. This spreads force over a greater area, reducing muscle fatigue.

Rivet guns

A plunger inside the barrel strikes the rivet tool, causing it to shape the rivet head. Since the plunger is free to come out, it should be removed to prevent loss or discharge when the tool is put aside.

Air Scalers

The air scaling gun is a lightweight, highspeed tool suitable for chipping, scaling, and removing caulking, rust, scale, flux, spatter, etc. from all types of surfaces and shapes.

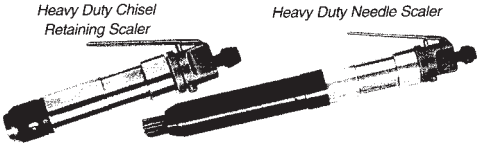


Figure 21.60 - Air Scalers

A needle scaler attachment is commonly used by boilermakers (Figure 21.60). Because of its configuration of many needles rapidly impacting individually, it is useful for cleaning all kinds of surfaces, including irregular ones, since it automatically fits the irregular contours.

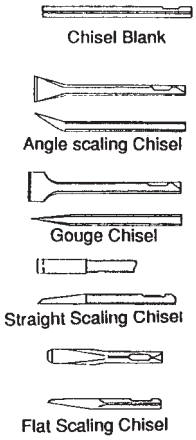


Figure 21.61 Common attachments for air scalers.

Besides the needle scaler attachment, there are other chisels that work well with air scalers (Figure 21.61). Some of these chisels have an offset blade at an angle to enable access into awkward corners. These are not intended to cut and are therefore sharpened to a dull edge to clean out slag in corners without undercutting.

Pipe Power Tools

Power Threading Machines (Figure 21.62). These are designed to let the operator cut, ream, and thread pipe of various sizes all in one power machine. The machine must be treated with respect. Potential hazards include:

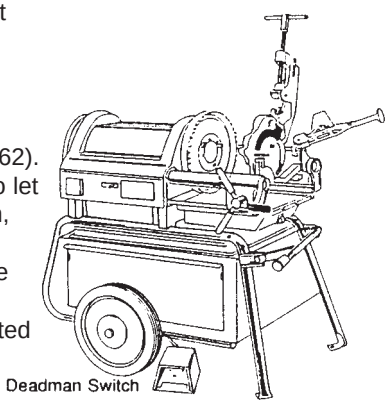


Figure 21.62

- catching clothing, gloves, or cleaning rag in revolving parts
- being struck by flying metal chips
- using a rag to clean oil from threads while machine is turning
- wearing loose-fitting clothes
- pipe wrench locking on pipe while reversing previous operation
- losing grip or footing because of oil and debris
- failure to install and use the deadman switch.

Roll Groover

This machine forms standard roll grooves in steel, stainless steel, and aluminum pipe. Figure 21.63 shows a heavy-duty roll groover designed for 2-inch to 8-inch schedule 40 steel pipe (up to 12-inch for schedule 20 or lighter wall pipe).

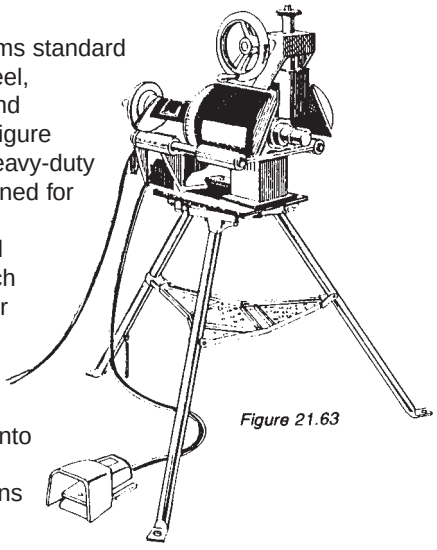


Figure 21.63

Grooves are formed by a grooving roll fed into a drive roll to the exact specifications required for mechanical

coupling systems. The roll groover can be mounted on a power drive or threading machine.

Set-up

- Read and follow the operator's manual and the information on the machine.
- Know the location and function of each control before using the machine.
- Wear snug-fitting clothes, safety boots, hard hat, and eye protection. Cover or tie up long hair. Do not wear gloves, unbuttoned jackets, loose sleeve cuffs, neckties, scarves, rings, watches, or other jewelry.
- Wear hearing protection — ear plugs or muffs — if you use the machine daily or in a noisy area.
- Use only an approved three-wire cord with a three-prong plug in a grounded receptacle. Replace or repair any damaged, frayed, broken, or worn cords.
- If an extension cord is required, it must be three-wire with three-prong plug and three-pole receptacle. Make sure the cord is large enough to prevent excessive voltage drop.
- Make sure that switch is in the OFF position before you plug in the power cord.
- Connect the machine to an AC power supply that matches the nameplate specifications.

Operation

- Clear the roll groover of all objects such as tools and material before turning it on.
- Keep guards in place. Never operate the machine with guards removed or disarmed. Your fingers can get caught between the grooving and drive rolls.
- Operate the roll groover from the switch side only.
- Keep good footing and balance. Do not operate the machine when you are tired.
- Do not use the machine in damp or wet conditions. Do not expose to rain.
- Unplug power cord when you are adjusting or servicing the machine and changing accessories.
- Use the footswitch. It lets you shut off the motor simply by removing your foot.
  Warning: clothing caught in the roll groover will continue to wind up, pulling you into the machine. Because the machine has high torque, the clothing itself can bind around your arm or other body parts with enough force to crush or break bones.
- Make sure that you can quickly remove your foot from the footswitch.
- Keep other workers out of the work area. Keep the area clean, dry, and well lighted.
- Do not reach across the machine.
- Properly support the work on a pipe stand.

Maintenance

- Follow manufacturer's instructions for cleaning, servicing, and inspection.
- Keep handles dry, clean, and free of grease.
- When not in use, store the roll groover in a locked area secure from people unfamiliar with the machine.
- Keep footswitch in working order. When not in use, lock the switch to avoid accidental start-up (Figure 21.64).

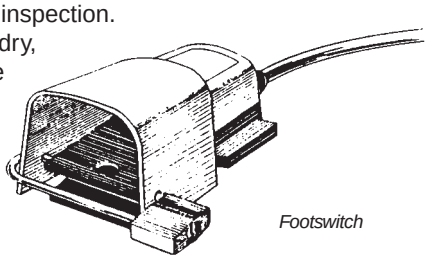


Figure 21.64

Pipe Preparation Tools

Some power tools are manufactured for specific piping systems. For instance, the Vitaulic Pressfit System for joining pipe with specially designed couplings uses a power crimping tool (Figure 21.65). It is designed for schedule 5 black or galvanized steel pipe prepared to meet Victaulic specifications.

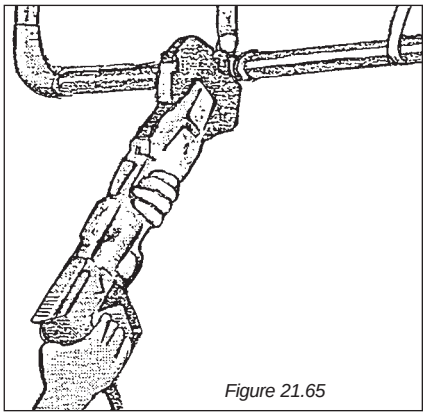


Figure 21.65

The T-Drill T-Less tube branching system mechanically forms outlets in copper tubing and eliminates the need for tee and cross fittings. The T-Drill (Figure 21.66) drills the required hole in the pipe and forms a collar to accept the branch pipe. The tube end notcher cuts and dimples the branch tube to limit insertion depth. The joint is then brazed.

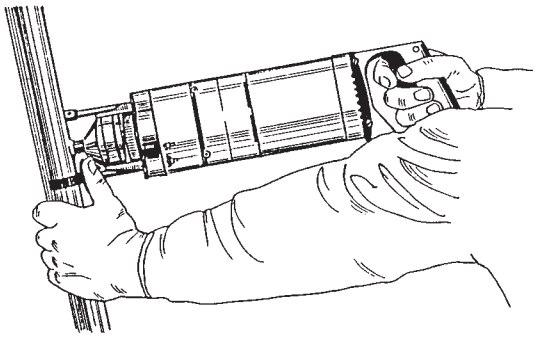


Figure 21.66

Victaulic crimpers and T-Drills are being used more and more in automatic sprinkler system installation. Take the following precautions.

- Read and understand all instructions in the manufacturer's operating manual before operating or servicing the tools.
- Inspect all movable parts before starting the tools. Check for obstructions and proper installation of components.
- Disconnect tools from power source before changing accessories or servicing. Be sure switch is off before plugging in the tools.
- Use only replacement parts supplied by the manufacturer.
- Keep work area clean.
- Guard against shock. Prevent body contact with grounded surfaces. Always use a ground fault circuit interrupter.
- Do not carry live tools with your finger on the switch.

- Keep unauthorized personnel out of the work area.
- Store tools in a dry location in a locked container.
- Do not force or overload the tool.
- Wear adequate eye protection.
- Use the tools only for their intended purpose.
- Do not operate the tools while wearing loose clothing, jewelry, or anything else that could get caught in moving parts.
- Never carry tools by the cord or yank the cord to disconnect the tool from the receptacle. Protect cord from heat, pinch points, and sharp edges.
- Use clamps, vice, or secure pipe hangers to hold work in place.
- Do not overreach. Keep proper footing and balance at all times.
- Keep tools clean and lubricated. Repairs should be done only by an authorized service shop. Inspect and replace damaged extension cords. Keep handles clean, dry, and free from oil and grease.
- Do not operate tools near flammable liquids or in explosive atmospheres.

Powder-Actuated Tools

Referred to as *explosive-actuated* or *powder-actuated*, these tools use a powder charge to fire a fastener into hard materials such as concrete, mild steel, and masonry (Figure 21.67). They provide a fast, efficient means of fastening certain combinations of materials.

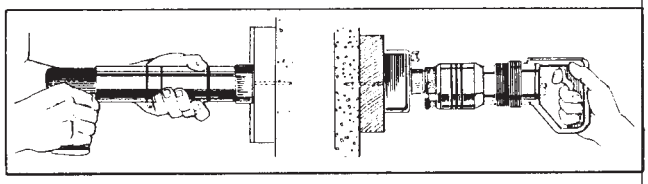


Figure 21.67

Used improperly, powder-actuated tools present obvious hazards. For that reason, most jurisdictions — including Ontario — require that operators be trained before using these tools.

Flying particles are the major hazard. On impact, materials may break up, blow apart, or spall off. This often happens when fasteners are fired too close to a corner of masonry or concrete (Figure 21.68) or when they strike materials such as glazed tile, hollow tile, or thin marble tile.

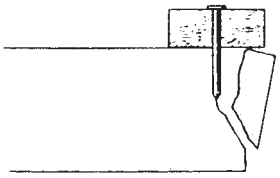


Figure 21.68

Ricochets usually result when the tool is not at right angles to the material or the fastener hits a particularly hard base material such as stone or hardened steel. Always check the base material to ensure that it will safely accept the fastening device.

Noise is extreme when powder-actuated tools are fired. Operators and others in the area should wear hearing protection. This is especially important when the tool is operated in a confined space.

Sprain and strain injuries usually result from using the tool repeatedly in awkward, cramped, or unbalanced positions. Operators should try to work from a balanced position on a solid surface.

Explosions and fires are always a risk when the tools are used where atmospheres may be flammable. The work area must be well ventilated, mechanically if necessary, as in confined spaces.

Blow-through results when the base material does not offer enough resistance and the fastener passes completely through and flies out the other side. This is particularly dangerous when fasteners blow through walls, floors, or ceilings where other trades may be working on the opposite side. Check the other side of walls, ceilings, and floors before firing and keep people clear if necessary.

Protective equipment for the operator of a powder-actuated tool should include hearing protection, eye protection, and a face shield. Heavy shirts and pants provide some protection against ricochets and fragments of material or fasteners.

High velocity powder-actuated tools use the exploding cartridge to propel the fastener directly rather than by a piston. These tools are rarely used in construction, except in special cases to penetrate thick steel or very hard material. These applications are usually military, salvage, or underwater. No one should operate high-velocity tools without special training.

Low velocity tools are the most common for construction. The explosive charge drives a piston which in turn drives the fastener (Figure 21.69).



Figure 21.69

Many different low velocity tools are available. Some are specialized for certain trades such as drywalling. Others are fitted with various pistons, base plates, spall stops, and protective shields for heavier-duty work.

Generally, low velocity tools should only be used on mild or structural grade steel no thicker than 7mm (1/4").

Fasteners used with powder-actuated tools such as studs and pins (Figure 21.70) are made of special steel to allow them to penetrate materials without breaking or bending.

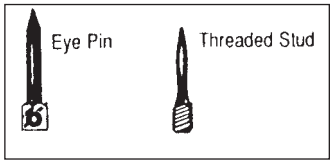


Figure 21.70

The fastener is fitted with a tip or eyelet as a guide. This aligns the fastener on the tool as it is being driven. It is also used to retain the fastener in the tool.

Generally, fasteners should not be used on hard, brittle, or glazed materials such as cast iron, marble, tiles, and most stone. The fastener will either fail to penetrate and ricochet or the base material will shatter or spall.

Materials whose hardness or ductility is unknown should be tested first. Try to drive a pin into the material with a standard hammer. If the pin point is blunted or fails to penetrate at least 2mm (1/16"), don't use a powder-actuated tool.

Cartridges are available in various powder loads. Manufacturers may recommend cartridges for certain applications but recommendations cannot cover every possibility and testing may be required with unfamiliar material. The general rule is to start with the weakest cartridge and increase one load number at a time to reach the penetration required.

Too strong a charge may shatter material, ricochet, or blow through. Standard loads, colour coding, and velocities for cartridges are listed in Figure 21.71.

Colour Identification of Powder Load Strengths

Load Number	Cartridge Case Colour	Powder Load Colour	Nominal Velocity	
			m/s	ft/s
1	Brass	Grey	91.4	300
2	Brass	Brown	118.8	390
3	Brass	Green	146.3	480
4	Brass	Yellow	173.7	570
5	Brass	Red	201.2	660
6	Brass	Purple	228.6	750
7	Nickel	Grey	256.0	840
8	Nickel	Brown	283.5	930
9	Nickel	Green	310.9	1020
10	Nickel	Yellow	338.3	1110
11	Nickel	Red	365.8	1200
12	Nickel	Purple	393.2	1290

Figure 21.71

Misfired cartridges can be dangerous. Take the following precautions.

- Hold the tool against the material for at least 30 seconds in case firing is delayed.
- Remove the cartridge from the tool with the tool pointed toward soft material such as wood.
- Regulations require that a misfired cartridge be placed in a container of water.
- Never throw a misfired cartridge in the garbage.

Explosive-Actuated Tools — General Safeguards

- Explosive-actuated tools should not be used, handled, or stored carelessly.
- Don’t fire fasteners through pre-drilled holes for two reasons:
  1) Unless the fastener hits the hole squarely, it will probably shatter the edge.
  2) The fastener gets its holding power from compressing the material around it. A pre-drilled hole reduces this pressure and therefore the fastener’s power.
- Because pressure must be applied to the material into which a fastener is being driven before the tool will fire, working from a ladder is not recommended. For work overhead or at heights, operate the tool from a scaffold or other approved work platform.
- Do not leave the tool unattended unless it’s locked in a box.
- Load the tool immediately before firing. Don’t walk around with the tool loaded.
- Do not use powder-actuated tools in areas where the atmosphere may be explosive or flammable.

The ***Regulations for Construction Projects*** define the minimum requirements for the operation, maintenance, storage, and training of workers. Refer to the regulations before operating any powder-actuated tool.

39 POWER TOOLS – AIR

Many different types of tools are powered by compressed air. They are fast, powerful, and ideal for repetitive tasks such as the nailing of large areas of roof decking or chipping and breaking concrete. A compressor, powered by a combustion or electric motor, supplies the air for the tools.

Air-powered tools include

– jackhammers
– chipping hammers
– drills
– grinders
– sanders
– staplers
– framing nailers
– wrenches
– brad nailers
– winches
– air nozzles
– saws
– buffers
– impact tools
– sprayers.

- Workers must be trained on the air-powered tool they intend to use.
- Run combustion engines outside or in a well-ventilated area to prevent the build-up of carbon monoxide gas. Always keep a fire extinguisher near flammable liquids.
- When moving compressors to another location, ask for help or use mechanical devices to prevent back injuries.
- Occasionally workers suffer eye injuries when compressed air is used to blow out formwork. Wear safety goggles and respiratory protection.
- Always secure hose connections with wire or safety clips to prevent the hose from whipping—except when automatic cut-off couplers are used.
- Make sure hoses are clear of traffic and pose no tripping hazards.
- Replace worn-out absorption pads and springs. Too much vibration of the tool can damage nerves in the fingers, hands, and other body parts. This is called “white finger disease” or Raynaud's Syndrome.
- Some tools have a high decibel rating—for instance, jackhammers and impact drills. To prevent hearing loss, always wear hearing protection.
- Never modify safety features, such as tying or wiring the nose contact in the activated position.
- Keep hands away from discharge area—on nailers in particular.
- Match the speed rating of saw blades, grinding wheels, cut-off wheels, etc. to tool speed. Too fast or too slow a rotation can damage the wheels, release fragments, and injure workers.
- Never use air to blow dust or dirt out of work clothes. Compressed air can enter the skin and bloodstream with deadly results.
- Turn off the pressure to hoses when the system is not in use.
- Turn off the air pressure and safety release any pressure remaining in the system before changing pneumatic tools or attachments.
- Never “kink” a hose to stop air flow.

Most air-powered tools need very little maintenance. At the end of the shift, put a teaspoon of oil in the air inlet and run the tool for a second or two to protect against rust.

Dust, moist air, and corrosive fumes can damage the equipment. An inline regulator filter and lubricator will extend tool life.

Before start-up, check the couplings and fittings, blow out the hose to remove moisture and dirt, and clean the nipple before connecting the tool. Set the air pressure according to the manufacturer's specifications and open gradually.

Compressed air can be dangerous. Hazards include

Air embolism	This is the most serious hazard, since it can lead to death. If compressed air from a hose or nozzle enters even a tiny cut on the skin, it can form a bubble in the bloodstream—with possibly fatal results.
Physical damage	Compressed air directed at the body can easily cause injuries—including damage to eyes and ear drums.
Flying particles	Compressed air at only 40 pounds per square inch can accelerate debris to well over 70 miles per hour when it is used to blow off dust, metal shavings, or wood chips. These particles then carry enough force to penetrate the skin.

WARNING: Make sure that air pressure is set at a suitable level for the tool or equipment being used. Before changing or adjusting pneumatic tools, turn off air pressure.

37 POWER TOOLS – DRILLS, PLANES, ROUTERS

Safety Basics

- Make sure that electric tools are properly grounded or double-insulated.
- Never remove or tamper with safety devices.
- Study the manufacturer's instructions before operating any new or unfamiliar electric tool.
- Regulations require that ground fault circuit interrupters (GFCIs) be used with any portable electric tool operated outdoors or in wet locations.
- Before making adjustments or changing attachments, always disconnect the tool from the power source.
- When operating electric tools, always wear eye protection.
- When operating tools in confined spaces or for prolonged periods, wear hearing protection.
- Make sure that the tool is held firmly and the material properly secured before turning on the tool.

Drills

Types

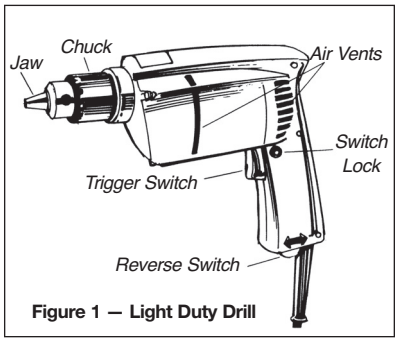


Figure 1 — Light Duty Drill

With suitable attachments, the drill can be used for disk sanding, sawing holes, driving screws, and grinding. However, when such applications are repeatedly or continuously required, tools specifically designed for the work should be used.

Trim carpenters will generally select a 1/4 or 3/8 inch trigger-controlled variable speed drill (Figure 1). Simply by increasing pressure on the trigger, the operator can change drill speed from 0 to 2,000 rpm.

Carpenters working in heavy structural construction such as bridges, trusses, and waterfront piers will usually select the slower but more powerful one- or two-speed reversible 1/2 or 3/4 inch drill (Figure 2).

Size of the drill is determined by the maximum opening of the chuck. For instance, a 3/8 inch drill will take only bits or attachments with a shank up to 3/8 inch wide.

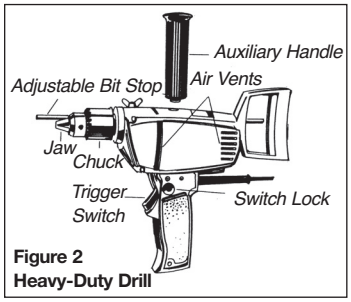


Figure 2
Heavy-Duty Drill

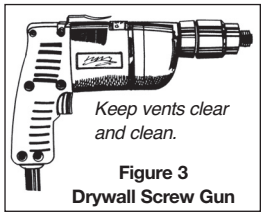


Figure 3
Drywall Screw Gun

For drywall screws, a drywall screw gun (Figure 3) should be used. The driving bit should be replaced when worn. Select a gun that can hang from your tool belt so it does not have to be continuously hand-held.

Attachments

Attachments such as speed-reducing screwdrivers, disk sanders, and buffers (Figure 4) can help prevent fatigue and undue muscle strain. A right-angle drive attachment (Figure 5) is very useful in tight corners and other hard-to-reach places.

