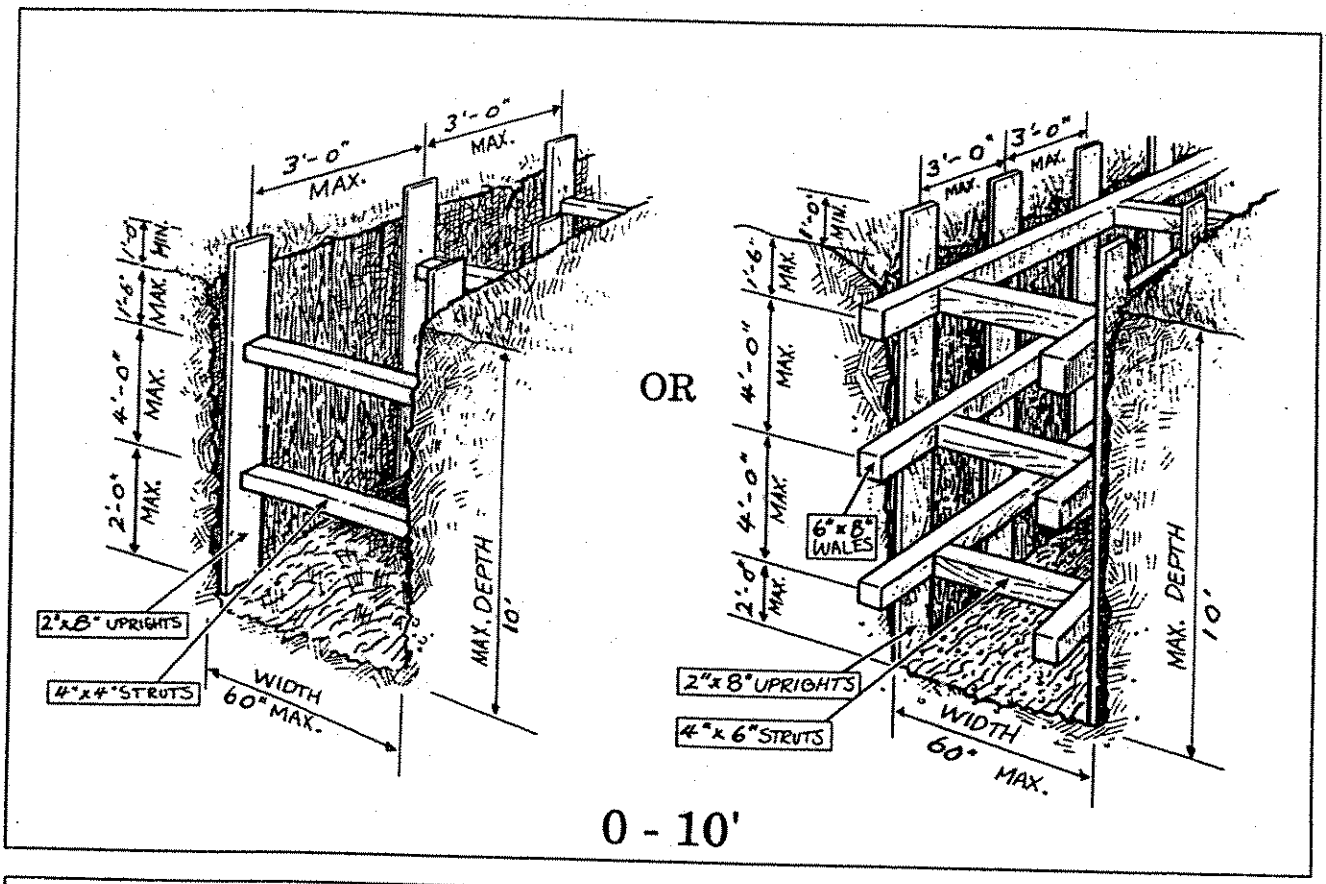
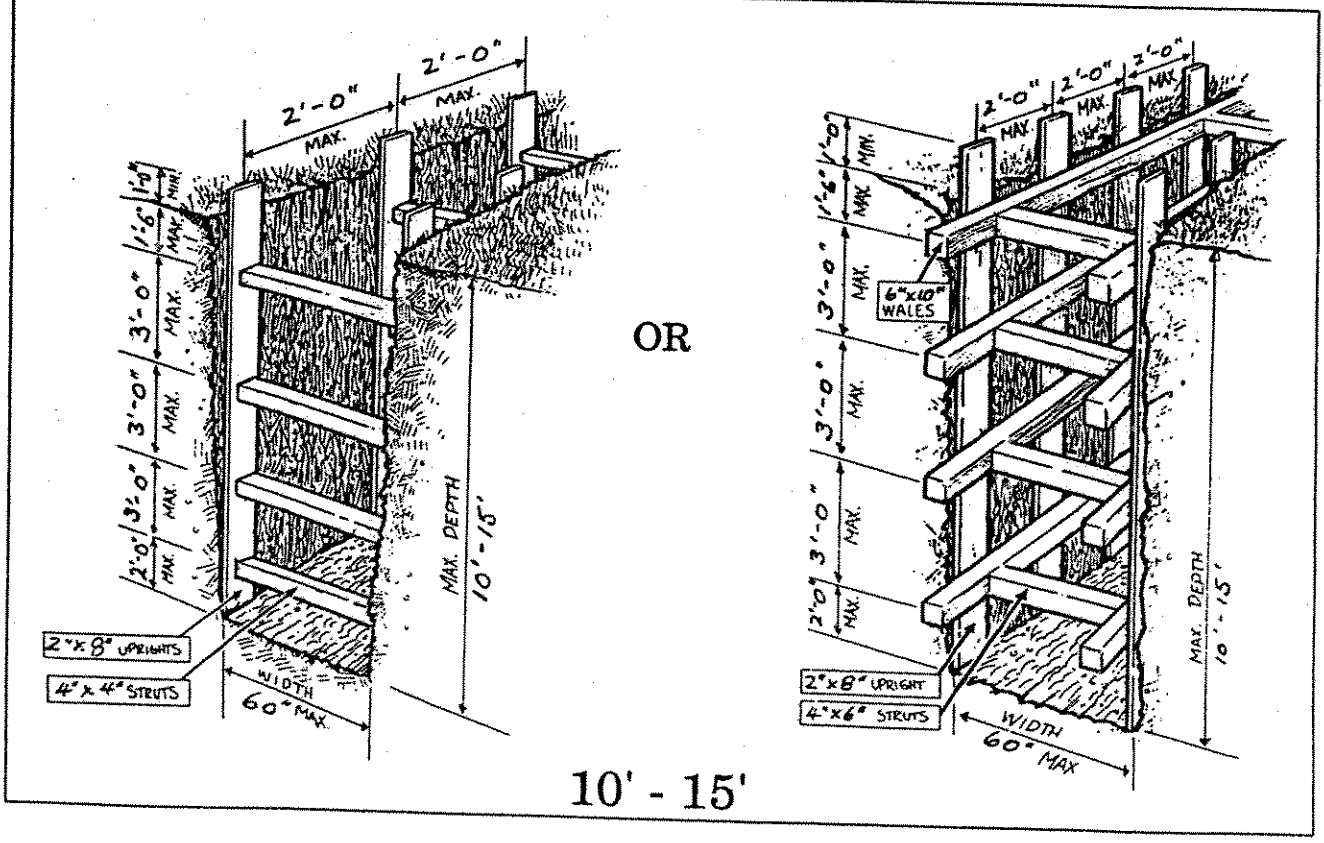
SOIL CATEGORY I - STIFF AND FIRM SOILS