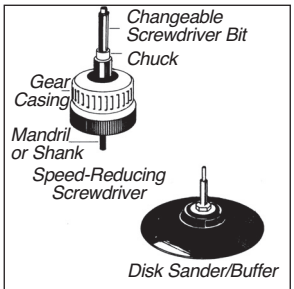


Figure 4 — Drill Attachments

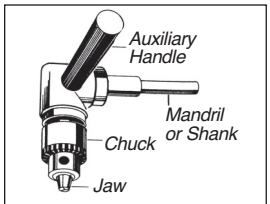


Figure 5
Right-Angle Drive Attachment

Cutting and drilling attachments must be kept sharp to avoid overloading the motor. Operators should not crowd or push the tool beyond capacity. Such handling can burn out the motor, ruin the material, and injure the operator in the event of a kickback.

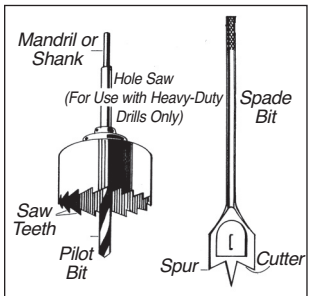


Figure 6 — Drill Attachments

Some attachments, such as hole saws, spade bits, and screwdrivers (Figure 6), require considerable control by the operator. If the operator does not feed the attachment slowly and carefully into the material, the drill can suddenly stop and severely twist or break the operator's arm. Stock should be clamped or otherwise secured to prevent it from moving. This will also enable the operator to control the tool with both hands and absorb sudden twists or stops caused by obstructions such as knots or hidden nails.

Operators must restrain the drill just before the bit or cutting attachment emerges through the material, especially when oversized spade bits are used. Sides of the bit often become hooked on the ragged edge of the nearly completed hole and make the drill come to a sudden stop that can wrench the operator's arm.

At the first sign of the bit breaking through the material, the operator should withdraw the drill and complete the work from the other side. This will produce a cleaner job and prevent the material from cracking or splintering.

The same result can be obtained by clamping a back-up piece to the material and drilling into that.

Select the bit or attachment suitable to the size of the drill and the work to be done. To operate safely and efficiently, the shanks of bits and attachments must turn true.

Make sure that the bit or attachment is properly seated and tightened in the chuck.

Some operations require the use of an impact or hammer drill. For instance, drilling large holes in concrete or rock with

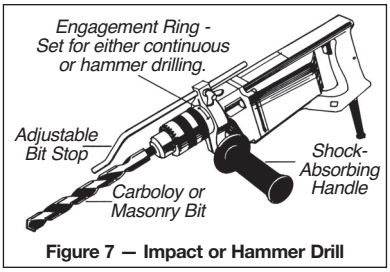


Figure 7 — Impact or Hammer Drill

a carboloy bit should be done with an impact drill (Figure 7).

Follow manufacturer's instructions when selecting and using a bit or attachment, especially with drills or work unfamiliar to you. If possible, choose a drill with a builtin anti-vibration feature or wear vibration-dampening gloves. This will help you avoid white finger disease.

Working with Small Pieces

Drilling into small pieces of material may look harmless, but if the pieces are not clamped down and supported, they can spin with the bit before the hole is completed.

If a small piece starts to twist or spin with the drill, the operator can be injured. Small work pieces should be properly secured and supported. Never try to drill with one hand and hold a small piece of material with the other (Figure 9).

Drilling from Ladders

Standing on a ladder to drill holes in walls and ceilings (Figure 8) can be hazardous. The top and bottom of the ladder must be secured to prevent the ladder from slipping or sliding when the operator puts pressure on the drill.

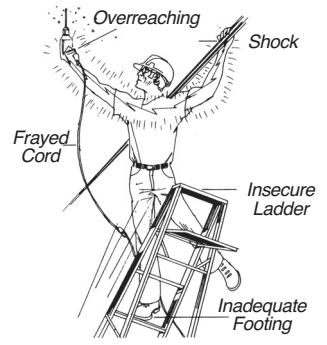


Figure 8 — Drilling and Ladder Hazards

When drilling from a ladder, never reach out to either side. Overreaching can cause the ladder to slide or tip.

Never stand on the top step or paint shelf of a stepladder. Stand at least two steps down from the top. When working from an extension ladder, stand no higher than the fourth rung from the top.

When drilling from a ladder, never support yourself by holding onto a pipe or any other grounded object. Electric current can travel from the hand holding the drill through your heart to the hand holding the pipe.

A minor shock can make you lose your balance. A major shock can badly burn or even kill you.

Operation

Always plug in the drill with the switch **OFF**.

Before starting to drill, turn on the tool for a moment to make sure that the shank of the bit or attachment is centred and running true.

Punch a layout hole or drill a pilot hole in the material so that the bit won't slip or slide when you start drilling. A pilot hole is particularly important for drilling into hard material such as concrete or metal.

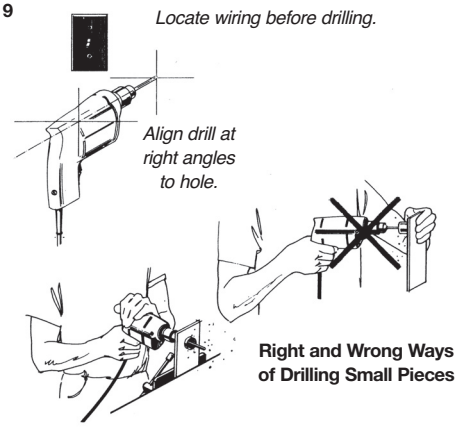
With the drill **OFF**, put the point of the bit in the pilot hole or punched layout hole.

Hold the drill firmly in one hand or, if necessary, in both hands at the correct drilling angle (Figure 9).

Turn on the switch and feed the drill into the material with the pressure and control required by the size of the drill and the type of material.

Don't try to enlarge a hole by reaming it out with the sides of the bit. Switch to a larger bit.

Figure 9



Right and Wrong Ways of Drilling Small Pieces

When drilling deep holes, especially with a twist bit, withdraw the drill several times with the motor running to clear the cuttings.

Never support material on your knee while drilling. Material should be firmly supported on a bench or other work surface for drilling.

Unplug the drill and remove the bit as soon as you have finished that phase of your work.

When drilling into floors, ceilings, and walls, beware of plumbing and especially of wiring.

Large rotary and hammer drills can generate extreme torque and must be handled with caution.

Remember that the longer you work, the heavier the drill feels, particularly when working overhead. Take a breather now and then to relax your arms and shoulders.

Thread angle determines how fast the bit will feed through the material.

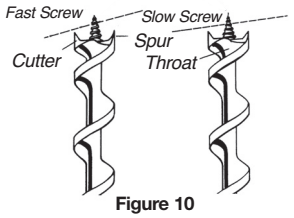


Figure 10
Self-Feeding Auger Bits

Drilling Timbers

When drilling timbers with a self-feeding auger bit (Figure 10), do not underestimate the physical pressure required to maintain control of the tool. Such work calls for a heavy-duty, low-rpm drill, 1/2 or 3/4 inch in size.

Never attempt to drill heavy timbers by yourself, especially when working on a scaffold or other work platform. If the self-feeding auger bit digs into a hidden knot or other obstruction, the sudden torque can twist or wrench your arm and throw you off balance.

Other Materials

The main hazard in drilling materials other than wood is leaning too heavily on the tool. This can not only overload and burn out the motor but also cause injury if you are thrown off balance by the drill suddenly twisting or stopping.

Always use a drill powerful enough for the job and a bit or attachment suited to the size of the drill and the nature of the work. As at other times, punching a layout hole or drilling a pilot hole can make the job safer and more efficient.

A drill press stand is ideal for drilling holes in metal accurately and safely. Small pieces can be clamped in a vise and bolted to the table. This prevents the workpiece from spinning when the drill penetrates the metal.

A drill press can also be used for cutting large holes in wood with a hole saw or spade bit. The stability of the press and the operator's control over cutting speed eliminate sudden torque.

Planes

Available in various types and sizes, electric planes are generally operated in similar ways. Adjustments between models may differ, however, depending on specific features.

Planes may be equipped with

– outfeed tables (back shoes) that are either fixed or movable
– infeed tables (front shoes) that move straight up and down or move up and down on an angle to keep the gap between the cutter head and table as small as possible
– cutter heads with two or more straight blades (also called knives or cutter blades)
– cutter heads with two curved blades.

Never operate an electric plane while wearing a scarf, open jacket, or other loose clothing. Always wear eye protection and practice good housekeeping.

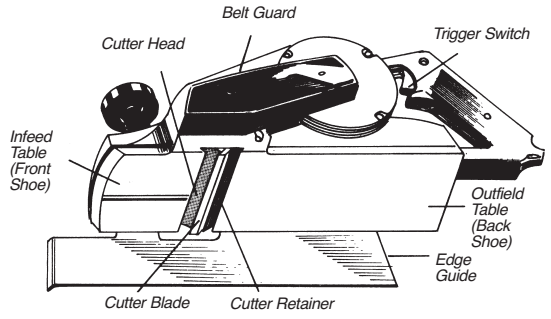


Figure 11 – Standard Power Plane

Standard Plane

- Hold with both hands to avoid contact with cutter blades.
- Always keep both hands on the plane until motor stops.
- Use the edge guide to direct the plane along the desired cut. Never try to guide the plane with your fingers. If the plane runs into an obstruction or starts to vibrate, your fingers can slide into the unprotected cutter head.

Block Plane (Electric)

Designed for use on small surfaces, the block plane is necessarily operated with only one hand. Though convenient and useful, it is more dangerous than the larger, standard plane.

Operators tend to support the work with one hand while operating the block plane with the other. Any unexpected twist or movement can force the plane or the material to kick back and injure the operator. Keep your free hand well out of the way, in case the plane slips accidentally.

Maintaining Blades

- Avoid striking staples, nails, sand, or other foreign objects. The first step in operation is to make sure the work is free of obstructions.
- Keep blades in good condition and sharp. A sharp blade is safer to use than a dull blade that has to be held down and forced. A dull blade tends to float over the work and can bounce off, injuring the operator.
- Restore blades to original sharpness on a fine grit oilstone. Unless nicked or cracked, blades can be resharpened several times.

Changing Blades

Raising or replacing cutter blades takes time and patience. Blades must be the same weight and seated at the same height to prevent the cutter head from vibrating. Any deviation can cause the head to run off balance. Blades can fly out, inuring the operator or fellow workers.

Replacing cutter blades involves two steps: removing and installing.

Removing Blades

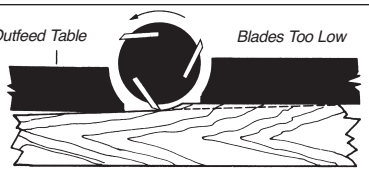
1) Disconnect the plane from the power source.
2) Turn the plane upside down and secure it in a fixed position.
3) Hold the cylinder head stationary by tapping a softwood wedge between the cutter head and the bearing (some tools are equipped with a locking device for this).
4) Loosen all the screws and lift out one blade and throat piece.
5) Turn the cutter head and repeat this procedure with other blades.
6) If necessary, clean parts thoroughly with recommended solvent.

Installing Blades

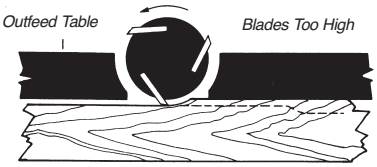
1) Replace one throat piece and blade.
2) Tighten the two end screws lightly.
3) Take a hardwood straight edge and use the outfeed table (back shoe) as a gauge. Raise or lower the blade until both ends are level with the outfeed table at the blade's highest point of revolution.
4) Tighten up the remaining screws.
5) Set the rest of the blades in the same way.
6) Turn the cylinder head and make sure that all blades are the same height.
7) Tighten up all the screws.
8) Double-check the height of all blades. Tightening can sometimes shift the set.
9) Double-check all the screws.
10) Turn the tool right side up and plug it in.
11) Hold the tool in both hands with the cutter blades facing away from you and switch it on.

Operation

- Always disconnect the plane from the power source before adjusting or changing blades or the cutter head.
- Make sure that blades at their highest point of revolution are exactly flush with the outfeed table for safe, efficient operation (Figure 12).



When cutter blades are installed lower than the level of the outfeed table, the plane hobbles over the material and the cut is uneven.



When cutter blades are installed higher than the level of the outfeed table, the plane gouges the material.

Figure 12

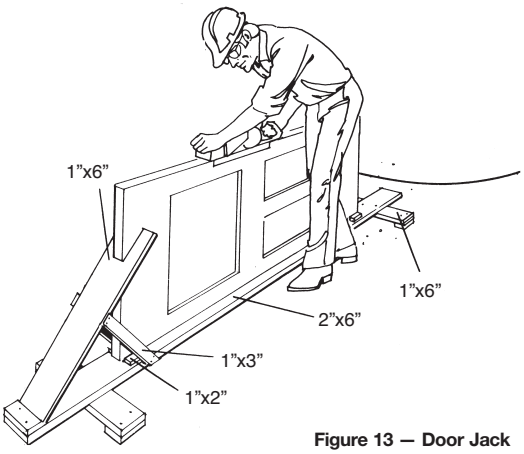


Figure 13 — Door Jack

- Support work securely for safety and accuracy.
- When planing doors and large pieces of plywood, use a jack (Figure 13) to secure material and keep edges clear of dirt and grit.
- When using an electric block plane, clamp or fasten the workpiece whenever possible. Keep your free hand well away from plane and material.
- When using the standard power plane, adjust the edge guide to provide desired guidance.
- Adjust depth of cut to suit the type and width of wood to be planed.
- To start a cut, rest the infeed table (front shoe) firmly on the material with cutter head slightly behind the edge of the material. After finishing a cut, hold both hands on the plane until motor stops.

Routers

With special guides and bits, the portable electric router can be used to cut dadoes, grooves, mortises, dovetail joints, moldings, and internal or external curves. Carpenters find routers especially useful for mortising stair stringers and recessing hinges and lockplates on doors.

The router motor operates at very high speed (up to 25,000 rpm) and turns in a clockwise direction. Components are shown in Figure 14.

WARNING The speed and power of the router require that it be operated with both hands.

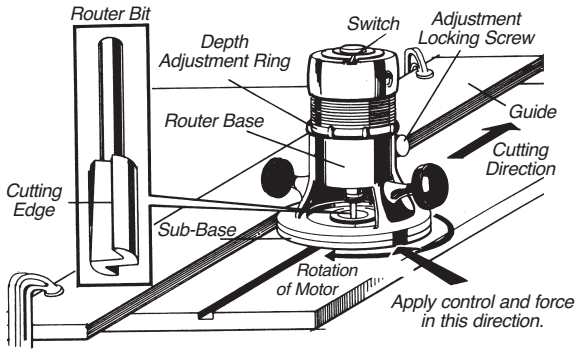


Figure 14
Router Parts and Operation

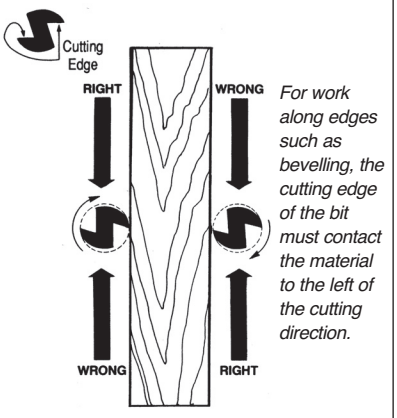
When starting a router with a trigger switch in the handle, keep both hands on the tool to absorb the counterclockwise starting torque.

When starting a router with a toggle switch on top of the motor, hold the router firmly with one hand and switch on power with the other, then put both hands on the tool for control and accuracy.

Always wear eye protection. You may also need hearing protection.

Operation

- Always support and secure the work in a fixed position by mechanical means such as a vise or clamps. Never try to hold the work down with your hand or knee. Never rely on a second person to hold the material. Human grip is no match for the torque and kickback that a router can generate.
- Make sure that the bit is securely mounted in the chuck and the base is tight.
- Set the base on the work, template, or guide and make sure that the bit can rotate freely before switching on the motor.



For work along edges such as bevelling, the cutting edge of the bit must contact the material to the left of the cutting direction.

Figure 15

- For work along edges such as bevels and moldings, make sure that the cutting edge of the router bit contacts the material to the ***left*** of the cutting direction (Figure 15). Otherwise the router will kick back or fly away from you.
- When routing outside edges, guide the router around the work in a counterclockwise direction (Figure 16). Splinters left at corners by routing ***across*** the grain will be removed by the next pass ***with*** the grain.
- Feed the router bit into the material at a firm but controllable speed. There is no rule on how fast to cut. When working with softwood, the router can

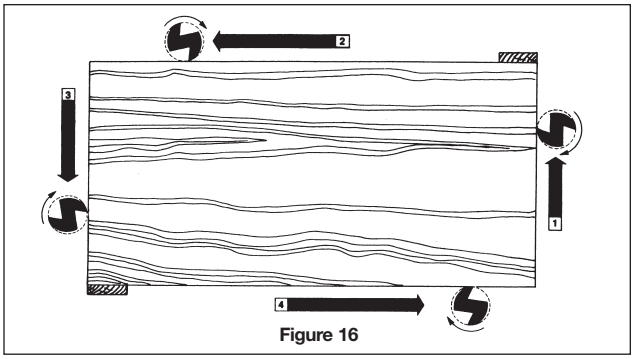


Figure 16

sometimes be moved as fast as it can go. Cutting may be very slow, however, with hardwood, knotty or twisted wood, and larger bits.

- Listen to the motor. When the router is fed into the material too slowly, the motor makes a high-pitched whine. Push too hard and the motor makes a low growling noise. Forcing the tool can cause burnout or kickback. Cutting through knots may cause slowdown or kickback.
- When the type of wood or size of bit requires going slow, make two or more passes to prevent the router from burning out or kicking back.
- If you're not sure about depth of cut or how many passes to make, test the router on a piece of scrap similar to the work.
- When the cut is complete, switch off power and keep both hands on the router until the motor stops. When lifting the tool from the work, avoid contact with the bit.

38 POWER TOOLS – SAWS

The saws covered in this chapter are

– circular
– sabre
– chain
– chop
– quick-cut
– table
– radial arm

Basic Saw Safety

- Wear protective clothing and equipment (see the chapters on personal protective equipment in this manual). Eye protection is essential.
- Where saws are used in confined spaces or for prolonged periods, wear hearing protection.

Tool	Minimum Noise Level (dBA)
Brick Saw	94
Chop Saw/Mitre Saw	92
Circular Saw	88
Concrete Saw	98
Cutoff Saw	98
Framing Saw	82
Jigsaw	91
Portable Handheld Band Saw	83
Quick-Cut Saw	105
Reciprocating Saw	105

- Where ventilation is inadequate, wear a dust mask for protection against dust. Over time, exposure to dust from particle board and other materials may cause respiratory problems.
- With electric saws operated outdoors or in wet locations, you must use a ground fault circuit interrupter.
- Never wear loose clothing, neck chains, scarves, or anything else that can get caught in the saw.
- Leave safety devices in place and intact on the saw. Never remove, modify, or defeat guards. Keep your free hand away from the blade (Figure 1).

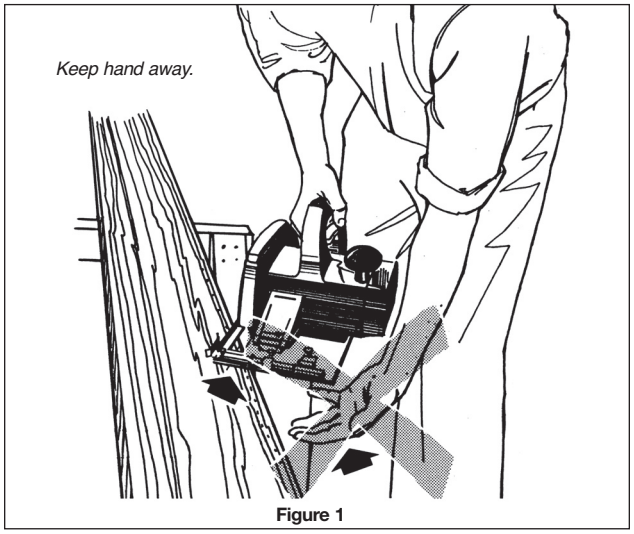
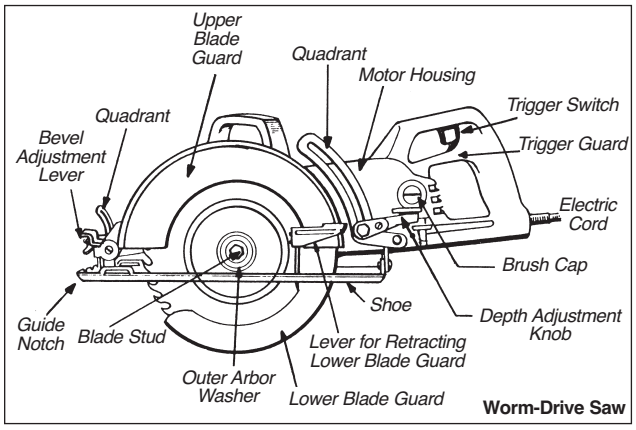
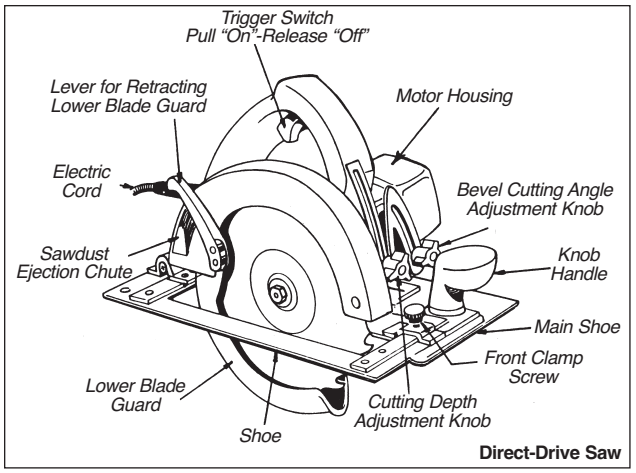


Figure 1

- Whenever possible, select the lightest tool or the tool with the least vibration. Wear anti-vibration gloves if provided by the employer.
- Always change and adjust blades with the power OFF. Disconnect electric saws from the power source before making changes or adjustments.



Worm-Drive Saw



Direct-Drive Saw

Circular Handsaws

The two models most often used on construction sites are illustrated above. The main difference between the two lies in the drive action. The worm-drive saw has gears arranged so that the blade runs parallel to the motor shaft. The direct-drive saw has the blade at a right angle to the motor shaft.

The worm-drive saw periodically requires special gear oil to keep the inner gears lubricated. This requirement is usually eliminated in the direct-drive saw, which has sealed bearings and gears.

Both saws must be inspected regularly for defects, and operated and maintained in accordance with manufacturers' recommendations.

Check for

– damaged cord
– faulty guards
– chipped or missing teeth
– loose blade
– defective trigger
– cracked or damaged casing

Safety Features

Sawdust Ejection Chute

This feature prevents sawdust from collecting in front of the saw and obscuring the cutting line. The operator can continue cutting without having to stop the saw and clear away sawdust.

Clutch

Some worm-drive saws are equipped with a clutch to prevent kickback. Kickback occurs when a saw meets resistance and violently backs out of the work. The clutch action allows the blade shaft to continue turning when the blade meets resistance. The blade stud and friction washer can be adjusted to provide kickback protection for cutting different materials. Check friction washers for wear.

Brake

An electric brake on some circular saws stops the blade from coasting once the switch is released. This greatly reduces the danger of accidental contact.

Trigger Safety

On some light-duty saws, a latch prevents the operator from accidentally starting the motor. The trigger on the inside of the handle cannot be pressed without first pressing a latch on the outside of the handle. On heavy-duty saws, a bar under the trigger switch helps to prevent accidental starting.

Blades

Blades should be sharpened or changed frequently to prolong saw life, increase production, and reduce operator fatigue. The teeth on a dull or abused blade will turn blue from overheating. Cutting will create a burning smell. Such blades should be discarded or reconditioned.

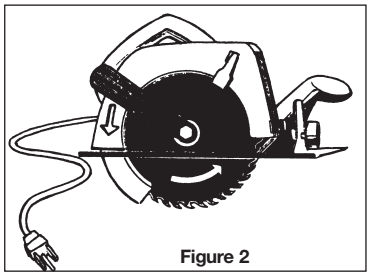


Figure 2

Before changing or adjusting blades, disconnect the saw from the power source.

Take care to choose the right blade for the job. Blades are available in a variety of styles and tooth sizes. Combination blades (rip and crosscut) are the most widely used.

Ensure that arbor diameter and blade diameter are right for the saw.

Because all lumber is not new, make sure it is clean and free of nails, concrete, and other foreign objects. This precaution not only prolongs blade life but may also prevent serious injury.

Take special care to ensure that blades are installed in the proper rotational direction (Figure 2). Remember that electrical circular handsaws cut with an upward motion. The teeth visible between the upper and lower guard should be pointing toward the front of the saw. Most models have a directional arrow on both blade and guard to serve as a guide.

Blade Guards

Never operate an electric saw with the lower guard tied or wedged open. The saw may kick back and cut you, or another worker may pick up the saw and—not knowing that the guard is pinned back—get hurt.

Accidents have also occurred when the operator forgot that the blade was exposed and put the saw on the floor. The blade, still in motion, forced the saw to move, cutting anything in its path.

Make sure that the lower guard returns to its proper position after a cut. Never operate a saw with a defective guard-retracting lever.

On most saws, the lower guard is spring-loaded and correct tension in the spring will automatically close the guard. However, a spring weakened by use and wear can allow the guard to remain open after cutting. This creates a potential for injury if the operator does not realize that the blade is still turning and rests it against a leg, for example. Always maintain complete control of the saw until the blade stops turning. The guard may also be slow to return after 45° cuts.

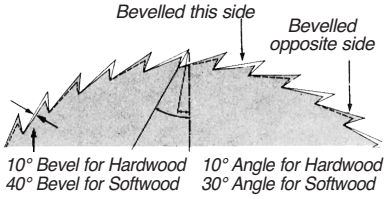
Choosing the Proper Blade

For safety, saw operators must understand the different designs and uses of blades (Figure 3). Blades unsuited for the job can be as hazardous as dull blades. For instance, a saw fitted with the wrong blade for the job can run hot so quickly that blade tension changes and creates a wobbly motion. The saw may kick back dangerously before the operator can switch it off.

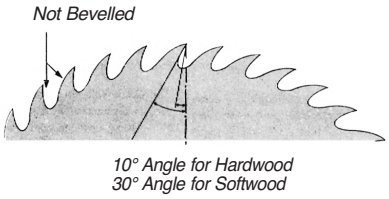
Resharpened blades can be substantially reduced in diameter—for instance, from nine to eight inches. Make sure that the blade diameter and arbor diameter are right for the saw.

Carbide-Tipped Blades – Take special care not to strike metal when using a carbide-tipped blade. The carbide tips can come loose and fly off, ruining the blade and injuring the operator. Inspect the blade regularly for cracked or missing tips.

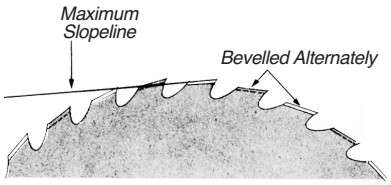
Crosscut Blade — The bevelled sharp-pointed teeth are designed to cut the crossgrain in wood. Size and bevel of the teeth are important factors in cutting different woods. Softwood requires bigger teeth to carry off the sawdust. Hardwood requires fine teeth with many cutting edges. Note the different angles and edges needed for cutting hardwood and softwood.



Ripsaw Blade — The flat sharp teeth are designed to cut the long grain in wood. They are neither bevelled nor needle-pointed. Needle-pointed teeth would get clogged and the blade would become overheated. Never use a ripsaw blade for crosscutting or for cutting plywood. The material can jam and overheat the blade or splinter in long slivers that may seriously injure the operator.



Combination Blade
This blade combines features of the crosscut and ripsaw blades. It can be used for crosscutting and ripping, or for cutting plywood. Carpenters on construction sites prefer the combination blade for rough woodwork such as stud walls and formwork because they don't have to change blades. The teeth are alternately bevelled and have a straight front. The heel of each tooth is not lower than the heel of the tooth on either side of it.



Standard Combination or Mitre Blade
This is mainly used by trim carpenters. It includes teeth for crosscutting, raker teeth for ripping, and deep gullets for carrying off sawdust. The blade can be used for cutting both hardwood and softwood and for mitring.

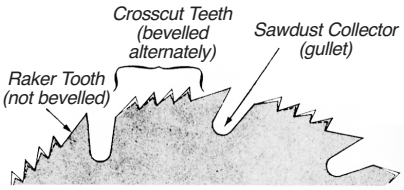


Figure 3

Changing, Adjusting, and Setting Blades

When changing blades, take the following precautions.

1. Disconnect the saw from the power source.
2. Place the saw blade on a piece of scrap lumber and press down until the teeth dig into the wood (Figure 4). This prevents the blade from turning when the locking nut is loosened or tightened. Some machines are provided with a mechanical locking device.
3. Make sure that keys and adjusting wrenches are removed before operating the saw.

Proper adjustment of cutting depth keeps blade friction to a minimum, removes sawdust from the cut, and results in cool cutting.

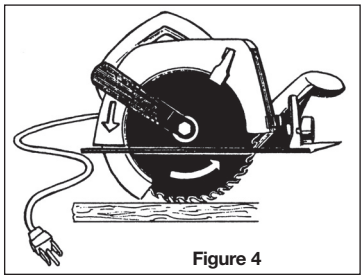


Figure 4

The blade should project the depth of one full tooth below the material to be cut (Figure 5). When using carbide-tipped blades or mitre blades let only half a tooth project below the material. If the blade is to run freely in the kerf (saw cut), teeth must be set properly, that is, bent alternately (Figure 6). The setting of teeth differs from one type of blade to another. Finer-toothed blades require less set than rougher-toothed blades.

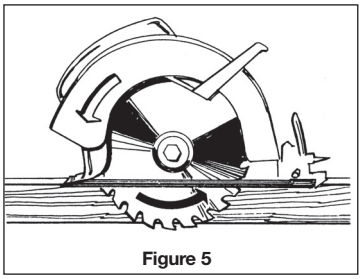


Figure 5

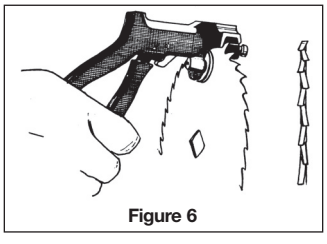


Figure 6

Generally, teeth should be alternately bent 1/2 times the thickness of the blade.

Sharp blades with properly set teeth will reduce the chance of wood binding. They will also prevent the saw from overheating and kicking back.

Cutting

Place the material to be cut on a rigid support such as a bench or two or more sawhorses. Make sure that the blade will clear the supporting surface and the power cord. The wide part of the saw shoe should rest on the supported side of the cut if possible.

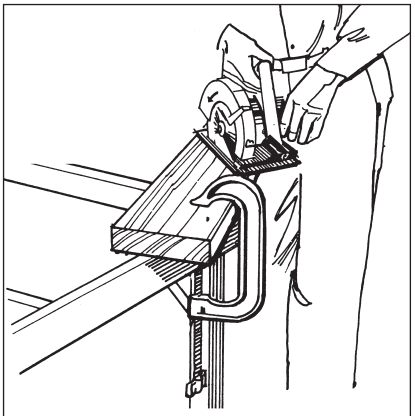


Figure 7

Plywood is one of the most difficult materials to cut with any type of saw. The overall size of the sheet and the internal stresses released by cutting are the main causes of difficulty. Large sheets should be supported in at least three places, with one support next to the cut.

Short pieces of material should not be held by hand. Use some form of clamping to hold the material down when cutting it (Figure 7).

NEVER use your foot or leg to support the material being cut. Too many operators have been seriously injured by this careless act.

The material to be cut should be placed with its good side down, if possible. Because the blade cuts upward into the material, any splintering will be on the side which is uppermost.

Use just enough force to let the blade cut without labouring. Hardness and toughness can vary in the same piece of material, and a knotty or wet section can put a heavier load on the saw. When this happens, reduce pressure to keep the speed of the blade constant. Forcing the saw beyond its capacity will result in rough and inaccurate cuts. It will also overheat the motor and the saw blade.

Take the saw to the material. Never place the saw in a fixed, upside-down position and feed material into it. Use a table saw instead.

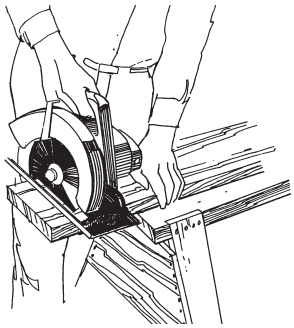
If the cut gets off line, don't force the saw back onto line. Withdraw the blade and either start over on the same line or begin on a new line.

If cutting right-handed, keep the cord on that side of your body. Stand to one side of the cutting line. **Never reach under the material being cut.**

Always keep your free hand on the long side of the lumber and clear of the saw. Maintain a firm, well-balanced stance, particularly when working on uneven footing.

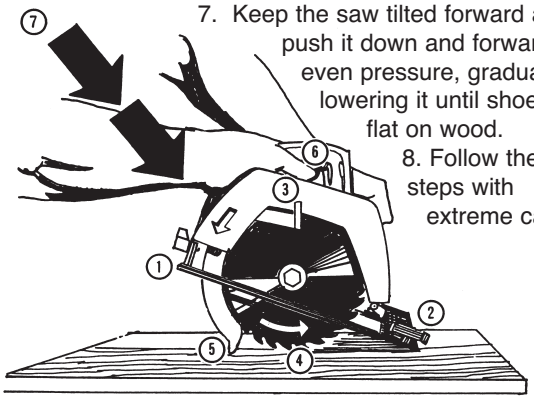
Plywood, wet lumber, and lumber with a twisted grain tend to tighten around a blade and may cause kickback. Kickback occurs when an electric saw stalls suddenly and jerks back toward the operator. The momentarily exposed blade may cause severe injury.

Use extreme caution and don't relax your grip on the saw.



Pocket Cutting

1. Tilt saw forward.
2. Rest front of shoe on wood.
3. Retract lower guard.
4. Lower saw until front teeth almost touch wood.
5. Release guard to rest on wood.
6. Switch on the saw.
7. Keep the saw tilted forward and push it down and forward with even pressure, gradually lowering it until shoe rests flat on wood.
8. Follow these steps with extreme care.



Sabre Saws

The sabre saw, or portable jigsaw (Figure 8), is designed for cutting external or internal contours. The saw should not be used for continuous or heavy cutting that can be done more safely and efficiently with a circular saw.

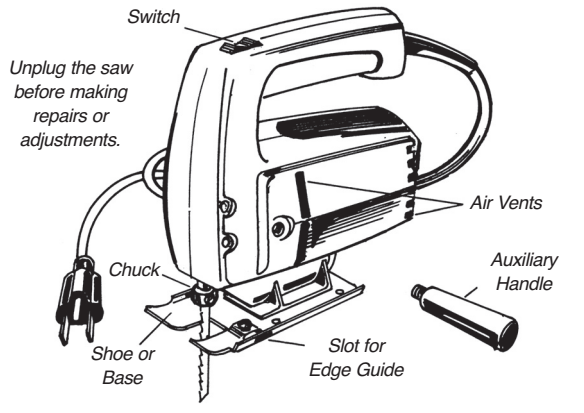


Figure 8 —Sabre Saw

The stroke of the sabre saw is about 1/2 inch for the light-duty model and about 3/4 inch for the heavy duty model. The one-speed saw operates at approximately 2,500 strokes per minute. The variable-speed saw can operate from one to 2,500 strokes per minute.

The reciprocating saw (Figure 9) is a heavier type of sabre saw with a larger and more rugged blade. The tool is often used by drywall and acoustical workers to cut holes in ceilings and walls. Equipped with a small swivel base, the saw can be used in corners or free-hand in hard-to-reach places. The reciprocating saw must be held with both hands to absorb vibration and to avoid accidental contact.

Eye protection is a must. You may also need respiratory protection.

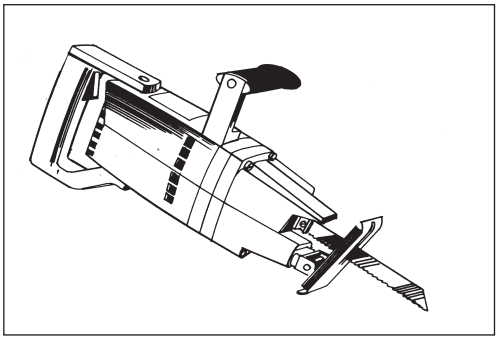
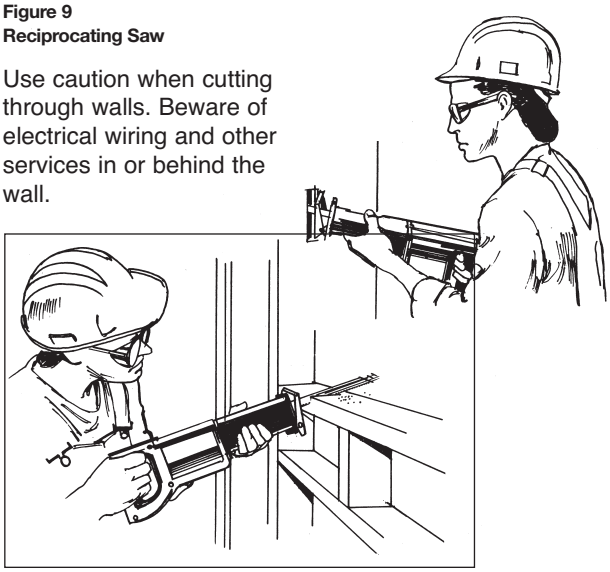


Figure 9
Reciprocating Saw

Use caution when cutting through walls. Beware of electrical wiring and other services in or behind the wall.



Choosing the Proper Blade

Various blades, ranging from 7 to 32 teeth per inch, are available for cutting different materials. For the rough cutting of stock such as softwood and composition board, a blade with 7 teeth per inch will cut the fastest. For all-round work with most types of wood, a blade with 10 teeth per inch is satisfactory.

Cutting

The sabre saw cuts on the upstroke. Splintering will therefore occur on the top side of the material being cut. Consequently, the good side should be facing down. The degree of splintering depends on the type of blade, the vibration of the material, and the feed of the saw.

To avoid vibration, the material should be clamped or otherwise secured and supported as close to the cutting line as possible. If the material vibrates excessively or shifts during cutting, the saw can run out of control, damaging the blade and injuring the operator.

- Before starting a cut, make sure that the saw will not contact clamps, the vise, workbench, or other support.
- Never reach under the material being cut.
- Never lay down the saw until the motor has stopped.
- Do not try to cut curves so tight that the blade will twist and break.
- Always hold the base or shoe of the saw in firm contact with the material being cut.

WARNING When sawing into floors, ceiling, or walls, always check for plumbing and wiring.

External Cut

To start an external cut (from the outside in), place the front of the shoe on the material (Figure 10). Make sure that the blade is not in contact with the material or the saw will stall when the motor starts.

Hold the saw firmly and switch it on. Feed the blade slowly into the material and maintain an even pressure. When the cut is complete, do not lay down the saw until the motor has stopped.

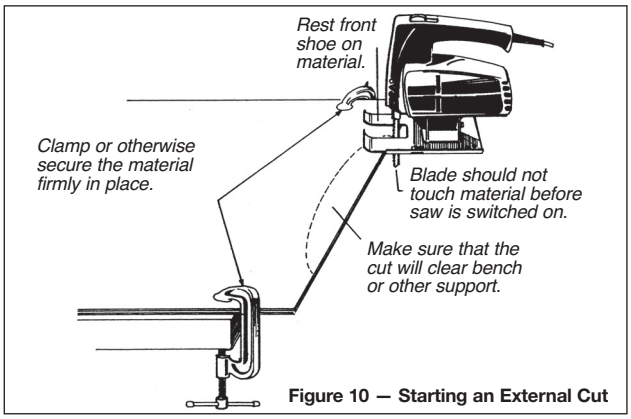


Figure 10 — Starting an External Cut

Inside Cuts

To start an inside cut (pocket cut), first drill a lead hole slightly larger than the saw blade (Figure 11). With the saw switched off, insert the blade into the hole until the shoe rests firmly on the material. Do not let the blade touch the material until the saw has been switched on.

It is possible to start an inside cut without drilling a lead hole first — but only when it's absolutely necessary. To do this, tip the tool forward so that the front edge of the shoe rests on the workpiece and the teeth of the blade face the material. Keep the blade out of contact with the material.

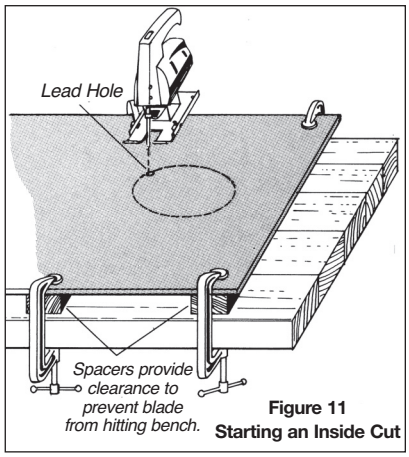


Figure 11 Starting an Inside Cut

Switch on the saw and slowly feed the blade into the material while lowering the back edge of the shoe. When the shoe rests flat on the material and the blade is completely through, proceed with the cut. Any deviation from this procedure can cause the blade to break and injure the operator or workers nearby.

Never try to insert a blade into, or withdraw a blade from, a cut or a lead hole while the motor is running.

Never reach under the material being cut.

Chainsaws

Each year in Ontario, construction workers are injured while using chainsaws. Generally the injuries result from two types of accidents:

1) the operator makes accidental contact with the revolving chain
2) the operator is struck by the object being cut, usually a tree or heavy limb.

Many of these injuries are serious.

While the chainsaw is relatively easy to operate, it can be lethal. As with all high-speed cutting tools, it demands the full attention of even the trained and experienced operator.

Requirements

Chainsaws can be powered by electric motors (Figure 12) or gasoline engines (Figure 13).

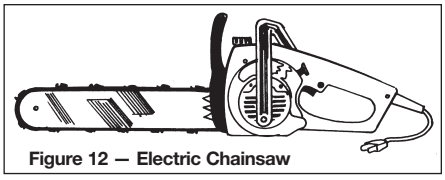


Figure 12 — Electric Chainsaw

Both saws are designed to provide fast cutting action with a minimum of binding in the cut, even though wood may be sap-filled or wet. Both afford about the same performance in terms of horsepower and they are equipped with similar controls and safety devices.

Regulations require that chainsaws used in construction must be equipped with a chain brake. Make sure that the saw is equipped with a chain brake mechanism, and not simply a hand guard, which is similar in appearance.

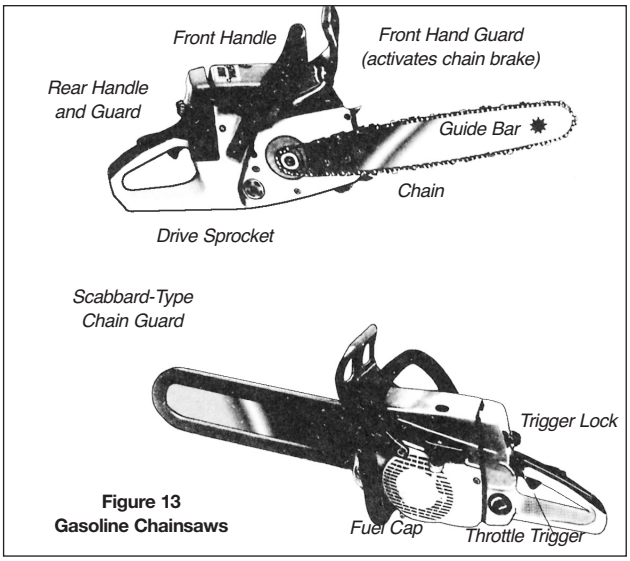


Figure 13 Gasoline Chainsaws

Regulations require that chainsaws used in construction must be equipped with “anti-kickback” chains. Called safety chains by the manufacturers, these chains incorporate design features intended to minimize kickback while maintaining cutting performance (Figure 14).