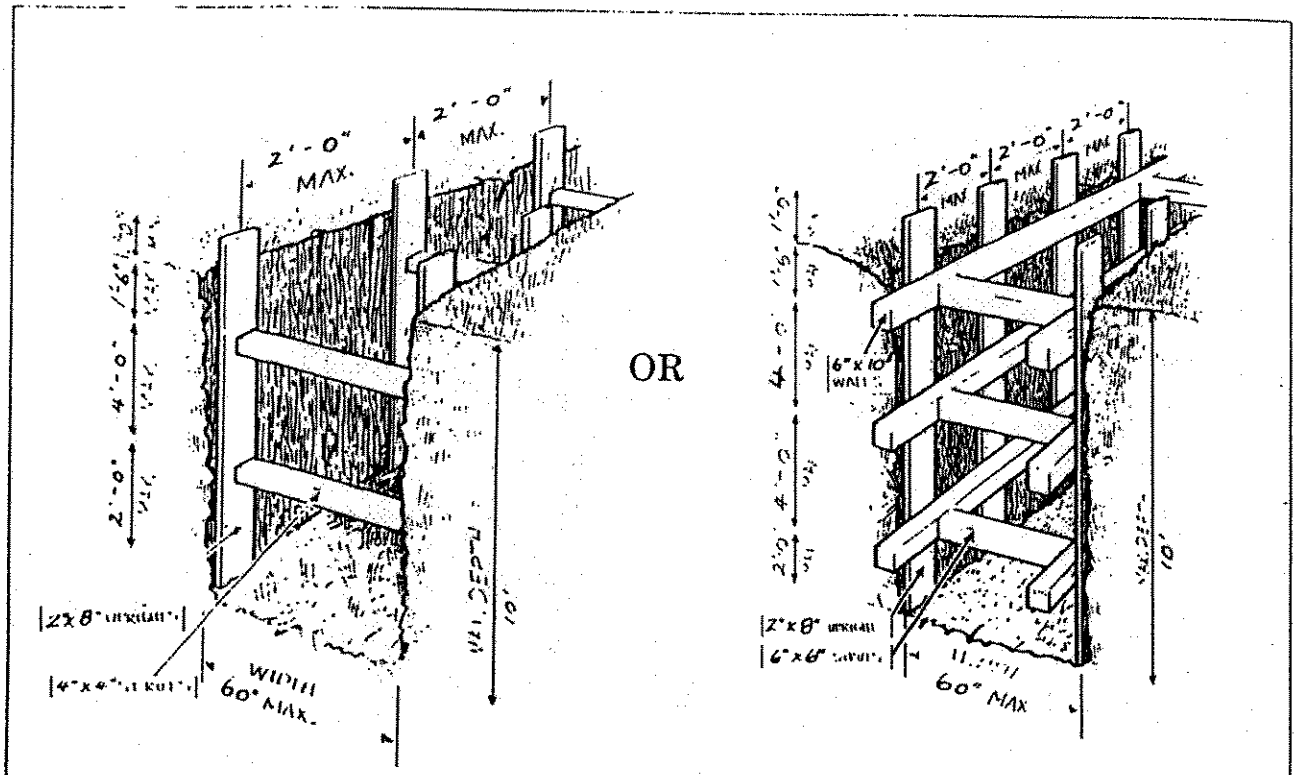


0 - 10'