Protective Clothing and Equipment

- Eye protection in the form of plastic goggles is

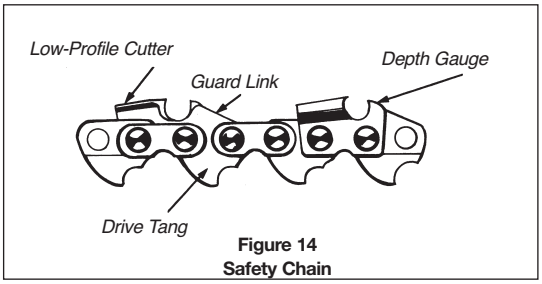


Figure 14
Safety Chain

  recommended. A faceshield attached to the hard hat will not provide the total eye protection of close-fitting goggles.
- Leather gloves offer a good grip on the saw, protect the hands, and absorb some vibration. Gloves with ballistic nylon reinforcement on the back of the hand are recommended.
- Since most chainsaws develop a high decibel rating (between 95 and 115 dBA depending on age and condition), adequate hearing protection must be worn, especially during prolonged exposure.
- Trousers or chaps with sewn-in ballistic nylon pads provide excellent protection, particularly for the worker who regularly uses a chainsaw.

Kickback

Kickback describes the violent motion of the saw that can result when a rotating chain is unexpectedly interrupted. The cutting chain’s forward movement is halted and energy is transferred to the saw, throwing it back from the cut toward the operator.

The most common and probably most violent kickback occurs when contact is made in the “kickback zone” (Figure 15).

Contact in this zone makes the chain bunch up and try to climb out of the track. This most often happens when the

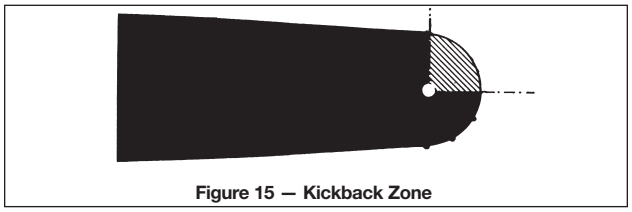


Figure 15 — Kickback Zone

saw tip makes contact with something beyond the cutting area such as a tree branch, log, or the ground.

To minimize the risk of kickback, follow these practices.

- Use a low-profile safety chain.
- Run the saw at high rpm when cutting.
- Sharpen the chain to correct specifications.
- Set depth gauges to manufacturers’ settings.
- Maintain correct chain tension.
- Hold the saw securely with both hands.
- Don’t operate the saw when you are tired.
- Know where the bar tip is at all times.
- Don’t allow the cut to close on the saw.
- Make sure the chain brake is functioning.

Starting

When starting, hold the saw firmly on the ground or other level support with the chain pointing away from your body and nearby obstructions. Use a quick, sharp motion on the starter pull (Figure 16). Never “drop start” the saw. This leaves only one hand to control a running saw and has resulted in leg cuts. Use the proper grip (Figure 17).

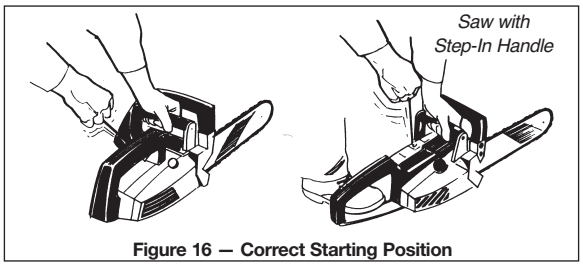


Figure 16 — Correct Starting Position

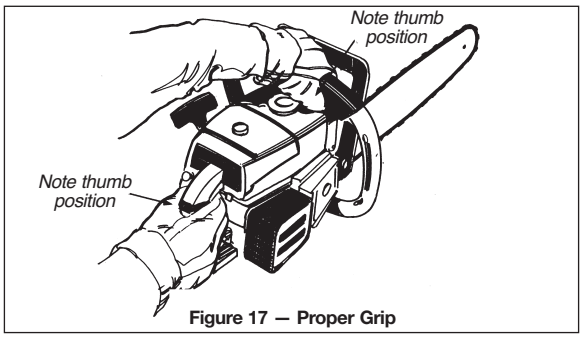
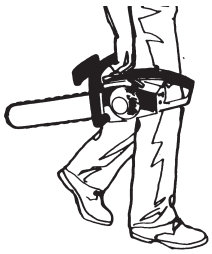


Figure 17 — Proper Grip

Site Hazards

Before moving from place to place, shut off the saw and walk with the guide bar pointed backwards. A trip or a stumble with a running saw can cause serious injury.



- Take extra care when making pocket cuts (Figure 18). Start the cut with the underside of the chain tip, then work the saw down and back to avoid contact with the kickback zone. Consider an alternative tool such as a sabre saw.

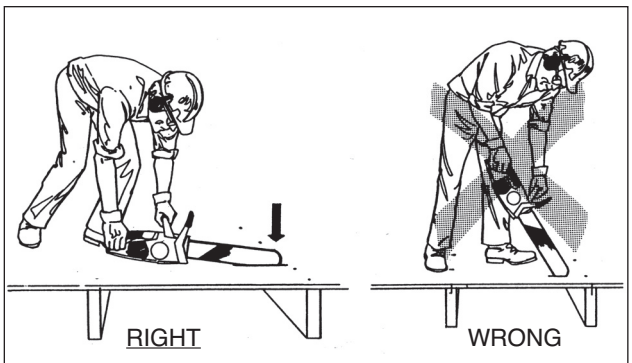


Figure 18 — Pocket Cuts

- Be particularly careful to avoid contact with nails, piping, and other metallic objects. This is especially important when making a pocket cut through framing lumber such as for a subfloor or when cutting used lumber such as for trench shoring, lagging, or blocking timbers.
- Use chainsaws to cut wood only. They are not designed to cut other materials.
- When using a chainsaw to trim rafter ends, take the following steps to avoid injury:
  – Cut down from the top of the rafter. Don't cut from underneath.
  – When performing a pocket cut, you could be creating a fall hazard. Make sure you use fall protection to avoid this hazard.
  – Work from a secure scaffold at eaves level.
  – The extension cord on an electric chainsaw should be secured on the roof above the operator with enough working slack. This will prevent the weight of a long cord from pulling the operator off balance.
  – Keep both hands firmly on the saw.

Maintenance

Well-maintained cutting components are essential for safe operation. A dull or improperly filed chain will increase the risk of kickback.

- Inspect and maintain your saw according to the manufacturer's recommendations regarding chain tension, wear, replacement, etc. Check for excessive chain wear and replace chain when required. Worn chains may break.
- Select the proper size files for sharpening the chain. Two files are necessary:
  1) a flat file for adjusting depth gauge
  2) a round file of uniform diameter for sharpening cutters and maintaining drive links.

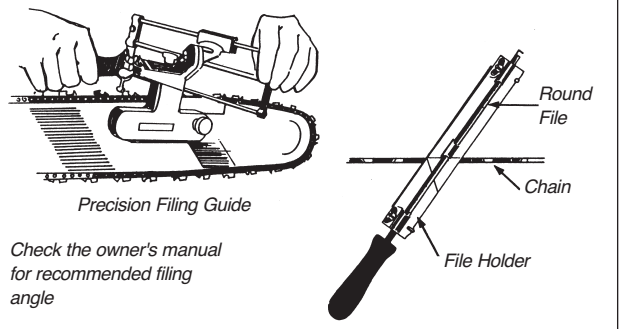


Figure 19 — Sharpening Tools

- You must choose the correct round file for your chain to avoid damaging the cutters. Consult the owner's manual or the supplier to be sure of file size.
- A round file used in combination with a file holder or, better yet, a precision filing guide will give the best results (Figure 19).

Adjusting Chain Tension

- Follow the manufacturer's instructions on chain tension.
- In general, the chain should move easily around the bar by hand without showing noticeable sag at the bottom (Figure 20).
- Be generous with chain lubricating oil. It is almost impossible to use too much. Most late model saws have automatic oilers. **But operators must still remember to fill the chain-oil reservoir.**

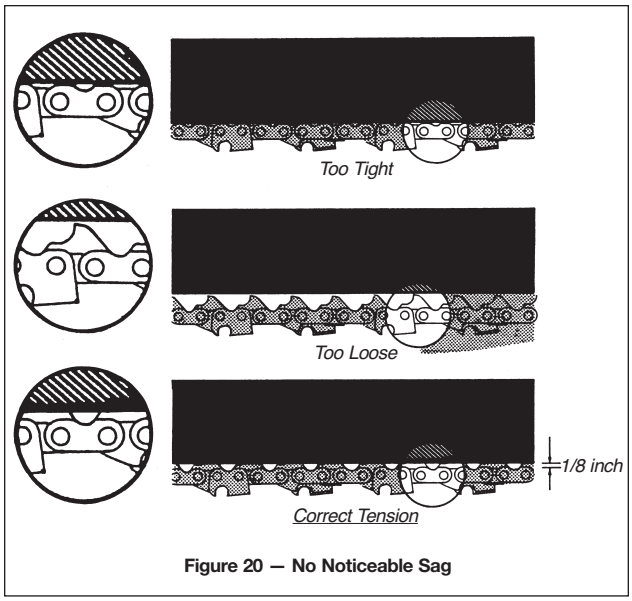


Figure 20 — No Noticeable Sag

Chop Saws

Increasingly, carpenters and other trades are using chop saws to cut various materials (Figure 21). These portable saws offer quick, efficient, and economical cutting.

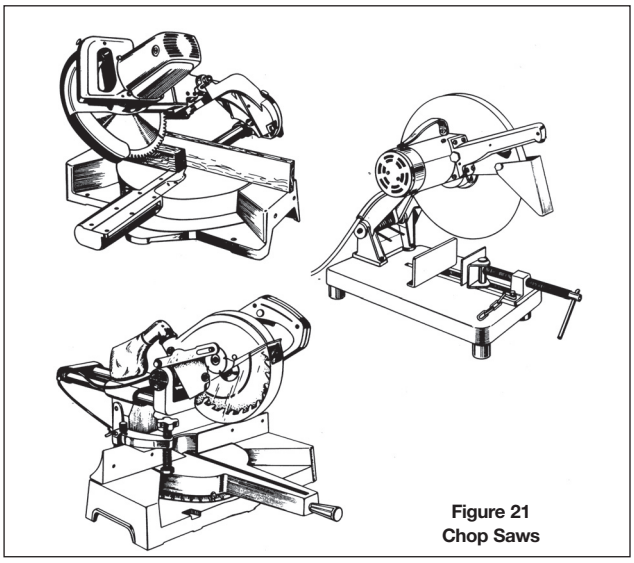


Figure 21
Chop Saws

Unfortunately, like all power equipment, chop saws pose serious hazards for the unwary or untrained operator. Follow **Basic Saw Safety** (at the beginning of this chapter) and **Safety Basics** (at the beginning of the chapter on "Power Tools – Drills, Planes, Routers), the same as for other power saws.

Most of these saws are equipped with abrasive wheels for quick cutting through metal studs and other material.

- Select the proper abrasive cutting wheel for the material being cut. For metals, use aluminum oxide. For masonry, stone, and concrete, use silica carborundum.
- The rpm of the saw should not exceed the recommended rpm printed on the blade label.

- The centre hole on the blade must fit the mandril and be snugly fastened in place with the proper washer and lock nut.

Warning A loose or off-centre blade can shatter in use.

- Position material to be cut at 90 degrees to the blade. Support the other end to prevent the blade from binding.
- Do not rush cutting. Let the wheel cut without burning or jamming.
- When cutting is complete, let the blade stop before moving material.
- Maintain the saw in good repair with the blade guard in place and working smoothly. Tighten any loose parts and replace any broken or damaged ones.
- Don't try to adjust for length on the downward cutting motion. Your hand could slide into the blade while it is spinning.
- With some large chop saws (Figure 22), additional precautions are required because of the tremendous torque the saws can develop.
- Beware of sparks landing on combustible material.

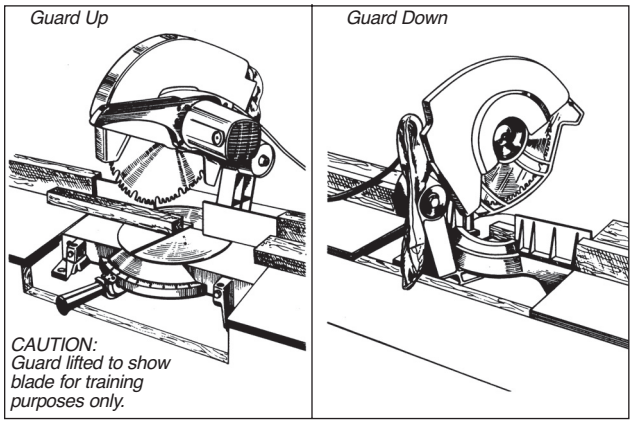


Figure 22 — Some large chop saws may require additional precautions

Quick-Cut Saws

Hand-held portable circular cut-off saws are commonly known as "quick-cut saws" in construction (Figure 23). They are widely used for cutting concrete, masonry products, sheet metal products (both steel and aluminum), and light steel sections such as angles and channels.

Hazards

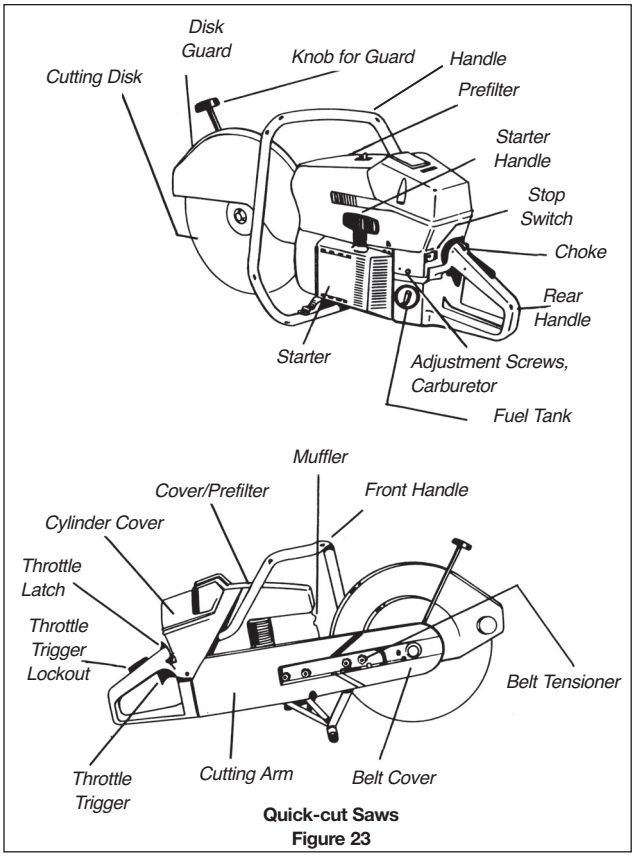
Quick-cut saws are high-powered as compared to similar tools. Hazards include high-speed blade rotation, blade exposure during operation, and exhaust from the internal combustion engine (the usual power source).

The saws also create clouds of dust when dry-cutting masonry and showers of hot sparks when cutting metal products, especially steel.

These hazards can result in cuts, kickbacks, exposure to carbon monoxide fumes, exposure to dusts (silica from concrete and masonry products in particular), burns, flying particles hitting the eye, and other injuries from flying material when work is not secured for cutting or when blades fly apart.

These hazards can be controlled by

- training operators to use quick-cut saws properly and to wear the right protective equipment such as eye, hearing, and respiratory protection as well as face shields and gloves
- keeping saws in good working condition, equipping them with proper blades or disks, and using them with all guards in place
- securing work to keep it from shifting during cutting
- being cautious around sharp edges left by cuts.



Quick-cut Saws
Figure 23

Training

Operators should be instructed in the care, maintenance, and operation of quick-cut saws. They should read the operating manual, review the major points, and receive both oral and written instruction.

The operating manual should be available on the job, not only for instruction but also for ready reference if something goes wrong with the saw or it must be used for work outside the operator's experience.

Time spent on instruction will reduce accidents and injuries as well as prolong the service life of the saw.

As a minimum, the operator should be instructed in

- caring for the saw
- installing disks and blades
- mixing fuel and fueling the saw
- starting the saw
- supporting and securing work to be cut
- maintaining proper cutting stance and grip
- using proper cutting techniques for different material
- wearing respiratory protection against dusts
- learning how to inspect and store abrasive disks.

Care

Quick-cut saws must be serviced and maintained in accordance with the manufacturers' instructions.

Replacement parts should be those recommended by the manufacturer.

Cracked, broken, or worn parts should be replaced before the saw is used again. Guards and air intakes should be cleaned regularly and often. Abrasive disks should be checked before installation and frequently during use. Correct any excessive blade vibration before trying to make a cut.

In confined areas, make sure that ventilation is adequate. Gasoline-driven saws release carbon monoxide gas, which is odourless, colourless, and highly toxic.

Starting

Most of the following procedures are for gasoline-powered quick-cut saws—the type most commonly used in construction.

- Use caution when preparing the oil/gasoline mixture and when fuelling the saw. No smoking or ignition sources should be allowed in the area where fuel is mixed or tanks are filled.
- Fill the tank outdoors in a well-ventilated space at least 3 metres from the area where the saw will be used. Spilled fuel should be wiped off the saw.
- Avoid fuelling the saw on or near formwork. Gasoline spills are a fire hazard. Use a funnel to avoid spills.
- Do not overfill the saw or run it without securing the fuel tank cap. Gasoline seeping from the tank can saturate your clothing and be ignited by sparks thrown off from metal cutting. The only cap to use is one supplied by the manufacturer.
- Check the saw for leaks. Sometimes vibration makes gas lines leak.
- Start the saw in an area clear of people and obstacles. Under no circumstances should anyone be standing in front of the saw as it starts or while it's running.
- Put the saw on a smooth hard surface for starting. The guard should be properly set for the type of cut beforehand.
- Assume a solid well-balanced stance. Do not wrap the starter cord around your hand—this can cause injury.
- Set one foot on the rear handle, put one hand on the top handle to lift the blade off the surface, and use the other hand to pull the starter cord (Figure 24).

Warning: Always shut off saw before fuelling. Keep fuel container well clear of work area.

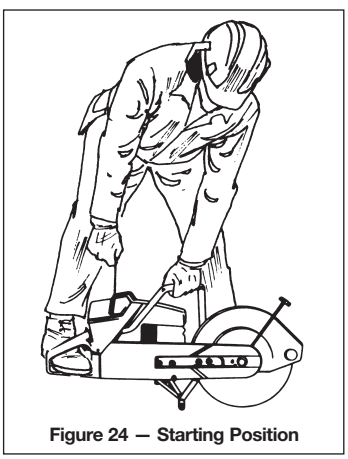


Figure 24 — Starting Position

- Once the saw is running, release the throttle and make sure the engine drops to idle without the disk or blade moving.
- Run the engine at full throttle and let the disk or blade run freely to make sure it turns on the arbor without wobbling or vibrating.

Support

One of the major hazards with quick-cut saws is failure to support and secure the work to be cut.

The saw is powerful enough to throw material around unless it is securely held and supported. Standing on material to hold it down is **not** recommended.

For repeated cuts of masonry or metal pieces, a jig is ideal for efficiency and safety. The jig should be designed and built to hold material in place after measurement without further manual contact (Figure 25).

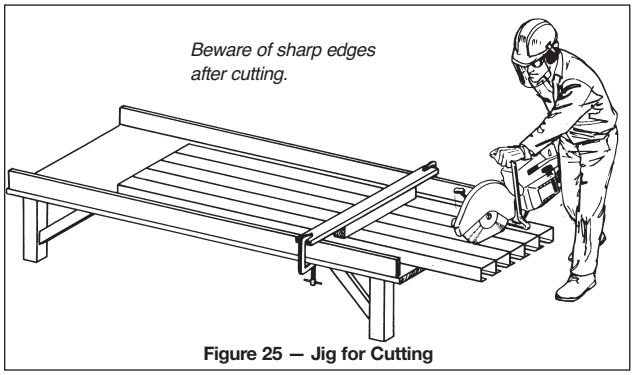


Figure 25 — Jig for Cutting

Stance and Grip

The quick-cut saw is a heavy, powerful tool that must be held by hand. Operators need a secure stance with legs apart for balance and support. The saw should be held at a comfortable, balanced location in front of the operator.

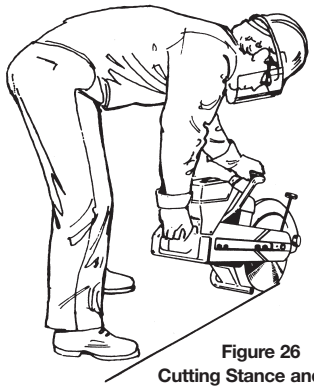


Figure 26
Cutting Stance and Grip

Grip the saw firmly with one hand on each handle. Hold your forward arm straight to keep the saw from kicking back or climbing out of the cut (Figure 26).

Cutting

Although skill in handling the quick-cut saw can only be learned through practice, some safety considerations and operating techniques must always be kept in mind, even by the most experienced operators.

Work should be supported so that the disk or blade will not bind in the cut. Support heavy materials on both sides

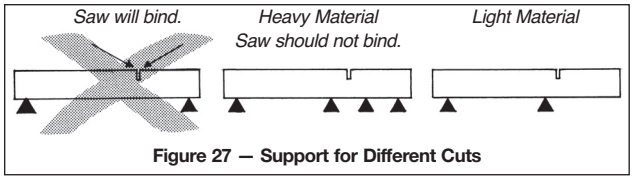


Figure 27 — Support for Different Cuts

of the cut so the cut piece will not drop or roll onto the operator's foot. Light materials can generally be allowed to fall. In all cases, the cut should be as close as possible to the supporting surface (Figure 27).

Kickback and Pull-In

Kickback can happen extremely fast and with tremendous power. If the segment of the disk or blade shown in Figure 28 contacts the work, the disk or blade starts to climb out of the cut and can throw the saw up and back toward the operator with great force.

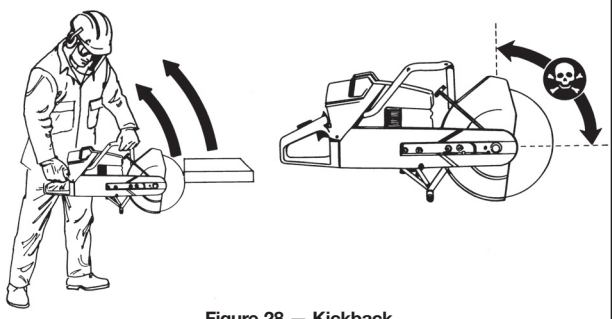


Figure 28 — Kickback

For cutting, keep the throttle wide open. Ease the blade down onto the cut line. Don't drop or jam the blade down hard. Move the saw slowly back and forth in the cut.

Hold the saw so that disk or blade is at right angles to the work and use only the cutting edge of the disk or blade (Figure 29). Never use the side of a disk for cutting. A worn disk will almost certainly shatter and may cause severe injury.

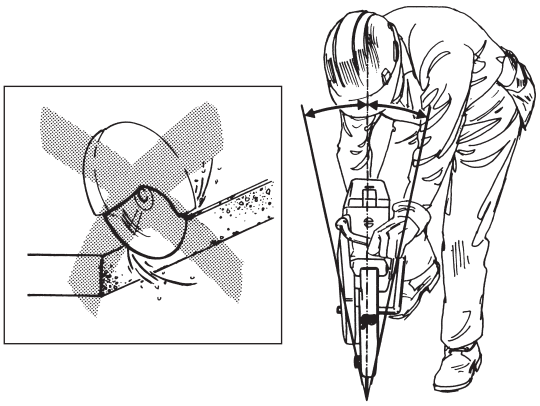


Figure 29 — Saw at Right Angles to Material

Beware of blade run-on. The blade may continue to rotate after the cut and run away with a saw set down too soon.

Don't force the saw to one side of the cut. This will bend the disk or blade and cause it to bind, possibly to break.

Water cooling is recommended for cutting masonry materials. It prolongs disk life and reduces dust exposure.

Keep pressure on the saw reasonably light. Although more pressure may be necessary for hard materials, it can cause an abrasive disk to chip or go “out of round.” This in turn will make the saw vibrate. If lowering the feed pressure does not stop the vibration, replace the disk.

Don't carry the saw any distance with the engine running. Stop the engine and carry the saw with the muffler away from you.

To avoid kickback, take the following steps:

- Secure and support the material at a comfortable position for cutting. Make sure that material will not move, shift, or pinch the blade or disk during cutting.
- Keep steady balance and solid footing when making a cut.
- Do not support the work on or against your foot or leg.
- Use both hands to control the saw. Maintain a firm grip with thumb and fingers encircling the handles.
- Never let the upper quarter segment of blade or disk contact the material.
- Run the saw at full throttle.
- Do not cut above chest height.
- When reentering a cut, do so without causing the blade or disk to pinch.

Pull-in occurs when the lower part of the disk or blade is stopped suddenly—for instance, by a cut closing up and binding. The saw pitches forward and can pull the operator off balance.

Protective Equipment

In addition to the standard equipment mandatory on construction sites, operators of quick-cut saws should wear snug-fitting clothing, hearing protection, eye and face protection, and heavy-duty leather gloves (Figure 30).

The dry cutting of masonry or concrete products calls for respiratory protection as well. (See the chapters on personal protective equipment in this manual.)

For general dust hazards, a half-mask cartridge respirator with NIOSH-approval for dust, mist, and fumes should provide adequate protection when properly fitted and worn by a cleanshaven person.

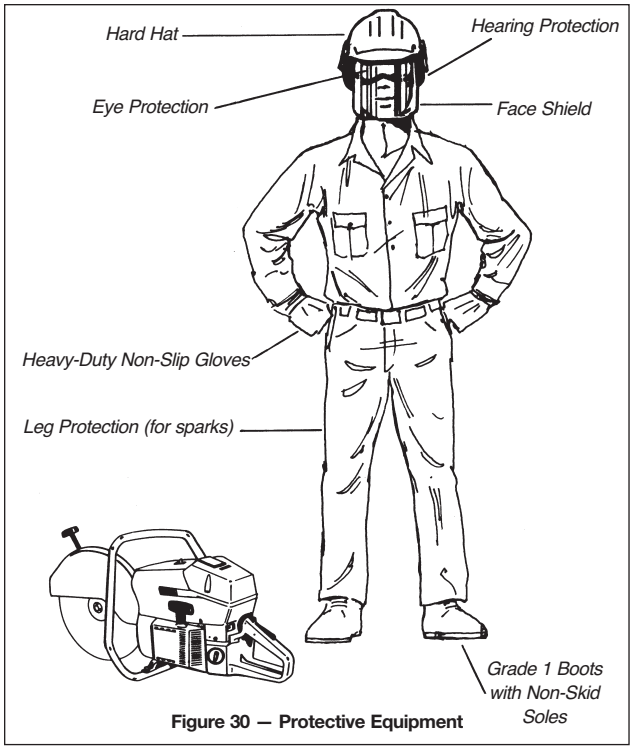


Figure 30 — Protective Equipment

Disks and Blades

Disks and blades are available in three basic types:

– abrasive disks
– diamond-tipped blades
– carbide-tipped blades.

Use only the disks and blades compatible with your saw and rated for its maximum rpm. Blades or disks may fly apart if their rpm is not matched to saw rpm. If you have any doubts, consult the operating manual or a reputable supplier.

Abrasive Disks — Types and Uses

Type	Uses	Materials
Concrete	All-around use, most economical for cutting concrete and masonry. **Water-cooling recommended to increase disk life and reduce dust.**	Concrete, stone, masonry products, cast iron, aluminum, copper, brass, cables, hard rubber, plastics.
Metal	Primarily for steel, not suited for masonry products. Water-cooling is not recommended with metal abrasive disks.	Steel, steel alloys, other hard metals such as cast iron.

Diamond Disks and Blades

Diamond disks are normally used with water cooling. They are now available for dry cutting, which may be necessary to avoid staining some masonry products.

When dry-cutting with a diamond blade, let the blade cool for 10–15 seconds every 40–60 seconds. This can be done simply by pulling the saw out of the cut.

Types and Uses

Type	Uses	Materials
Diamond Abrasive Disk	Cuts faster than other abrasive disks and creates less dust. **Water-cooling is absolutely necessary to prevent heat build-up that can make disk disintegrate.**	Stone, all masonry and concrete products. Not recommended for metals.
Dry-Cut Diamond Blade	Fast cuts, lots of dust, very expensive. Let blade cool for 10–15 seconds every 40–60 seconds. Continuous cutting will damage the blade.	Stone, all masonry and concrete products. Not recommended for metals.

Carbide-Tipped Blades

These blades must be used with care. If a carbide-tipped blade encounters material harder than what it is designed to cut, the tips may fly off.

A carbide-tipped blade used with a quick-cut saw **must** be designed for that purpose. It must also be used only to cut the materials specified by the manufacturer.

Inspection/Installation

Inspect disks and blades before installing them.

- Make sure that contact surfaces are flat, run true on the arbor, and are free of foreign material.

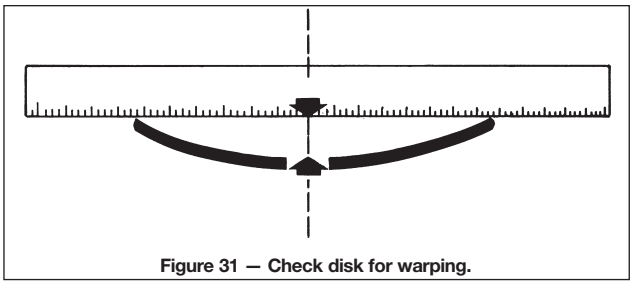


Figure 31 — Check disk for warping.

- Check that flanges are the correct size and not warped or sprung (Figure 31).
- Check the label to make sure that the disk or blade is approved for use on high-speed quick-cut saws and has a rated rpm suitable to the saw being used. A periodic service check may be necessary to ensure that the rpm still meets the manufacturer's requirement.
- Inspect the disk or blade for damage. Abrasive disks tapped lightly with a piece of wood should ring true. If the sound is dull or flat, the disk is damaged and should be discarded.
- Make sure that diamond or carbide tips are all in place. Do not use diamond or carbide-tipped blades or disks if any tips are missing.
- Do not drop abrasive disks. Discard any disk that has been dropped.
- Use the proper bushing on the arbor so that the disk runs true on the shaft without wobbling or vibrating.
- Discard badly worn disks that are uneven or "out of round."

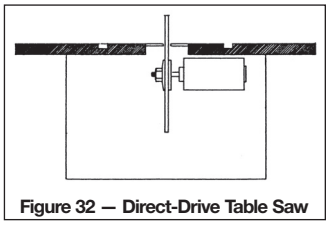


Figure 32 — Direct-Drive Table Saw

Table Saws

Types

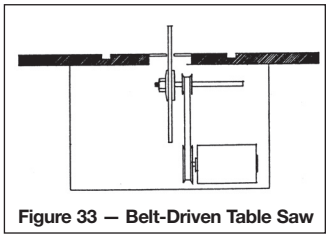


Figure 33 — Belt-Driven Table Saw

The table saw most often used in construction is the 10-inch belt-driven tilting arbor saw. The dimension refers to the diameter of the saw blade recommended by the manufacturer.

Although some saws are direct-drive (Figure 32), with the blade mounted right on the motor arbor, most are belt-driven (Figure 33).

Both types are equipped with a fixed table top and an arbor that can be raised, lowered, or tilted to one side for cutting at different depths and angles.

Basket Guards

Basket guards may be fastened to the splitter or hinged to either side of the saw on an L-shaped or S-shaped arm (Figure 34).

Basket guards can protect the operator from sawdust, splinters, and accidental contact with the blade. Keep the basket guard in place for normal operations such as straight and bevel ripping and mitre cutting. When the guard is removed to permit cutting of tenons, finger joints, rabbets, and similar work, use accessories such as feather boards, holding jigs, push sticks, and saw covers.

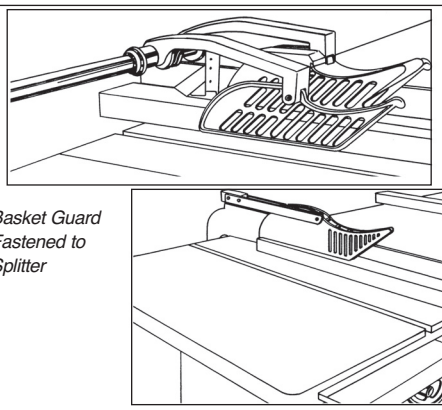


Figure 34 — Basket Guards

Figure 35 shows a split basket guard with a see-through cover. One side can be moved sideways for a blade tilted to 45 degrees. One side can be lifted up while the other remains as a protective cover.

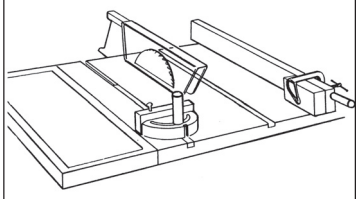


Figure 35
See-Through Plastic Basket Guard

Sheet metal baskets fastened to the splitter are less effective because the operator cannot see the saw blade.

Kickback

Kickback occurs when stock binds against the saw blade. The blade can fire the wood back at the operator with tremendous force, causing major injuries to abdomen, legs, and hands.

- Never stand directly behind the blade when cutting. Stand to one side. See that other workers stand clear as well.
- Make sure the rip fence is aligned for slightly more clearance behind the blade than in front. This will help prevent binding.
- Use a sharp blade with teeth properly set for the wood being cut. A dull or badly gummed blade will cause friction, overheating, and binding.
- Install a splitter to keep the kerf (cut) open behind the blade. Also effective are anti-kickback fingers attached to the splitter.

Splitters

Splitters prevent the kerf from closing directly behind the blade. Ideally, they should be slightly thinner than the saw blade and manufactured from high tensile steel.

Splitters are not always needed with carbide-tipped saw blades, whose relatively wide kerf may provide the desirable clearance. A wide kerf alone, however, is often not enough to keep some boards from closing behind the cut and binding against the blade.

In general, it is impossible to predict how a board will behave during ripping. It may remain straight, presenting no problems. On the other hand, the release of internal stresses may make the two ripped portions behind the blade either close up or spread apart.

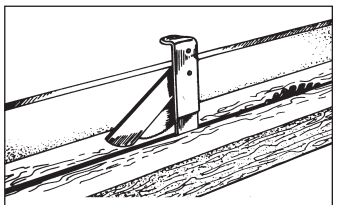


Figure 36 — Disappearing Splitter with Anti-Kickback Fingers

Figure 36 shows a disappearing splitter with anti-kickback fingers. It can be pushed down when in the way of a workpiece and pulled up when necessary after the machine has been shut off.

Roller Stand

Operators risk injury trying to maintain control over long pieces of stock singlehandedly, especially if the stock begins to bind on the blade and kick back.

A roller stand (Figure 37) provides the needed support. Adjust it to a height slightly lower than the saw table to allow for sagging of the material. Be sure to set up the stand so the roller axis is at 90 degrees to the blade. Otherwise, the roller could pull the stock off to one side and cause binding.

Whatever the design, a support stand should be standard equipment in every carpentry and millwork shop. It can be used as an extension to a workbench, jointer, or bandsaw and is especially important with the table saw.

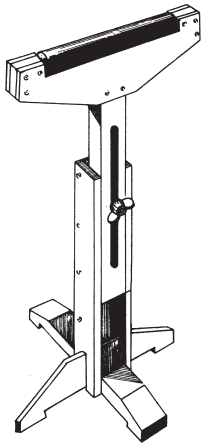


Figure 37 — Roller Stand

Extensions

Made of wood or metal, table top extensions installed behind and to both sides of the machine can make the cutting of large sheets of plywood and long stock safer and more efficient.

In most cases, a space must be provided between the extension and saw top for adjusting the basket guard and allowing scrap to fall clear.

Blades

Table saw blades are basically similar to those for circular saws.

The teeth on carbide-tipped, hollow-ground, and taper blades do not need setting (Figure 38).

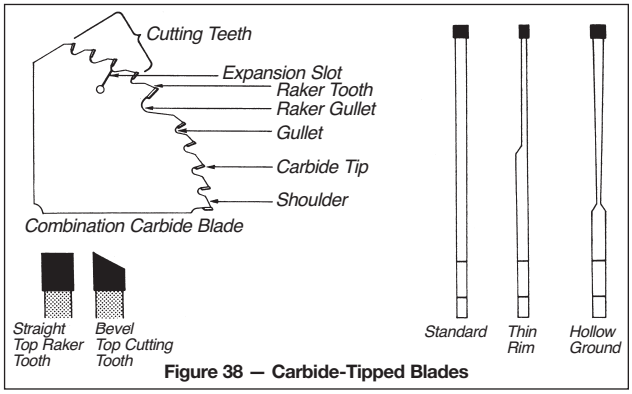


Figure 38 — Carbide-Tipped Blades

Blade Adjustment

Proper adjustment of cutting depth holds blade friction to a minimum, removes sawdust from the cut, and results in cool cutting.

Sharp blades with properly set teeth will keep the work from binding and the blade from overheating and kicking back.

The blade should project the depth of one full tooth above the material to be cut. When using carbide-tipped blades or mitre blades, let only half a tooth project above the material.

Blade Speed

The right cutting speed is important. The blade should turn at the correct rpm to yield the recommended cutting speed.

When not in motion, saw blades, especially large blades, are usually not perfectly flat because of internal tensions. At the right operating speeds, however, the blades straighten out as a result of centrifugal force and cut smoothly at full capacity.

Blades running too fast or too slow tend to start wobbling either before or during a cut. If cutting continues, the blade will overheat and may kick back, damaging the equipment, and injuring the operator.

Rip Fence

The rip fence is used mainly to guide the stock and maintain correct width of cut. The fence on small saws is usually clamped down at both the front and back of the table by pushing down a lever or turning a knob. Adjust the fence slightly wider at the back to let the wood spread out behind the cut and reduce the risk of kickback.

Many carpenters add a piece of hardwood to the rip fence in order to rip thin pieces of wood and make dadoes and rabbets. The auxiliary fence can be set close to the cutters without the risk of contact between the blade and the steel fence.

Pushsticks

Narrow pieces can be cut safely and efficiently with the help of pushsticks (Figure 39), which should be painted or otherwise marked to prevent loss.

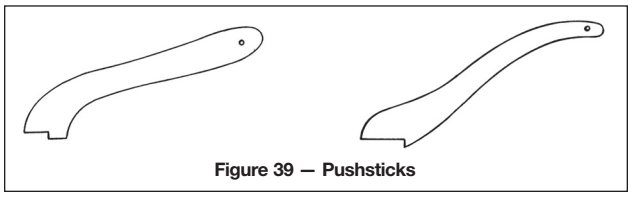


Figure 39 — Pushsticks

To rip narrow, short pieces, a push block is the right choice (Figure 40). The shoe holds the material down on the table while the heel moves the stock forward and keeps it from kicking back.

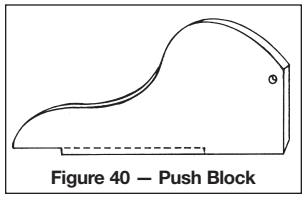


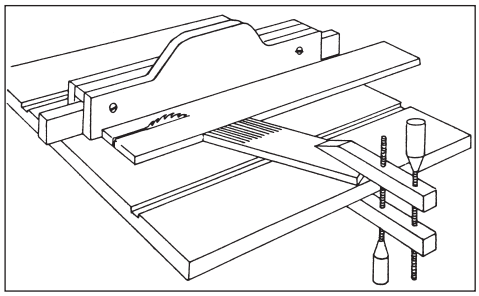
Figure 40 — Push Block

Different designs of pushsticks are required for cutting different kinds of stock.

The heel of the pushstick should be deep enough to prevent it from slipping and strong enough to feed the stock through the saw.

Feather Boards

You can also use one or two feather boards (Figure 41) to rip narrow stock safely. A feather board clamped immediately in front of the saw blade will provide side pressure to the stock without causing binding and kickback. Use a push block to feed stock all the way through.



Clamp feather board in front of saw blade.

Clamp second feather board to auxiliary rip fence.

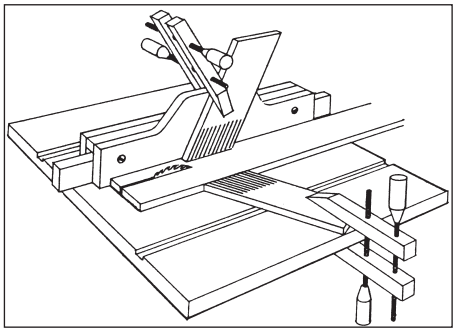


Figure 41 — Feather Boards

Operation

- Follow **Basic Saw Safety** (at the beginning of this chapter).
- Keep the floor around the saw clear of scrap and sawdust to prevent slipping and tripping.
- Always stop the machine before making adjustments. Before making major adjustments, always disconnect the main power supply.
- Select a sharp blade that is suitable for the job.
- Use the safety devices such as pushsticks and feather boards recommended in this chapter.
- Make sure nobody stands in line with a revolving blade.
- Don't let anyone or anything distract you when you are operating the saw.
- Whenever possible, keep your fingers folded in a fist rather than extended as you feed work into the saw.
- Never reach around, over, or behind a running blade to control the stock.
- Follow the manufacturer’s recommendations in matching the motor size to the saw. Underpowered saws can be unsafe.
- Table saws should be properly grounded. Check the power supply for ground and always use a ground fault circuit interrupter. This is mandatory for saws used outdoors or in wet locations.
- Table saws should be equipped with an on–off switch so power can be shut off quickly in an emergency.
- A magnetic starter switch is preferable to a mechanical toggle because it prevents the saw from starting up again unexpectedly after an interruption in power.
- When purchasing a new table saw, try to get one equipped with an electric brake. The brake stops the blade rotation within seconds of the operator turning off the saw. The reduced risk of injury is worth the extra cost.

- Extension cords should be of sufficient wire gauge for the voltage and amperage required by the saw and for the length of the run.

Radial Arm Saws

The motor and blade of the radial arm saw are suspended above the table (Figure 42). Because the motor and blade assembly can be locked in different positions and can travel during the cut, the operator must pay special attention to keeping fingers and hands clear.