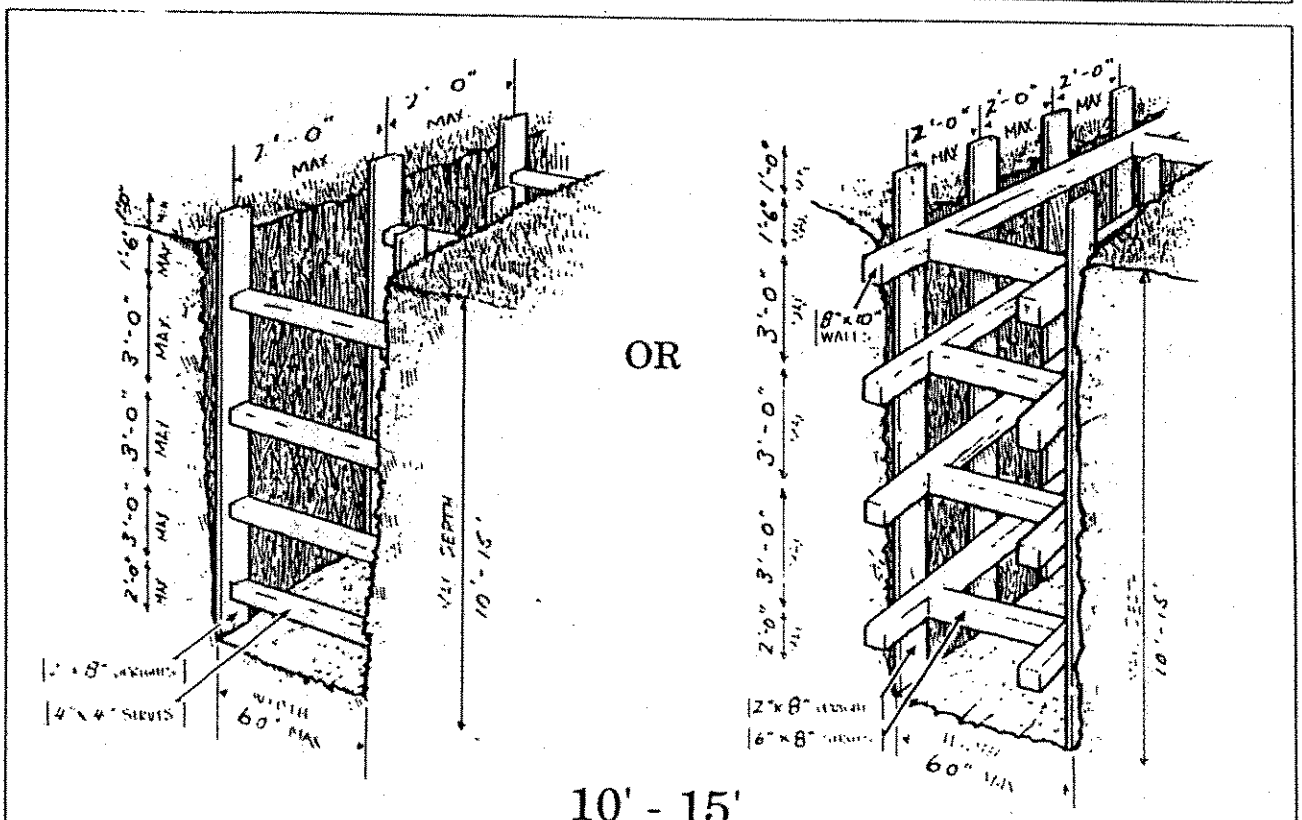


10' - 15'

SOIL CATEGORY II - SOILS LIKELY TO CRACK & CRUMBLE

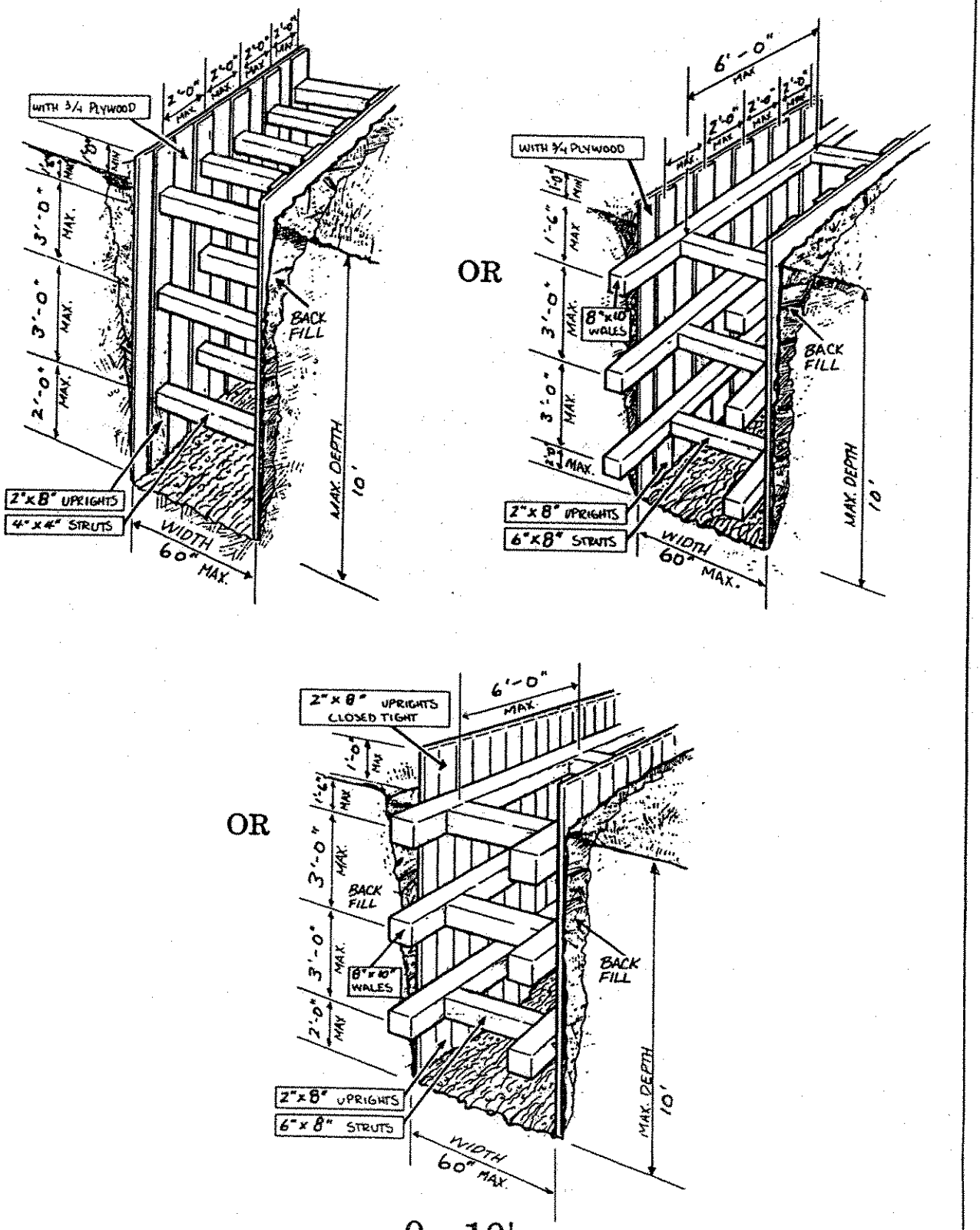


0 - 10'



10' - 15'

SOIL CATEGORY III - LOOSE & SOFT SOILS



0 - 10'

E. SHORING OF TRENCH EXCAVATIONS

When installing shoring within a trench type excavation, proper methods and procedures **must be followed** to provide for a safe excavation.