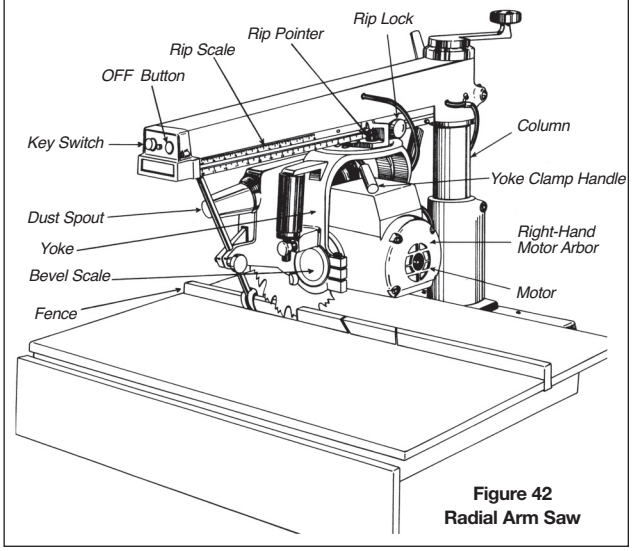


Figure 42
Radial Arm Saw

Injuries involving radial arm saws tend to be serious. By using appropriate guards and procedures, however, operators can safely use the saw for crosscuts, mitre cuts, ripping, and dadoes.

Set-Up

- The saw must be adequately powered for the work, especially for cutting thick hardwood.
- The saw should be installed in a well-lit area out of the way of traffic, with enough space to store and handle long lengths of wood. Locating the machine with its back to a wall or partition can help to keep flying pieces from hitting anyone.
- Where possible, mark the floor with yellow warning lines to keep other personnel back from the saw.
- Make sure all safety guards and devices are in place.
- Choose the right blade for the job. A sharp tungsten carbide combination blade is good for both crosscutting and ripping without frequent resharpening. For information on blade types and uses, refer to earlier sections of this chapter.

General Procedures

- Follow **Basic Saw Safety** (at the beginning of this chapter).
- If you don't have someone to help with long stock, use a roller stand or extension table to support the work.
- Always return the motor head to the column stop.
- When crosscutting or mitring, keep hands at least six inches away from the blade. **Do not adjust the length of cut until the motor is back at column.**
- Slope the table top back slightly to keep the blade at the column, thereby preventing contact with stock being placed in position.
- Do not allow the blade to cut too quickly when crosscutting or mitring.
- Avoid drawing the blade completely out of the cut. The cut piece, whether large or small, often moves. When the saw is rolled back towards the column, the teeth can grab the piece and shoot it in any direction.
- Do not cut by pushing the saw away from you into the stock. The material can lift up and fly over the fence.

Ripping and Crosscutting

- For regular ripping, turn the motor away from the column to the in-rip position. Feed stock into the saw from the right side.
- To cut wide stock, change the saw to the out-rip position. Feed stock into the saw from the left side. Operators accustomed to in-ripping may find this set-up awkward. Remember—the blade must turn **up and toward** the person feeding the stock.
- Do not force the cut. Allow the blade through the wood at its own pace.
- **To avoid kickback, take the following precautions.**
  - Maintain proper alignment of blade with fence.
  - Adjust anti-kickback device (Figure 43) to 1/8 inch below the surface of stock being fed.
  - Use a sharp blade, free of gum deposits and with teeth properly set.
  - When binding occurs, stop saw and open kerf with a wedge.
  - After completing cut, remove stock from rotating blade to prevent overheating and possible kickback.
  - Always push stock all the way through past the blade.
  - Do not leave machine with motor running.
  - Use a push stick when ripping narrow pieces. Have suitably sized and shaped pushsticks for other jobs as well.

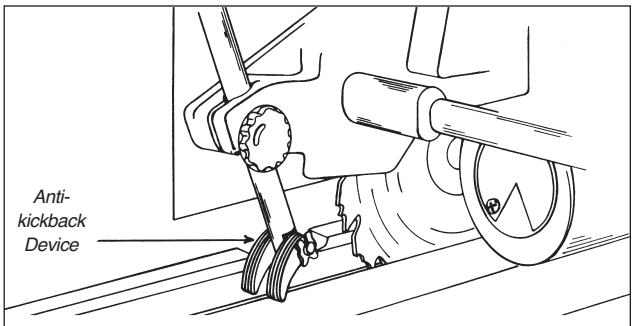


Figure 43

See information on pushsticks and feather boards under Table Saws, earlier in this chapter.

Jigs

The control provided by a well-made jig is essential for making irregular cuts safely and accurately.

Keep commonly used jigs (Figure 44) on hand. Jigs such as those for making stair and doorframe wedges and tapers are designed to carry stock past the blade with the saw locked in the rip position.

When you're drawing the saw into the stock, clamp or nail jigs to the table to prevent slipping.

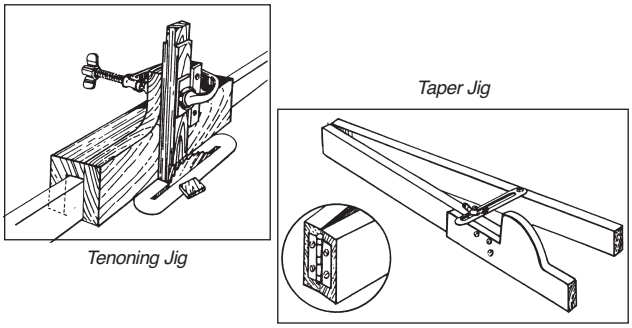


Figure 44 — Jigs

Re-Sawing with Blade Horizontal

The rip fence on the radial arm saw is too low for supporting material to be re-sawn on edge. Therefore the material must be laid flat on the table and the motor must be turned so the blade is parallel to the table. The closeness of the arbor requires an auxiliary table top and fence to re-saw thin stock.

Because the kickback fence can't be used and controlling stock is sometimes difficult, re-sawing on the radial arm saw can be hazardous.

If no other equipment is available, rip the stock halfway through, then turn it around and complete the cut.

On the second cut, be sure to push the two halves well past the blade once they have been cut apart. Pushsticks and featherboards clamped to the table can reduce hazards.

Dadoes

A dado head is an essential tool for cutting grooves, rabbets, and dadoes. A groove is cut with the grain; a dado is cut across the grain; and a rabbet is a shoulder cut along the edge of a board.

The most common dado head consists of two outside cutters and several inside chippers between the outside cutters (Figure 45).

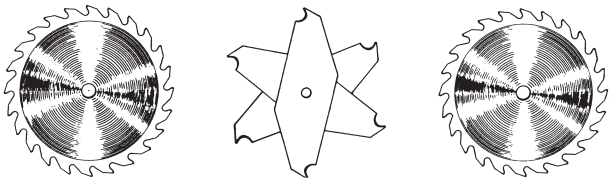


Figure 45
Dado Head Cutter Blades and Chippers

Another type is sometimes called a quick-set dado, consisting of four tapered washers and a blade. By rotating the locking washers, the blade will oscillate and cut a groove to the desired width.

Because of their small size, dado heads do not run at the peripheral feed speed on a big radial arm saw. As a result, the blade feeds itself too fast, either stopping the motor or lifting the work and throwing it back. To prevent this, **make several light passes**, lowering the dado head 1/8 to 1/4 inch each time.

Dado heads require guards for safety. Always make sure guards are in place before starting work.

Proper rotation of the teeth is **up and toward** you.

Other Accessories

Rotary accessories of various types are advertised as turning the radial arm saw into a multifunction machine. Operators should remember that the saw has its limitations. Possible problems include the following.

- Shaper heads run too slow for safe and smooth work.
- Grinding stones may run too fast or slow and are not recommended.
- Sanding drums tend to run too fast and may burn the wood.

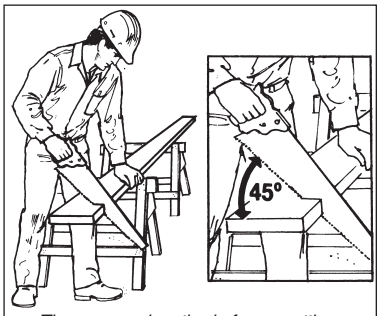
36 HAND TOOLS

Injuries with hand tools are not often serious but they do involve lost time. Common causes include using the wrong tool, using the right tool improperly, haste, and lack of training or experience.

Hand Saws

Select the right saw for the job.

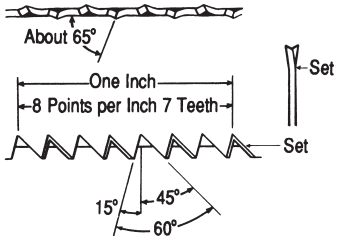
A 9-point hand saw is not meant for crosscutting hardwood. It can jump up and severely cut the worker's hand or thumb.



The approved method of crosscutting.

For this kind of work, the right choice is an 11 point (+). When starting a cut, keep your thumb up high to guide the saw and avoid injury.

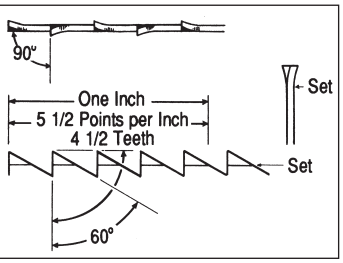
The side and tooth-edge views of a typical crosscut saw. This saw is used for cutting across the grain and has a different cutting action than that of the ripsaw. The crosscut saw cuts on both the forward and backward strokes.



For cutting softwood, select a 9 point (-). The teeth will remove sawdust easily and keep the saw from binding and bucking.

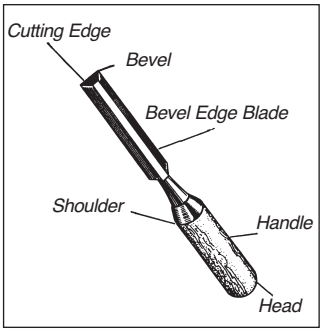
Ripping requires a ripsaw. Check the illustrations for the differences in teeth and action between rip and crosscut saws.

The side and tooth-edge views of a typical ripsaw. This saw is used for cutting with the grain. Cutting is done only on the forward stroke.



Wood Chisels

Most injuries with this tool can be prevented by keeping the hand that holds the work ***behind***, not in front of, the chisel.



A dull or incorrectly sharpened chisel is difficult to control and tedious to work with.

Chisels not in use or stored in a toolbox should have protective caps.

Wood chisels are tempered to be very hard. The metal is brittle and will shatter easily against hard surfaces.

Never use a chisel for prying.

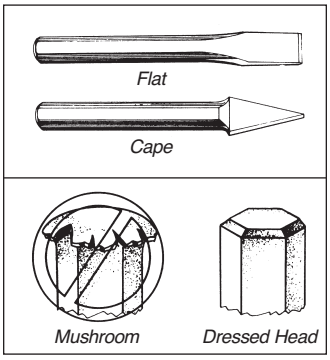
Repeatedly striking the chisel with the palm of your hand may lead to a musculoskeletal disorder.

With chisels and other struck tools, ***always wear eye protection***. Gloves are recommended to help prevent cuts and bruises.

Cold Chisels

Cold chisels are used to cut or shape soft metals as well as concrete and brick.

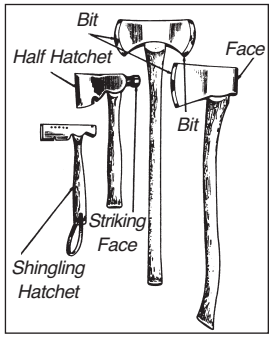
In time, the struck end will mushroom. This should be ground off. Don't use chisels with mushroomed heads. Fragments can fly off and cause injury.



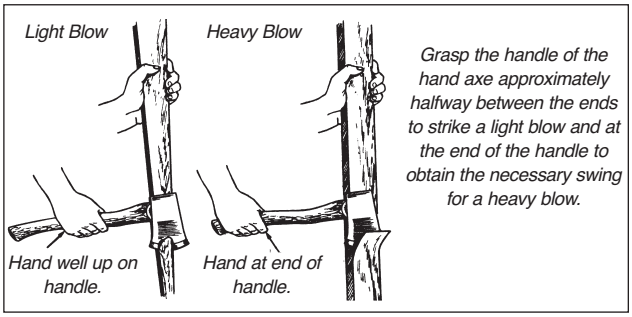
Axes and Hatchets

In construction, axes are mainly used for making stakes or wedges and splitting or shaping rough timbers.

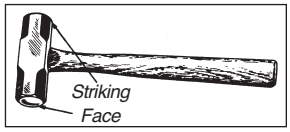
Unless it has a striking face, don't use the hatchet as a hammer. The head or the wooden handle can crack and break.



Hatchets with striking faces are meant only for driving common nails, not for striking chisels, punches, drills, or other hardened metal tools.



Never use an axe or hatchet as a wedge or chisel and strike it with a hammer.



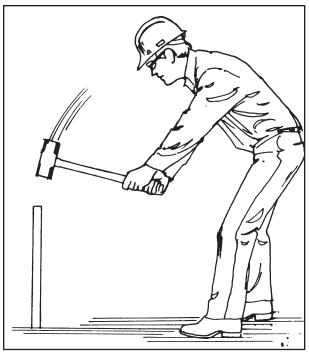
Most carpenters prefer a hatchet with a solid or tubular steel handle and a hammer head with a slot for pulling nails.

Sledgehammers

Sledgehammers are useful for drifting heavy timbers and installing and dismantling formwork. They can knock heavy panels into place and drive stakes in the ground for bracing.

Sledgehammers can also be used to drive thick tongue-and-groove planking tightly together. Use a block of scrap wood to prevent damage to the planks.

The main hazard is the weight of the head. Once the hammer is in motion it's almost impossible to stop the swing. Serious bruises and broken bones have been caused by sledgehammers off-target and out of control.



Hammer On Target

Missing the target with the head and hitting the handle instead can weaken the stem. Another swing can send the head flying.

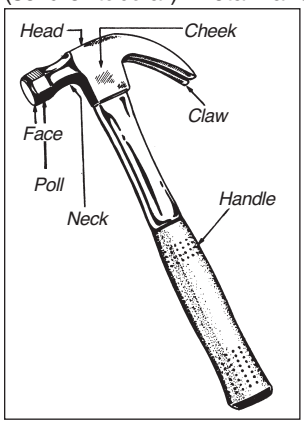
Always check the handle and head. Make sure the head is secure and tight. Replace damaged handles.

As with any striking or struck tool, always wear eye protection.

Swinging a sledgehammer is hard work. Avoid working to the point of fatigue. Make sure you have the strength to maintain aim and control.

Claw Hammers

These are available in many shapes, weights, and sizes for various purposes. Handles can be wooden or steel (solid or tubular). Metal handles are usually covered with shock- absorbing material.



Caution: Repeated use of a hammer may lead to musculoskeletal injury, strain, or carpal tunnel syndrome. Exercising to warm up, as well as to develop and maintain overall muscle condition, may help to reduce the risk of strain or injury.

Start with a good quality hammer of medium weight (16 ounces) with a grip suited to the size of your hand.

Rest your arm occasionally to avoid tendinitis. Avoid overexertion in pulling out nails. Use a crow bar or nail puller when necessary.

When nailing, start with one “soft” hit, that is, with fingers holding the nail. Then let go and drive the nail in the rest of the way.

Strike with the hammer face at right angles to the nailhead. Glancing blows can lead to flying nails. Clean the face on sandpaper to remove glue and gum.

Don't use nail hammers on concrete, steel chisels, hardened steel-cut nails, or masonry nails.

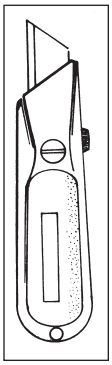
Discard any hammer with a dented, chipped, or mushroomed striking face or with claws broken, deformed, or nicked inside the nail slot.

Utility Knives

Utility knives cause more cuts than any other sharp-edged cutting tool in construction.

Use knives with retractable blades only.

Always cut away from your body, especially away from your free hand. When you’re done with the knife, retract the blade at once. A blade left exposed is dangerous, especially in a toolbox.

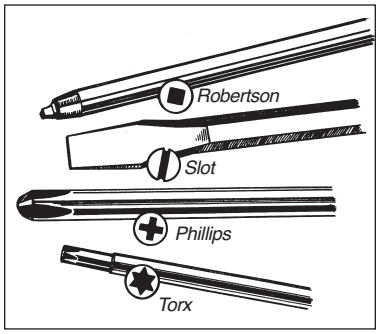


Screwdrivers

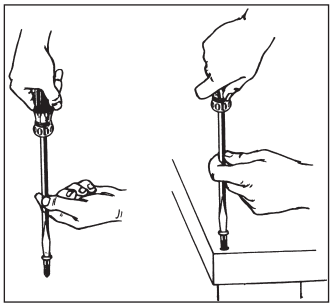
More than any other tool, the screwdriver is used for jobs it was never meant to do.

Screwdrivers are not intended for prying, scraping, chiselling, scoring, or punching holes.

The most common abuse of the screwdriver is using one that doesn't fit or match the fastener. (i.e., using a screwdriver too big or too small for the screw or not matched to the screw head).



The results are cuts and punctures from slipping screwdrivers, eye injuries from flying fragments of pried or struck screwdrivers, and damaged work.

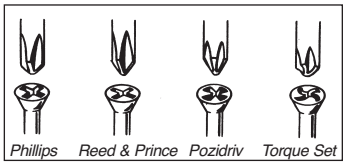


Always make a pilot hole before driving a screw.

Start with one or two “soft” turns, that is, with the fingers of your free hand on the screw. Engage one or two threads, make sure the screw is going in straight, then take your fingers away.

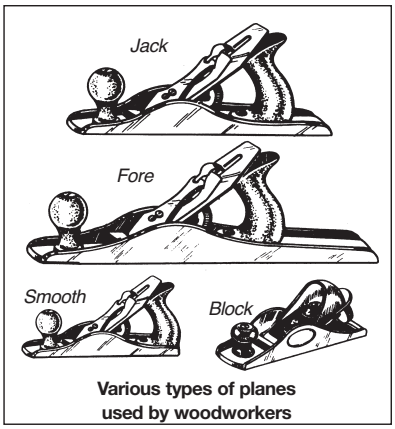
You can put your fingers on the shank to help guide and hold the screwdriver. But the main action is on the handle, which should be large enough to allow enough grip and torque to drive the screw. Power drivers present obvious advantages when screws must be frequently or repeatedly driven.

Note: All cross-point screws are not designed to be driven by a Phillips screwdriver. Phillips screws and drivers are only one type among several crosspoint systems. They are ***not*** interchangeable.



Hand Planes

Hazards include the risk of crush and scrape injuries when the hand holding the plane strikes the work or objects nearby. Cuts and sliver injuries are also common.



Various types of planes used by woodworkers

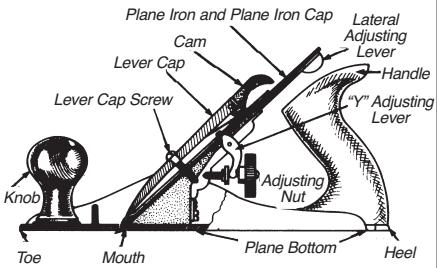
The hand plane requires some strength and elbow grease to use properly. The

hazards of overexertion and tendinitis can be aggravated by using a dull iron or too short a plane.

Use the plane suited to the job and keep the iron sharp.

For long surfaces like door edges, use a fore plane 18" long and 2 3/8" wide or a jointer plane 24" long and 2 5/8" wide.

For shorter surfaces, use a jack plane 15" long and 2 3/8" wide or a smoothing plane 10" long and 2 3/8" wide.



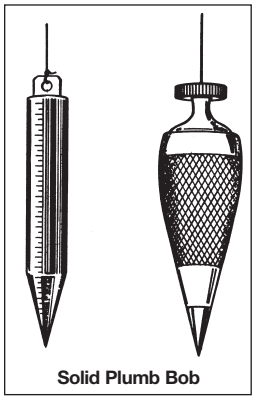
Typical smoothing plane.

Remember that sharp tools require less effort and reduce the risk of fatigue, overexertion, and shoulder and arm strain.

Work can also be easier with a door jack and supports on your work bench.

Plumb Bobs

The weight of a mercury-filled plumb bob will surprise you. Designed for use in windy conditions, the bob has considerable weight in proportion to its surface area.


Solid Plumb Bob

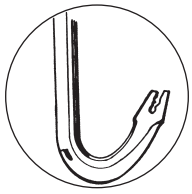
The weight and point of the bob can make it dangerous. Ensure that all is clear below when you lower the bob.

Don't let it fall out of your pocket, apron, or tool bag. The same goes for the standard solid bob.

Crow Bars

Any steel bar 25-150 cm long and sharpened at one end is often called a crow bar.

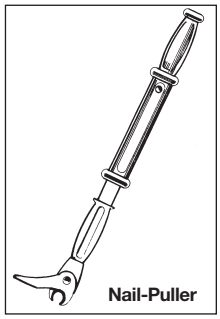
The tools include pry bars, pinch bars, and wrecking bars. Shorter ones usually have a curved claw for pulling nails and a sharp, angled end for prying.



Nail Pulling

Pulling out nails can be easier with a crow bar than a claw hammer.

In some cases, a nail-puller does the job best. Keep the hand holding the claw well away from the striking handle.


Nail-Puller

Lifting

Loads levered, lifted, or shifted by bars can land on fingers and toes.

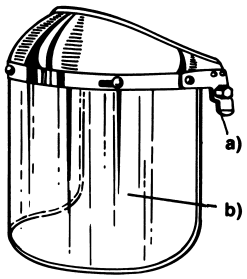
- Make sure to clear the area and maintain control of the load.
- Have enough rollers and blocking ready.
- Never—not even for a split second—put fingers or toes under the load.

General

Try to avoid prying, pulling, wedging, or lifting at sharp angles or overhead.

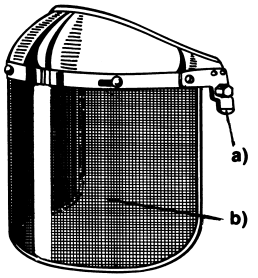
Wherever possible, keep the bar at right angles to the work.

Wear eye protection and, where necessary, face protection.



Class 6A
Face shield for impact, piercing, splash, head, and glare protection.
a) hard hat attachment; b) face shield (window).

Class 6B
Face shield for light non-piercing impact, splash, low heat, and glare protection. The major difference between 6A and 6B is the degree of thickness in the shield.