> Uprights, struts (screw-jacks), wales, and plywood must be installed in accordance with the shoring tables based on the soil conditions, depth, and width of the trench excavation.

INSTALLATION OF SHORING

When shoring is in progress, the bucket of the excavation machine **must** be placed in the trench directly in front of the shoring being installed. The bucket will serve as additional protection if a cave-in occurs.

A proper ladder must be provided in a trench or open excavation. The ladder must extend at least 1 metre (3 feet) above ground level and be within 3 metres (10 feet) of a worker's working position.

It is essential that shoring struts/jacks be installed from the top down. It is important that the top (first) strut/jack be placed approximately 0.5 metres (18 inches) below the surface, then the second strut/jack placed according to the shoring table. The installation of the first and second strut/jack to support the vertical uprights is very important as it stabilizes the excavation walls.

When plywood is used, the jacks or struts must **never** be installed directly on to the plywood. (If the walls move, the jack or strut could push through the plywood). Where plywood is used, the jacks must be placed on the uprights that support the plywood.

Once the worker has a minimum of two struts/jacks placed on each set of uprights, the worker can proceed to install the bottom strut/jack. There must never be less than two struts/jacks used on each set of shoring.

This procedure is to be followed with each set of shoring. Using this method, the worker is protected by the bucket of the digging machine and the shoring already installed.

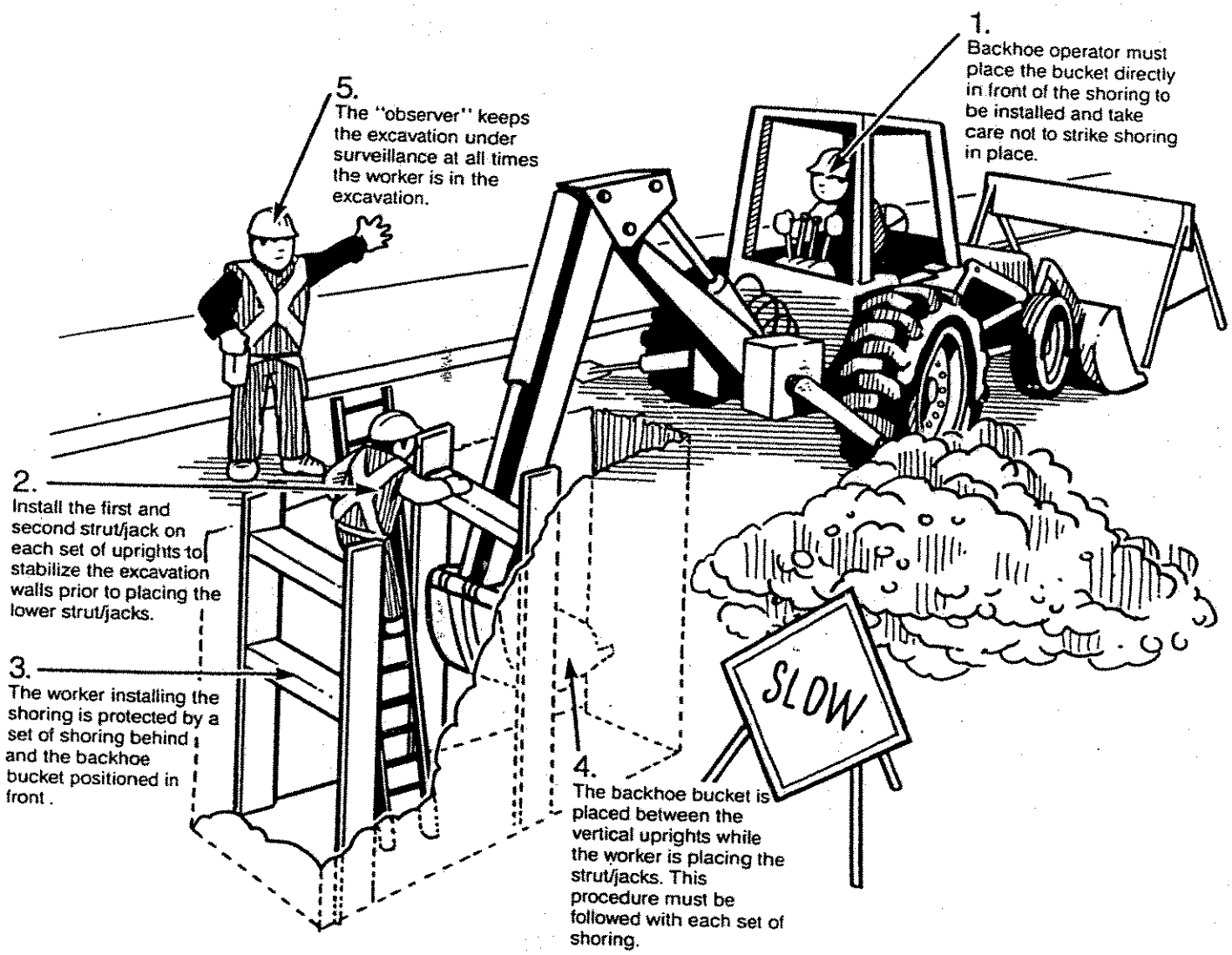
REMOVAL OF SHORING

When removing shoring, the reverse procedure is used. That is, the struts are removed from the bottom to the top. Remember, there MUST never be less than two sets of uprights in place and the worker must always remain within the shoring in place for protection.

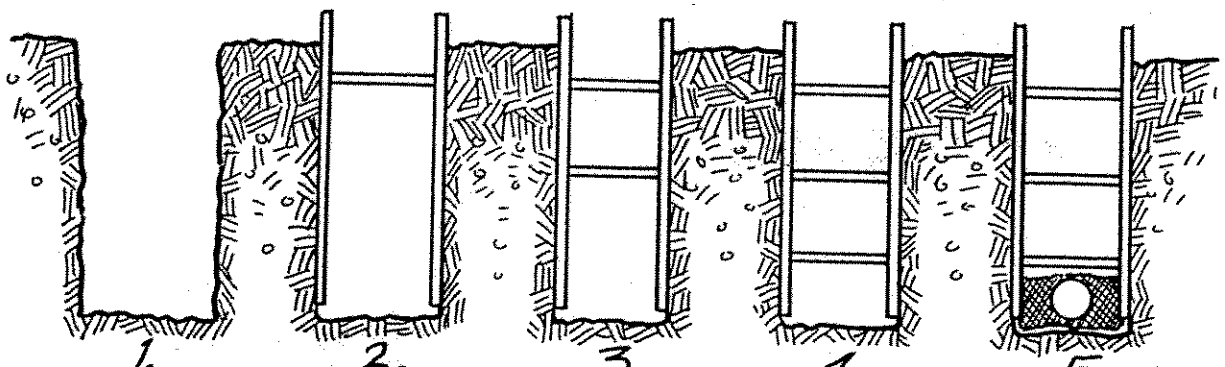
If there is undue pressure felt when removing a strut or jack, it means that the soil has moved and the trench must be backfilled up to the bottom jack before it is removed; then up to the next jack and so forth. Remember, do not try to remove a jack with undue pressure, as it may cause a sudden collapse.

It is preferable to have the worker who installed the struts to be the one who removes them. That worker will know if there has been a change in conditions, undue pressure on struts or other potentially dangerous conditions.