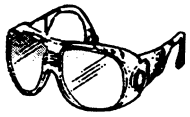


Class 6C
Face shield for light non-piercing impact and high heat protection only (usually wire screen windows). a) hard hat attachment; b) wire screen.

Examples of Class 1 - Spectacles



Class 1A
Spectacles with side protection



Class 1B
Spectacles with side and radiation protection

Company Health and Safety Rules

It is the policy of RenoDemoClean Inc. to insist that all subcontractors, their employees, and our direct workforce, understand and strictly adhere to the provisions of the *Occupational Health and Safety Act* and all applicable regulations.

The duties and responsibilities of the supervisor, worker and employer, legislated in the *Occupational Health and Safety Act*, are of paramount importance. Below, are some of the most fundamental Safety Rules; know them and adhere to them. Your foreman or project superintendent will inform you of any additional safety rules and procedures as the need arises.

Personal Health and Safety Rules

Head Protection

C.S.A.-approved class “B” hardhats must be worn at all times while you are on the project.

Foot Protection

C.S.A.-approved footwear (“Green Patch”) with toe and sole protection must be worn at all times while you are on the project.

Skin Protection

Appropriate work clothing must be worn when handling and using tools and materials which may cause injuries to your skin.

Eye Protection

Face shields, goggles or glasses must be worn by workers and must be of a design to afford suitable eye and face protection when:

1. Welding, burning or cutting with torches
2. Using abrasive wheels, portable grinders or files
3. Chipping concrete, stone or metal
4. Working with materials
5. Drilling or working under dusty conditions
6. Sand or water blasting

7. Waterproofing
8. Working on energized switchboards
9. Using explosive actuated fastenings or nailing tools
10. Working with compressed air or other gases
11. When working near any of the operations listed above

Clothing

For your protection on the job, DO NOT WEAR:

1. Loose clothing or cuffs
2. Greasy or oily clothing, gloves or boots
3. Torn or ragged clothing
4. Finger rings, bracelets or neck chains

Other Personal Protective Equipment

Other equipment, such as safety belts, full-body harnesses, respirators, reflective vests, floatation vests, ear protection devices, etc., must be worn when required by the Act or Regulations and your foreman.

Non-Prescription Drugs or Alcohol

Non-prescription drugs or alcohol will not be allowed on the job. Any employee found to be in possession of, or under the influence of, drugs or alcohol will not be allowed to work and is liable to be severely disciplined or terminated from employment.

Reporting Injuries and Accidents/Incidents

All injuries and accidents/incidents, no matter how minor, must be reported immediately to your supervisor. The supervisor will conduct his/her investigation and report it to management.

Reporting Unsafe Practices and Conditions

If you should notice any unsafe practice or condition on the job, you are obligated by law and by this company to report the situation immediately to your supervisor so that corrective action can be taken.

Placement of Tools and Materials

Never place tools or materials near edges to openings or levels, as these items may fall onto someone below. Keep all tools and materials at least six feet back from edges and openings.

Heavy Lifting

Always seek assistance or use mechanical lifting devices when attempting to lift heavy material. Avoid awkward positions and always lift with the legs, not your back. Your back is very susceptible to injury in a bent position.

Jumping

No person shall jump from one level to another and anyone discovered jumping will be reprimanded and subject to immediate termination from employment. Use proper means for access and egress.

Horseplay

Do not engage in any prank, contest, feat of strength, unnecessary running or boisterous conduct.

Guardrails or Coverings

Do not remove guardrails or coverings.

Accountability

Distribution of safety directives shall be as follows:

- Copy to the Supervisor in charge of the subcontract work
- Copy to the Project Superintendent
- Copy to the Subcontractor's Head Office
- Copy to RenoDemoClean's General Manager

Employees of construction including sub-contractor employees working on sites will be held accountable for their actions and any violations of this safety policy.

<< NOTICE >>

Violations to the following safety concerns represent a serious level of neglect and [Company Name]'s project superintendent or his competent replacement has the right to exercise a "ZERO TOLERANCE" policy and have the violator(s) dismissed from the project. No further warnings are required or will be given.

FALL PROTECTION VIOLATIONS

ELECTRICAL OR MECHANICAL LOCK-OUT VIOLATIONS

FIRE PREVENTION VIOLATIONS

TRENCHING VIOLATIONS

a) Construction Employees

1st violation – a recorded verbal warning
2nd violation (same offence) – written notice and one day loss of work and pay
3rd violation (same offence) – permanent dismissal from employment

b) Subcontractor Employees

1st violation – a recorded verbal warning
2nd violation (same offence) – written notice to employee and employer – temporary removal from site
3rd violation (same offence) – permanent removal from site

NOTE: Architects, owners, suppliers, sales personnel and public visitors must abide by the personal protective equipment rulings and other rulings that may be associated with their work. Failure to do so may cause the project superintendent to take action.

These notices and penalties shall be enforced as written on all projects. Dismissal of an employee shall be reviewed with a party of three (e.g. superintendent, management and safety committee labour member).

Discipline Policy

- Addressing disciplinary issues can be a very sensitive and stressful process for most mangers, supervisors and employees. However, if disciplinary issues are avoided or handled poorly, it can lead to serious consequences such as injury, property damage or fatality.

- At RenoDemoClean, we do not view discipline as a form of punishment but as a rule or system of rules governing conduct or activity in order to eliminate unsafe circumstances.

- RenoDemoClean believes that education is the key to establishing proper disciplinary procedures and holding all employees accountable to our company's health and safety policy and program, as well as to applicable regulatory requirements.

Disciplinary Program

- The main objective of our disciplinary program is to ensure that [company name]'s rules and safe work practices are taken seriously by all employees and are followed.

- Where disciplinary action is deemed to be appropriate, it shall be conducted in timely manner.

- Trying to correct unsafe behaviour by waiting only allows the behaviour or habit to become more ingrained.

- Discipline shall be kept as positive as possible and not used in a punitive or negative way. Remember that the goal is to correct the problem, action, or behaviour of the person. The type of discipline shall fit the severity of the misconduct and shall be conducted in private.

Disciplinary Program Process

In order to ensure effectiveness and fairness of the program all of the following five steps must be addressed with equal importance:

1) Review of disciplinary policies and procedures (Managers & Supervisors)

2) Investigation of accusations and infractions (Supervisors and Health & Safety Reps)

3) Determining and reviewing disciplinary action (Supervisors, Health & Safety

Enforcement Policy

This policy is applicable to all workers at sites. All workers are required to comply with the *Occupational Health and Safety Act* and all applicable regulations. Failure to comply with the OHSA and Regulations will result in the following action:

1) 1st Offence – Worker will be given a verbal warning. The details will be documented and may be forwarded to the applicable employer for corrective action.

2) 2nd Offence – Worker will be given a written warning. A copy of the warning will be forwarded to the applicable employer for corrective action.

3) 3rd Offence – Worker will be given a suspension or permanent dismissal from the site. The details will be documented and forwarded to the applicable employer for corrective action.

4) Violations that could result in a fatality or serious injury are grounds for immediate suspension or dismissal.

Note: Warnings are intended to give workers the opportunity to correct their actions. Serious offences or flagrant violations of the safety program or the Occupational Health and Safety Act and Regulations are grounds for immediate suspension or dismissal.

Reps, Professional Health & Safety Consultants)

4) Documenting Disciplinary action and program enforcement (Supervisors, Health & Safety Reps, Professional Health & Safety Consultants)

5) Conducting the disciplinary meetings and promoting safe work practices and compliance to regulatory requirements (Supervisors, Health & Safety Reps, Professional Health & Safety Consultants)

Disiplinary Measures and Accountability

WARNING TO SUBCONTRACTORS:
RenoDemoClean Inc. requires all personnel to comply with the *Occupational Health and Safety Act* and all applicable regulations. Subcontractors are also required as part of the RenoDemoClean Inc. sub-contractual agreement to comply with theRenoDemoClean Inc. Corporate Health and Safety Policy.

Any health and safety contravention observed at the work site is to be dealt with immediately through a documented verbal and/or written warning.

Such written warnings shall include:

- Project name and number
- Trade Subcontractor/Vendor Responsible
- Identity of Subcontractor's Superintendent/Foreman in charge of the work, and his signature of acknowledgement
- Names of individual violators if any
- An explanation of the Health and Safety Violation Observed
- Date and Time as to when the infraction is to be rectified
- The signature of the Project Superintendent and the Safety Inspector/Consultant

In the event that a subcontractor refuses or neglects to rectify a hazardous condition, practice or any violation, RenoDemoClean Inc. shall exercise the right to take immediate steps to correct the unsafe condition at the expense of the responsible parties.
Reno DemoClean Inc. may also remove from the work site any individual who continues to cause the unsafe condition to remain or performs in a manner not consistent with the guidelines of the Act, its Regulations or our Safety Policy.

Substance Abuse Control

It is the policy of RenoDemoClean Inc. to recognize and assist any employee in dealing with substance abuse. RenoDemoClean Inc. recognizes the inherent dangers to other workers who have to work with a worker who is impaired through substance abuse, as well as the personal problems associated with the substance abuser.

Any worker suspected of being impaired will not be allowed to continue working. The site supervisor will discuss the situation with the worker safety representative and site foreman if a sub-contractors' worker is involved. If the employee is deemed unfit for work, the employee will be taken home.

The Substance Abuse Control Policy applies to all of RenoDemoClean's employees including sub-contactors' employees. RenoDemoClean will not condone the following behavior by any worker.

- Use or consumption of any form of alcohol or any prohibited substance on a construction project at any time.
- Sale, purchase, transfer, offering, use or possession of alcohol on company property or at a site where RenoDemoClean Inc. is engaged.
- A worker will not arrive or be at work while under the influence of alcohol or prohibited substances.

These employees will be made to understand that RenoDemoClean Inc. management cannot allow them to continue working until they seek attention and treatment to eliminate their dependence or practice of substance abuse. The worker will be suspended from working until his/her treatment is completed and his/her reliance to the substance(s) is over.

[ABC Construction] management will assist in setting up such treatment necessary for any employee in:

- Addiction Research Foundation [1-888-441-2892]
- Ont. Drug & Alcohol Registry of Treatment [1-800-565-8603]
- Alcoholics Anonymous Ottawa [613-237-6000]

All supervisors/foremen will be instructed to recognize the problems of substance abuse and the seriousness of its effects on the safety of the worker and his/her co-workers.

Cell Phone Policy

Purpose

The purpose of this policy is to protect your safety by banning you from using cell phones and other wireless devices when driving that may cause distractions that prevent you from concentrating 100% on the safe operation of the vehicle and may lead to accidents.

1. Rules For Drivers

a. Ban on Wireless Communication Devices.

When you are on duty and driving, you may not use a wireless communication device of any type. This includes not only cell phones, but also mobile phones, text pagers, two-way radios and other wireless devices.

b. Scope.

The ban on the use of wireless communication devices above applies:

- To all vehicles operated by workers while on duty, whether owned by the company or the individual worker;
- To all wireless devices, whether owned by the company or by the worker; and
- To all conversations, whether personal or business-related.

c. Hands-Free Devices.[1]

Option 1: The ban on using cell phones and other devices while driving applies to all devices, including the use of cell phones with hands-free headsets.

Option 2: As an exception to this policy, workers may use cell phones and other wireless devices to conduct conversations when they drive as long as they use headsets and other hands-free devices. However, workers are strongly encouraged to keep calls as brief as possible and to pull off the roadways when conversations become technical or emotional in nature.

d. Handling Calls While Driving.

[1] This section includes an option that would allow the use of headsets or hands-free devices. Although some cell phone laws might allow for this, the scientific literature provides evidence that use of a hands-free device does not result in any significant improvement in driving performance. A total ban on all cell phones is the superior safety policy. While Option 2 is legally viable, legal obligations are minimum requirements, not ultimate standards.

Incoming Calls: Make sure your phone has caller ID and/or voice mail. If the phone rings, don't answer it unless and until you pull over in a safe spot (or let a passenger or voicemail answer the call). If it's urgent, you may accept or return the call, provided that you remain parked off the roadway. You may not resume driving until your conversation ends.

Outgoing Calls: You may not make outgoing calls while driving. If you want to place a call, pull over in a safe spot first.

2. **Rules For Site Workers**

   a. **Ban on Calling Workers Who Are Driving.**

   If you know that a worker is driving, do not call him or her on the cell phone or other wireless device.

   b. **Procedures for Calling Workers Who Might Be Driving.**

   If you do not know if the worker is driving and the matter is urgent, you may place the call at the worker's cell phone but must immediately ask the person if he or she is driving. If the worker is in fact driving, hang up after telling the worker to call you back when he/she pulls over or gets out of the vehicle.

   c. **Procedures for Receiving Calls from Workers Who May Be Driving.**

   If you receive a call from workers who are on their cell phone or other wireless device, ask them if they are driving. If they are, tell them to pull over and call you back. Hang up the phone as quickly as possible.

3. **All Workers**

   Effect of Policy.
   Violations of the foregoing rules will be considered a serious offence and may result in the imposition of discipline up to and including termination.

   Reminder: The use of cell phones and other wireless devices while driving leads to distractions that can result in traffic accidents. So, while we cannot force you to adhere to these rules when you are not on duty, we strongly urge you to do so for your own safety and well-being and that of family, friends and third parties on the roadways.

Health and Safety Policy

Mobile Devices on Worksites

Purpose

The purpose of this policy is to establish a procedure to reduce injuries directly or indirectly related to using mobile devices on worksites. There are many hazards associated with using mobile devices on a worksite. It can distract users from the hazards associated with their work tasks and their surroundings, and it can distract other workers in the area.

Restricting the use of mobile devices on a worksite will increase the level of concentration of workers. If workers are more focused on their job, the quality of their work will improve and the number of incidents associated with the distractions caused by using mobile devices will decrease.

Application

This policy applies to all workers and visitors entering the worksite.

Types of Mobile Devices

This policy includes all mobile devices including, but not limited to, cell phones, tablets, MP3 players, and iPods.

Company Rules

- Only those individuals authorized by Project Management are permitted to use mobile devices on worksites. The use of mobile devices on site is prohibited unless expressed consent is granted by Project Management. This includes talking, texting, emailing, playing games, etc.
- The use of mobile devices is not permitted while operating any mobile material handling equipment, while working on any aerial work platforms, or while performing activities that require your full attention.
- The use of mobile devices is not permitted while attending safety meetings or while receiving safety-related information such as a safety talk.
- Supervisors should make every reasonable effort to avoid using their mobile device or making calls while directing activities on the worksite.
- Mobile devices should be turned off when working. The ringer may startle you or someone else in the area.

- The use of mobile devices is not permitted around explosive or flammable atmospheres or while decanting or working with flammable or combustible material.
- If an urgent family matter requires a worker to use their mobile device, the worker must coordinate with the supervisor so that the communication can be done in a safe manner.
- In areas where the employer mandates that mobile devices are not permitted on site, the employer may provide secure storage for mobile devices to prevent theft (e.g., a lockbox).

Permitted Uses

- Workers are permitted to use mobile devices when they are in the following designated safe areas:

  [Insert designated areas such as the company's break room, lunch room, site trailer, and offices.]

- Supervisors are permitted to use mobile devices in the construction trailer, in the site office, or at one of the designated safe areas listed above, provided it is away from general work activities.
- Supervisors are permitted to use mobile devices on site when expressed consent is provided by Project Management.

Discipline

Anyone who violates this policy will be subject to disciplinary measures, up to and including dismissal, depending on the circumstances and the company policy.

Employee Acknowledgment

I acknowledge that I have read and understood and will abide by the terms of this policy regarding the use of mobile devices at work.

Name (printed) _____

Signature _____ Date _____

Witness _____ Date _____

Orientation Policy

All new employees of RenoDemoClean Inc. will read and review RenoDemoClean's Health and Safety Policy with the Safety Coordinator. After completion the worker will sign the sheet at the end of the policy acknowledging acceptance and understanding of his/her obligations and responsibilities.

The Site Supervisor will complete the *New Worker Orientation Checklist* with the employee before they start working at the site. The completed checklist will be submitted to the Safety Coordinator to be kept on file at the head office.

The Site Supervisor will complete the *Supervisor Site Orientation Checklist* before job start up. Upon completion the copy will remain on site and the Supervisor shall review the checklist items with all RenoDemoClean employees.

Subcontractor orientation will require the completion of a Pre-Job Safety Analysis (PSA) for each trade prior to the start of work. RenoDemoClean's Supervisor will review and accept or modify the proposed PSA as required.

The Subcontractor Supervisor will then review the contents with their workers, with a copy of the final PSA signed off and kept on site.

At least once per year, each Supervisor will review the orientation policy and procedures with the Safety Coordinator.

Supervisor Site Orientation

Checklist

No.	Item	Supervisor's initials
1.	Notice of Project	
2.	Emergency Response Plan	
3.	“In Case of Injury” Poster (WSIB Form 82)	
4.	Company Health and Safety Policy	
5.	*Occupational Health and Safety Act and Regulations for Construction Projects*	
6.	First Aid Equipment & Certificate, Injury Treatment Form	
7.	Fire Protection	
8.	Washroom Facilities	
9.	Tools and Equipment Storage	
10.	Materials Storage and laydown areas.	
11.	M.S.D.S. (as required)	
12.	Health & Safety Rep/Joint Health & Safety Committee Poster	
13.	Pre-Job Safety Analysis (PSA)	
14.	Subcontractor/Supplier Contacts	
15.	Personal Protective Equipment	

New Worker Orientation Checklist

Leadership & Organization		Control Activities	
❑	Responsibilities for contractor, worker, supervisor, management, h & s rep	*Emergency Procedures*	
❑	H & S program: Leadership, Organization, Hazard Recognition and Controls	❑	First Aid Station/First Aid Kit, First Aid Attendants (names/trades)
❑	Discipline policy	❑	Procedures for First Aid/Major Accident, Loss of Power, Fire Response, Severe Weather, Evacuation Plan, Fall Rescue
❑	Substance Abuse policy	❑	Emergency procedures coordinator(s) _____
❑	Authority of Company policy, OHSA and construction regulations	❑	Meeting place for evacuation
Project Orientation		❑	Location of phone and emergency numbers or additional procedures
❑	Lunch, coffee breaks – duration, time and location	❑	Location of fire extinguishers
❑	Location of washroom, clean-up facilities and drinking water	❑	Emergency access route
❑	Tool and equipment damage procedures	❑	Ladders, scaffolds, power tools, electrical hazards, access, egress
❑	Physical tour of project including: relevant personnel, hazards and areas of note (parking, entry route, access points)	*Safe Work Procedures*	
❑	Right to know (about all hazards) Right to participate (in health & safety) Right to refuse (work that is hazardous)	❑	Confined spaces, fall hazards, traffic control, trenching, moving equipment
Hazard Recognition & Assessment		❑	Compressed gases, MSDS, contractor requirements, guarding, PPE
❑	Injury and incident reporting procedures	❑	Housekeeping/daily clean up
❑	Accidents, accident investigation procedures	❑	Return to work procedures
❑	Property damage reporting procedures	*Training*	
❑	Project inspection procedures	❑	Certificates available: WHMIS, Fall Protection, First Aid/CPR and other relevant training
❑	Specific project hazards _____	❑	Other _____
❑	Specific project hazards _____	❑	Other _____

Worker's Signature Supervisor's Signature

Orientation

Responsibilities

Senior Management

Senior management shall:

1. Prepare a corporate “Orientation Checklist” for new workers signing on, and compile records of orientation.

2. Provide orientation to subcontractors.

3. Ensure that new employees and subcontractors receive a written copy of the company's Health & Safety Policy and Program.

Supervisor

The supervisor shall:

1. Review the corporate “Orientation Checklist” with each new member of the crew and return a copy to _____ at head office for recording.

Subcontractor

All subcontractors shall:

1. Provide site orientation to their direct-hire employees and the sub-trades under their direction.

2. Forward copies of completed orientation checklists to _____ (senior management) at head office.

Employee Orientation

Health and Safety Orientation Requirements

RenoDemoClean Inc. management and supervision will ensure each new construction employee participates in the RenoDemoClean's Health and Safety Orientation process and reviews all necessary site and project specific health and safety information.

The safety orientation must, at a minimum, include the following elements:

1. Review of the RenoDemoClean Inc. health and safety policy.

2. Overview of applicable health and safety legislation including employee rights.

3. Overview of the company health and safety program including:
    - Health and safety responsibilities
    - Safety investigations (accident reporting)
    - Modified work / workplace accommodation
    - Disciplinary action
    - Drug and alcohol policy
    - Discrimination and harassment policy
    - Common safety standards

4. Site specific health & safety requirements.

5. Any additional regional/divisional health and safety requirements as deemed necessary by local management and/or the joint health and safety committee

6. Verification/evaluation process to ensure the information has been clearly understood. This can include a written evaluation, oral evaluation or work practice evaluation

Annual Orientation and Update

To ensure that all employees remain familiar with RenoDemoClean Inc. health and safety requirements, including any legislative changes or safety program updates and revisions, all employees will be required to participate in an annual health and safety orientation. This annual update review must be performed by a supervisor or competent designate. All orientation records must be formally documented and filed in the employee file.

Site Specific Orientation

When a new employee reports for work, they must have all the “extra” safety requirements that pertain to the particular job site explained to them by a competent person. This site specific orientation will be documented and must contain all site particular information such as:

1. Site specific safety standards/ applicable client procedures.

2. Names of first aid attendants and location of first aid stations/kits.

3. Location of posted copies of:

    - Legislation, RenoDemoClean Inc.health and safety program, site MSDS booklet;

    - Emergency procedures; and

    - Name of health and safety representative.

Training

Employee Training

RenoDemoClean Inc. is responsible for ensuring all employees and supervisors are properly trained. It is committed to providing adequate time and resources to train all personnel to perform their duties in an efficient and safe manner.

Management is responsible for ensuring records of all completed training courses are maintained. A review of all training should take place at the regular management/supervisor meetings and meetings of the joint health and safety committee and must be completed no less than annually.

Management Training

In addition to participating in RenoDemoClean Inc. supervisory training requirements, operations management will be given the opportunity to attend advanced training in maintaining safety in the workplace.

Supervision Training

All construction supervision must attend the following safety competency courses:

- Supervisor competency via an accredited organization (e.g. CSAO)
- First aid and CPR
- Fall protection train the trainer
- RenoDemoClean Inc. health and safety program training
- Specialized tool and equipment instruction as required

Worker Training/Instruction

Workers will be instructed by a competent person to ensure that safety is maintained in the workplace. Formal training must be provided for the following:

- Fall Protection
- Personal Protective Equipment (Respirator, hazmat if required)
- WHMIS
- Tools and equipment (new or specialized)
- Emergency Response

An evaluation must be completed to ensure workers are familiar with program content and the activities for which they will be responsible.

Visitors

Any RenoDemoClean Inc. employee authorizing a site visit assumes responsibility that visitors are aware of all safety requirements and have in their possession all safety equipment required for the site.

Accident/Incident Investigation

Policy Statement

RenoDemoClean Inc. requires all employees to immediately report to their supervisor all accidents and incidents that result in injury or property damage, and all near misses with the potential for serious injury or property damage. Supervisors will report the accident promptly to management to ensure timely submission to WSIB. Each incident will be analyzed to determine causes and contributing factors and the analysis will be used to reduce or eliminate the risk of further incident.

Definitions

An **Accident** is defined as an unplanned event that causes harm to people or damage to property. Accidents are categorized as one of the following:

- **Lost Time Injury** (LTI) refers to any injury that prevents a worker from coming to work on the day following the day of the injury.

- **Medical Aid** refers to any injury not severe enough to warrant more than the day of injury off, but where medical treatment by a doctor is given.

- **First Aid** refers only to injuries that can be treated on the job without any days lost.

- An **Incident** is defined as property damage but with no injury to workers.

- A **Near Miss** is a situation in which no injury or damage occurred but might have if conditions had been slightly different.

- **Occupational Illness** is defined as a condition resulting from a worker's exposure to chemical, biological or physical agents in the workplace to the extent that the health of the worker is impaired.

- **Critical Injury** is defined as an injury of a serious nature that:
    a) Places life in jeopardy;
    b) Produces unconsciousness;
    c) Results in substantial loss of blood;
    d) Involves the fracture of a leg or arm but not a finger or toe;
    e) Involves the amputation of a leg, arm, hand or foot but not a finger or toe;
    f) Consists of burns to a major portion of the body; or
    g) Causes the loss of sight to an eye.

Role of Supervisor in an Accident Investigation

The Supervisor and the Site Health and Safety Coordinator if applicable) must investigate all accidents and incidents that involve workers. This includes completing the Accident Investigation Report, taking statements from witnesses and collecting any other pertinent information and ensuring the injured worker has received the necessary medical assistance.

The supervisor is responsible for ensuring that all accident reports are transmitted to the Health and Safety Department as described below. If a worker sustaining a First Aid later seeks medical aid, the supervisor must advise the Health and Safety Department and have the treating practitioner complete a Functional Abilities Form.

If we are not the Constructor, report the accident to the Constructor through their Safety Coordinator or Project Manager.

The supervisor should contact the injured worker as frequently as the injury deems, or at least once a week. If you require assistance, contact the Health and Safety Department.

Procedure:

1. The employee reports a work related accident

2. Administer first aid as required

3. Arrange for transportation for injured employee to medical treatment if required

4. Ensure Return to Work package accompanies worker

5. Eliminate the hazard if possible or guard the accident scene if worker is critically injured

6. Investigate the cause of the accident and report findings in the Accident/Incident Report form. Ensure all areas of the form are completed.

7. Send copy of the form to Health and Safety Department

8. Report all accidents/incidents as follows:
    - Lost Time Injuries
    - Medical Aid
    - First Aid
    - Incidents and Near Misses

Accident/Incident Investigation

Purpose

To investigate all incidents/accidents in order to determine the cause and what corrective actions need to be implemented to prevent a recurrence.

Policy

The following types of incidents/accidents shall be fully investigated:

1. Accidents that result in injuries requiring medical aid,
2. Accidents that cause property damage or interrupt operation with potential loss,
3. Incidents that have the potential to result in (1) or (2) above, and
4. All incidents that, by regulation, must be reported to MOL, WSIB or other regulatory agencies.

Responsibilities

1. All employees shall report all incidents/accidents to their immediate supervisor.
2. Supervisors shall conduct initial investigations and submit their reports using the Accident Investigation Form promptly to management.
3. Superintendents shall determine the need for and, if necessary, carry out detailed investigations. They shall also determine causes, recommend corrective action, and report to the manager.
4. The manager shall review all superintendents' reports, determine corrective action to be taken, and ensure that such action is implemented.

Accident Investigation Report

Date of investigation			Investigator		
Date of injury			Injured worker		
Project location			Project Supervisor		
M.O.L. notified?	No ❑	Yes ❑	Joint H & S Committee in place?	No ❑	Yes ❑
Injured worker's address:					
Nature of injury reported (injured body part):					
Factors that led up to accident:					
Project Safety Representative:					
Comments:					
Names and addresses of witnesses and their comments (please use back for additional comments):					
Recommendations for corrective measures:					
Corrective measures taken?	N/A ❑	Yes ❑	To follow up on	(Date)	❑

Investigator Signature

President

Accident Investigation Report Reviews

Health & Safety Committee (Worker Members)

Name: _____ Signature: _____ Date: _____

Health & Safety Committee (Management Members)

Name: _____ Signature: _____ Date: _____

President

Name: _____ Signature: _____ Date: _____

Accident Report

Injured Worker's Last Name	First Name	Occupation
Location where injury/accident occurred		First Aid Provider
Hospital or Clinic Attended for Medical Aid		Treating Physician's Name
Nature of Injury		Project Location of Accident/Injury

Person who transported employee						
Will this be a lost time injury?	No ❑	Yes ❑	Is injury work-related?	No ❑	Yes ❑	
Were any subcontractors involved?	No ❑	Yes ❑	Was the MOL called[1]?	No ❑	Yes ❑	

Injury Details

Date and Hour of Injury					Date and Hour Reported to Employer				
Day	Month	Year	Time		Day	Month	Year	Time	
				a.m. p.m.					a.m. p.m.

Date and Hour Last Worked				Normal Working Hours			
Day	Month	Year	Time	from		to	
			a.m. p.m.		a.m. p.m.		a.m. p.m.

Who was the injury reported to?	

What caused the injury? Describe the injury, the body part involved and specify left or right side (use back of sheet if necessary).
Describe the worker's activities at the time of the injury. Include details of equipment or materials used (use back of sheet if necessary).
Did anyone else witness the accident or know more about the injury?

[1] Reasons to call the MOL: fatality, critical injuries (defined as an injury of a serious nature that: places life in jeopardy, produces unconsciousness, results in substantial loss of blood, involves the fracture of a leg or arm, involves the amputation of a leg, arm, hand or foot, consists of burns to a major portion of the body, causes the loss of sight in an eye), fire, explosion or hazardous material release, lost time injuries or accident requiring medical treatment, occupational illnesses, any worker who has had their fall arrested, any 'prescribed incident', or property damage >$500.

Corrective Action Form

Date of injury/incident: _____ Injury/incident number: _____

Date: _____

Corrective action taken (as indicated on the Accident/Investigation Form):

_____

_____

_____

Recommendations:	
Date assigned:	
Responsibility assigned to:	
Details of what has to be done:	
Who has completed it?	
When was it completed?	

Witness Statement Form

Date of injury/incident: _____ Injury/incident number: _____

Name of witness: _____

Date: _____

Name of interviewer: _____

Details of interview:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Signature of witness: _____

Signature of interviewer: _____

Fall Protection Checklist

Project			**Project Location**	**Fall Protection Locations**
Supervisor			**Date**	**Time**
☑	**Step**	**Action**	**Description**	
❑	1.	Choose appropriate fall protection system	Consider the work to be performed, the training needed for each system, the project conditions and the availability.	
		❑ Powered Elevating Work Platform	Perform system checks, ensure level ground, operate according to manufacturers' recommendations, tie off to PEWP or to adequate anchor point above at all times.	
		❑ Horizontal Lifeline	Install and use according to engineer's design drawings, use min. ½" steel wire, <30 ft. between vertical posts, <15" sag in a 30 ft. span, 3 clips tying wire at beam end, engineer's design drawings available, workers using double lanyard, and workers tied off at all times.	
		❑ Vertical Lifeline	Column adequately secured with ½" steel wire or 5/8" polypropylene rope, vertical lifeline attached, vertical lifeline with rope grab extends from top of column to base, 1 worker using lifeline at a time.	
		❑ Self Retracting Lifeline (SRL)	Anchor to approved roof anchor, 1 worker using SRL at a time, must be moved periodically, lifeline locks up in quick movement, automatically retracts when tension removed, minimizing fall distance.	
		❑ Guardrail, Scaffolding, etc.	Removes fall potential by providing a physical barrier, must meet minimum horizontal and vertical forces, must have toprail, midrail and toe board, scaffolding must be built accordingly.	
❑	2.	Frequent inspections of fall protection components	All components of fall protection systems are to be inspected prior to each use by each worker. If deficiency is found, remove equipment from service.	
		❑ Harness	Burns, cuts, loose stitching, frayed webbing, D-rings, grommets and buckles not worn or damaged, CSA stamp.	
		❑ Lifelines	Burns, cuts, frayed material, no discolouration or other damage.	
		❑ Lanyards	Burns, cuts, loose stitching, frayed webbing, CSA stamp, shock absorber in good condition, locking snap hook.	
		❑ Anchor Points	Able to support 3600 lbs., verified by a competent worker.	
		❑ PEWP	Maintenance log, manufacturer's recommended inspections.	
		❑ Rope Grab	Damage, cracking, dents, bends, connecting rings centred, rust, moving parts working smoothly, other wear.	
❑	3.	Rescue procedure chosen	Refer to Construction Regulations, Sec. 26 for employer's Fall Rescue requirements.	
❑	4.	Engineer's design drawings and manufacturer's specifications available	Engineer's design drawings for: ❑ Horizontal lifeline ❑ Scaffold system ❑ Anchor systems Manufacturer's specifications for: ❑ Anchor systems ❑ PEWP ❑ SRLs ❑ Harnesses ❑ Rope grab	

Health and Safety Inspections

Policy Statement

_____ will conduct weekly documented workplace inspections for the purpose of identifying and correcting unsafe conditions and behaviour. The inspections will cover premises, job sites, buildings, temporary structures, excavations, tools, equipment, machinery and work methods and practices. The sites safety inspection form is to be used as a guideline since specific sites may have unique situations and potential hazards that may not be covered by this list.

Site Health and Safety Inspections – Weekly

Planned inspections will occur weekly on project sites and monthly at the company premises. Supervisors representing the general contractor and/or sub-contractors and the health and safety representative will be involved in workplace inspections.

All health and safety inspection reports must be reviewed during toolbox safety talks and management meetings. All completed health and safety inspection reports will be evaluated and monitored by project management and the health and safety representative and filed with the health and safety documentation.

Procedure

1. Review previous inspection records and note any commonly reported hazards.
2. Familiarize yourself with the type of workplace and unique hazards.
3. Use your eyes, ears and other senses to identify actual or potential problems as you go about your inspection. Record the hazards on the Site Safety Inspection Form.
4. When unsafe conditions are noted requiring immediate action, correct the situation immediately.
5. Look for basic causes of sub-standard conditions, practices and procedures.
6. Keep a copy of the inspection form on the project.
7. Review items with the Health and Safety representative and during toolbox talks and management meetings.

Follow-Up Actions to Health and Safety Inspections

- Where unsafe conditions, practices or procedures are noted:
- Take action immediately to rectify the problem if possible.
- Place warning signs and barricades to keep workers away. Use verbal warnings if applicable.
- Notify management to rectify conditions, record conditions, actions taken and the date on the inspection form.
- Record and complete the site health and safety inspection form and file it with safety documentation.

When a worker is noted performing an unsafe act, advise as follows:

- Inform him/her of the unsafe situation
- Discuss the unsafe condition with him/her
- Advise on how to correct the unsafe condition
- Re-visit the area to ensure the safe practice is being followed
- Discuss with the supervisor

Jobsite Inspection Checklist

Inspected by: _____

Company/Project: _____

Number of Employees: _____ **Copies to:** _____

Date: _____ _____

1.	**SITE ACCESS**		**OK**	**Not OK**	**ACTION TAKEN**
	Clean, level ground		☐	☐	_____
	Adequate ramps		☐	☐	_____
	Adequate stairs		☐	☐	_____
	Adequate ladders		☐	☐	_____
2.	**PROTECTIVE EQUIPMENT**		**OK**	**Not OK**	**ACTION TAKEN**
	Hard hats worn		☐	☐	_____
	Fall protection worn		☐	☐	_____
	Skin protection:	Worn	☐	☐	_____
		Available	☐	☐	_____
	Eye & face protection:	Worn	☐	☐	_____
		Available	☐	☐	_____
	Hearing protection:	Worn	☐	☐	_____
		Available	☐	☐	_____
	Respiratory protection:	Worn	☐	☐	_____
		Available	☐	☐	_____
3.	**GUARDRAILS, BARRICADES**		**OK**	**Not OK**	**ACTION TAKEN**
	Located where required		☐	☐	_____
	Properly constructed		☐	☐	_____
	Adequately secured		☐	☐	_____
4.	**LADDERS**		**OK**	**Not OK**	**ACTION TAKEN**
	Secured		☐	☐	_____
	Proper angle (extension ladders)		☐	☐	_____
	Proper size and type		☐	☐	_____
	Safe, usable condition		☐	☐	_____
	Properly used		☐	☐	_____
	Proper Handrail and landings		☐	☐	_____
	Non-slip bases		☐	☐	_____
5.	**FIRE PROTECTION**		**OK**	**Not OK**	**ACTION TAKEN**
	Extinguishers where required		☐	☐	_____
	Fully charged		☐	☐	_____
	Adequately identified		☐	☐	_____
	Master emergency plan		☐	☐	_____

6. PUBLIC WAY PROTECTION	OK	Not OK	ACTION TAKEN
Properly located (within 4.5 m)	☐	☐	
Covered where required	☐	☐	
Min. height, width requirement	☐	☐	
Proper rail on street side	☐	☐	
Proper lighting, where required	☐	☐	

7. HOUSEKEEPING	OK	Not OK	ACTION TAKEN
Clear walkways	☐	☐	
Clear work areas	☐	☐	
Clear access and landing	☐	☐	

8. FALL PROTECTION		OK	Not OK	ACTION TAKEN
CSA approved		☐	☐	
Properly worn		☐	☐	
Safe, usable condition		☐	☐	
Unprotected openings and edges		☐	☐	
Working from:	Ladders	☐	☐	
	Scaffolds	☐	☐	
	Swingstages	☐	☐	

9. STAIRWELLS & RAMPS	OK	Not OK	ACTION TAKEN
Proper filler blocks in metal stairs	☐	☐	
Proper cleats on ramps	☐	☐	
Adequate lighting in stairwells	☐	☐	
Proper handrails or guardrails	☐	☐	

10. SCAFFOLDS	OK	Not OK	ACTION TAKEN
Properly erected (all parts used)	☐	☐	
Properly secured	☐	☐	
Properly planked	☐	☐	
Proper guardrails, toeboards	☐	☐	
Proper access to platform	☐	☐	
Acceptable loading	☐	☐	

11. POWER TOOLS, EQUIPMENT	OK	Not OK	ACTION TAKEN
General condition	☐	☐	
Proper guards, cords, PPE	☐	☐	
Tagging as DEFECTIVE	☐	☐	

12. EXTENSION CORDS	OK	Not OK	ACTION TAKEN
Outdoor-type, rated over 300 volts	☐	☐	
Condition of casing, ends, connections	☐	☐	

13. GAS CYLINDERS	OK	Not OK	ACTION TAKEN
Properly located	☐	☐	
Properly secured	☐	☐	
Properly moved or lifted	☐	☐	
Properly hooked up	☐	☐	

14. WORKER EDUCATION	OK	Not OK	ACTION TAKEN
WHMIS training	☐	☐	
Company safety policy & program	☐	☐	
Injury reporting	☐	☐	
Hazard reporting	☐	☐	
OH&S Act and Regulations	☐	☐	
Personal H&S responsibilities	☐	☐	

15. FIRST AID REQUIRMENTS		OK	Not OK	ACTION TAKEN
Adequate qualified first aiders on jobsite		☐	☐	
First aid kits:	Adequate number	☐	☐	
	Adequate contents	☐	☐	

16. CRANES, HOISTS, ETC.	OK	Not OK	ACTION TAKEN
Safe setup of equipment	☐	☐	
Maintenance log available	☐	☐	
Competent operator	☐	☐	
Condition of slings, hardware	☐	☐	
Safety catches on all hooks	☐	☐	
Proper use of tag lines	☐	☐	
Proper lifting containers	☐	☐	
Competent signaller	☐	☐	

17. TRAFFIC CONTROL	OK	Not OK	ACTION TAKEN
Trained traffic controllers	☐	☐	
Properly located	☐	☐	
Clean, regulation sign	☐	☐	
Properly dressed (including vest)	☐	☐	

18. WELDING	OK	Not OK	ACTION TAKEN
Rods & cylinders properly labeled	☐	☐	
MSDSs readily available	☐	☐	
Properly secured ground cables	☐	☐	
Proper eye protection worn	☐	☐	
Proper screens and exhaust	☐	☐	
Gas cylinders upright and secured	☐	☐	
Fire extinguisher readily available	☐	☐	

19. ELEVATING WORK PLATFORM	OK	Not OK	ACTION TAKEN
Worker training	☐	☐	
Properly used	☐	☐	
Safe, usable condition	☐	☐	
Acceptable loading	☐	☐	
Manufacturer’s operating manual	☐	☐	

20. TEMPORARY POWER SUPPLY	OK	Not OK	ACTION TAKEN
Properly identified	☐	☐	
Overhead lines flagged & secured	☐	☐	
Surface cables buried or protected	☐	☐	

21. SIGNS & PRINT MATERIAL	OK	Not OK	ACTION TAKEN
OH&S Act and regulations	☐	☐	
WSIB Form 82 poster	☐	☐	
MSDSs	☐	☐	
Warning signs	☐	☐	
Emergency phone list	☐	☐	
Report forms	☐	☐	

22. MATERIALS STORAGE	OK	Not OK	ACTION TAKEN
Properly located	☐	☐	
Safely piled, stacked, bundled	☐	☐	
Properly moved or lifted	☐	☐	
Properly labeled (WHMIS)	☐	☐	

23. TRENCHES & EXCAVATIONS	OK	Not OK	ACTION TAKEN
Properly sloped, where required	☐	☐	
Excavated soil properly placed	☐	☐	
Appropriate shoring used	☐	☐	
Proper access to trench	☐	☐	
Proper storage of materials in and above Trench	☐	☐	

24. CONFINED SPACES	OK	Not OK	ACTION TAKEN
Proper access	☐	☐	
Air testing before entry	☐	☐	
Rescue equipment readily available	☐	☐	
Safety harness, lifeline properly anchored & used	☐	☐	
Second person for rescue	☐	☐	
Outgoing air monitored	☐	☐	
Entry permit where required	☐	☐	

25. SUSPENDED SCAFFOLDS	OK	Not OK	ACTION TAKEN
Properly attached and capable of at least 4 times maximum load	☐	☐	
Outrigger beam tied to fixed support with adequate counterweight	☐	☐	
All mechanical/electrical devices in good working condition	☐	☐	
Independent lifelines for each worker (extend to ground)	☐	☐	
Engineer's drawing on site if required	☐	☐	

26. FORMWORK	OK	Not OK	ACTION TAKEN
Guardrails and fall-arrest system	☐	☐	
Design drawings kept on project	☐	☐	
Inspection statement by engineer or competent worker	☐	☐	

27. HYGIENE	OK	Not OK	ACTION TAKEN
Cleanliness of facilities	☐	☐	

Attendance Form

Date _____ **Session/Topic** _____ **Location** _____

Name	Firm Name	Signature

Worker Orientation – Record of Training

Training Program	Yes	Date Completed	Verified by
Certificate of Qualification			
Apprenticeship letter			
WHMIS			
Fall Protection			
Propane			
Forklift			
Powered Platforms			
Health & Safety Rep.			
Certified Member			
First Aid			
CPR Training			
Accident Investigation			
Basics of Supervising			
Fire Protection Training			
Traffic Control			
Powder Actuated tools			

Record of Training

Title of Program:			
Date of Training:		**Certificate Issued:**	[Yes/No]
Instructor's Name:			
Location of Training:			

Print Name	**Signature**	**Successfully Completed**	
		Yes	No

Original copy of the training record will be kept with the Health and Safety Coordinator in the Master Training file.

Records of training will be kept for 3 years or required by legislation.

Master copies of any in-house program will be kept with the Health and Safety Coordinator and will be reviewed on an annual basis or if there is a legislative change.

Employee Warning Report

Employee's Name _____

Date of Warning _____

Project _____

Issued by _____

Type of Violation Safety ❑ Other ❑

Company Statement (Supervisor's Report)

_____

_____

_____

Signature _____

Employee Statement (check the appropriate statement)

I agree with the Company's statement ❑

I disagree with the Company's statement, for the following reasons ❑ (state below)

_____

_____

_____

_____

I have entered my statement of the above matter.

Employee Signature _____ Date _____

Witness Name _____ Signature _____

I would like to receive a copy of this statement for my records. ❑

Please be aware that this report will be kept in the personnel file.