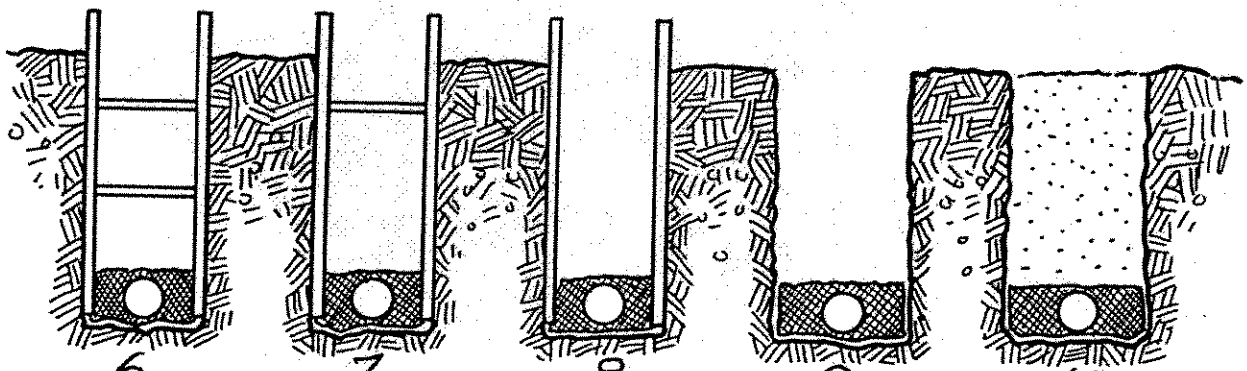
PROPER SHORING PROCEDURE



SEQUENCE FOR THE INSTALLATION AND REMOVAL OF SHORING

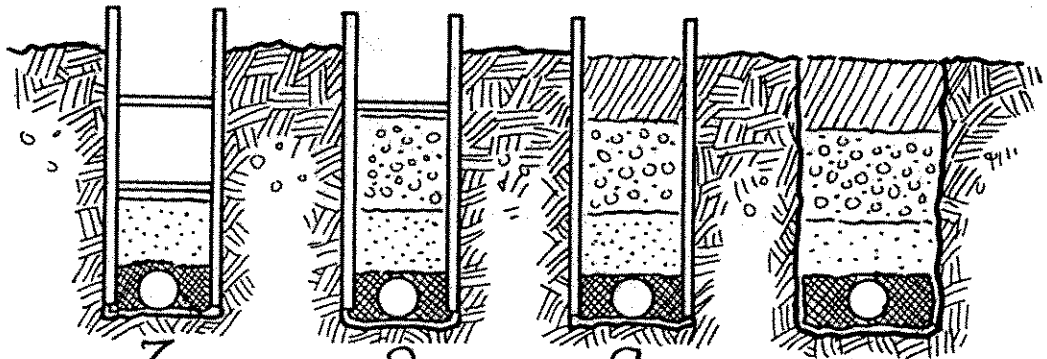


1. EXCAVATE.
2. PLACE UPRIGHTS AND UPPER STRUT.
3. INSTALL OTHER STRUTS WORKING FROM THE TOP DOWN.
4.
5. MAKE THE IMPROVEMENTS.



6. REMOVE LOWEST STRUT FIRST.
7. REMOVE OTHER STRUTS WORKING FROM THE BOTTOM UP.
8.
9. REMOVE UPRIGHTS
10. BACKFILL (NO WORKERS ALLOWED IN TRENCH TO COMPACT BACKFILL

OR



7. BACKFILL AND COMPACT TO LEVEL OF NEXT STRUT.
8. REMOVE STRUT AND REPEAT STEP 7.
9. REMOVE STRUT AND COMPLETE BACKFILL
10. PULL UPRIGHTS.

F. TRENCH CAGES

A trench cage is a self-contained steel structure placed in an excavation (prior to a worker entering) that is designed to withstand soil pressures and protect the worker(s) against soil cave-ins.

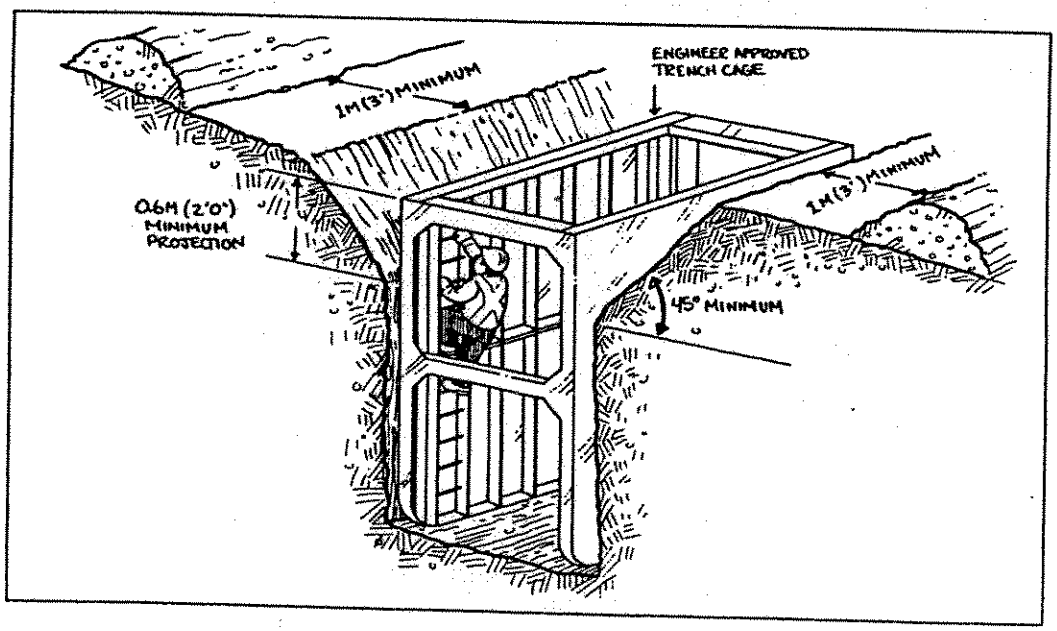
Trench cages **must** be designed by a professional engineer and constructed inspected and maintained in accordance with the engineering specifications. The design criteria for a trench cage is normally based on 75 pounds per square foot of earth pressure, per foot of depth of the excavation.

Where trench cages are designed to be "stacked" in deep excavations, these must be secured in a manner to transmit the loading condition between cages.

Trench cages shall have continuous sides and extend at least 600 mm (24 inches) above the vertical wall of the excavation.

Hoisting hook-up and drag points on trench cages must be designed and engineer approved. Workers working in a trench cage that is to be dragged forward, must be protected against rigging failure by suitable protective screening or other means.

NO WORKER IS TO WORK OUTSIDE THE PROTECTION OF THE TRENCH CAGE!



G. HYDRAULIC/PNEUMATIC SHORING SYSTEMS

Hydraulic and pneumatic shoring systems are advantageous because a worker does not have to enter the excavation in order to put the supports in place. These systems are often made of lighter weight material such as aluminum and can be handled easily. Care must be taken to ensure that the systems are property maintained and not damaged when in use.

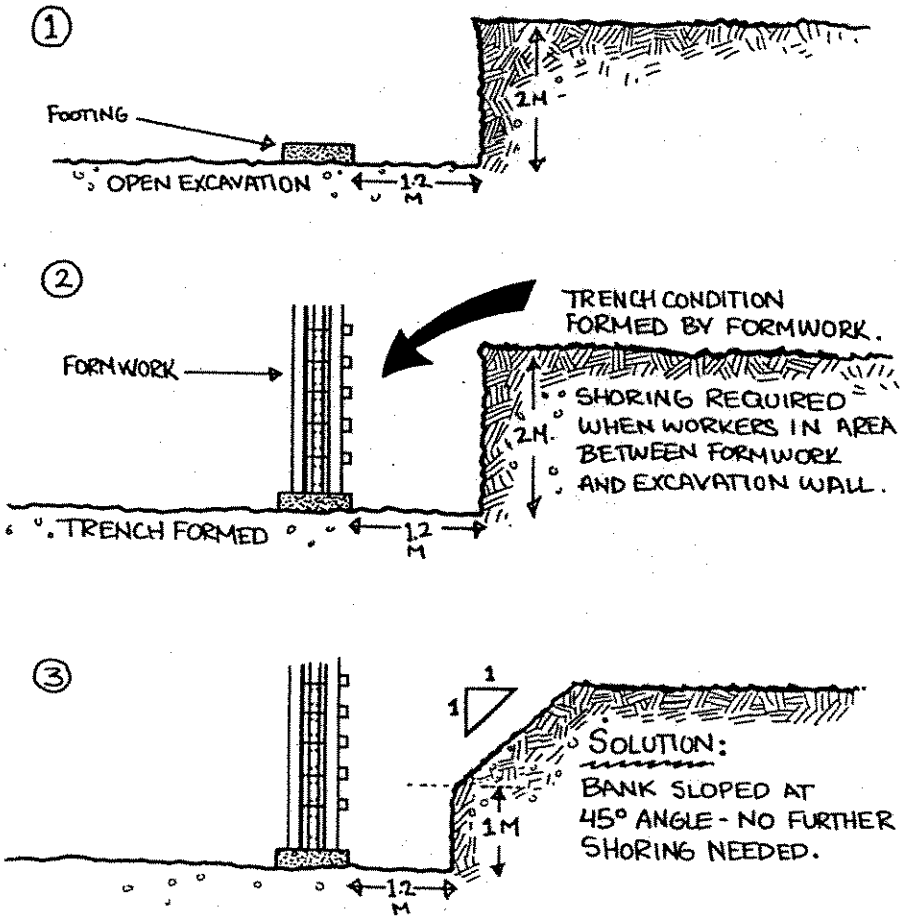
Hydraulic and pneumatic shoring systems must be certified by a professional engineer to be equivalent to the requirements as specified in the trench shoring tables for the particular soil conditions.

2. OPEN EXCAVATIONS

Excavations that are **not** considered to be trenches, caissons, shafts, or tunnels may be classified as open excavations. A basement or foundation excavation for a building or structure is a good example of an open excavation. If an open excavation exceeds 2.4 metres (8 feet) in depth, then the walls of the excavation must be vee'd-out or a shoring support structure designed and installed.

A shoring support structure for an open excavation must be designed by a professional engineer. Typical structures consist of heavy wood lagging supported by steel I-beams properly installed into the foundation. The engineering specifications must include complete details on the correct procedures to install the support structure and on-going inspection criteria to ensure the shoring is maintained in a safe condition.

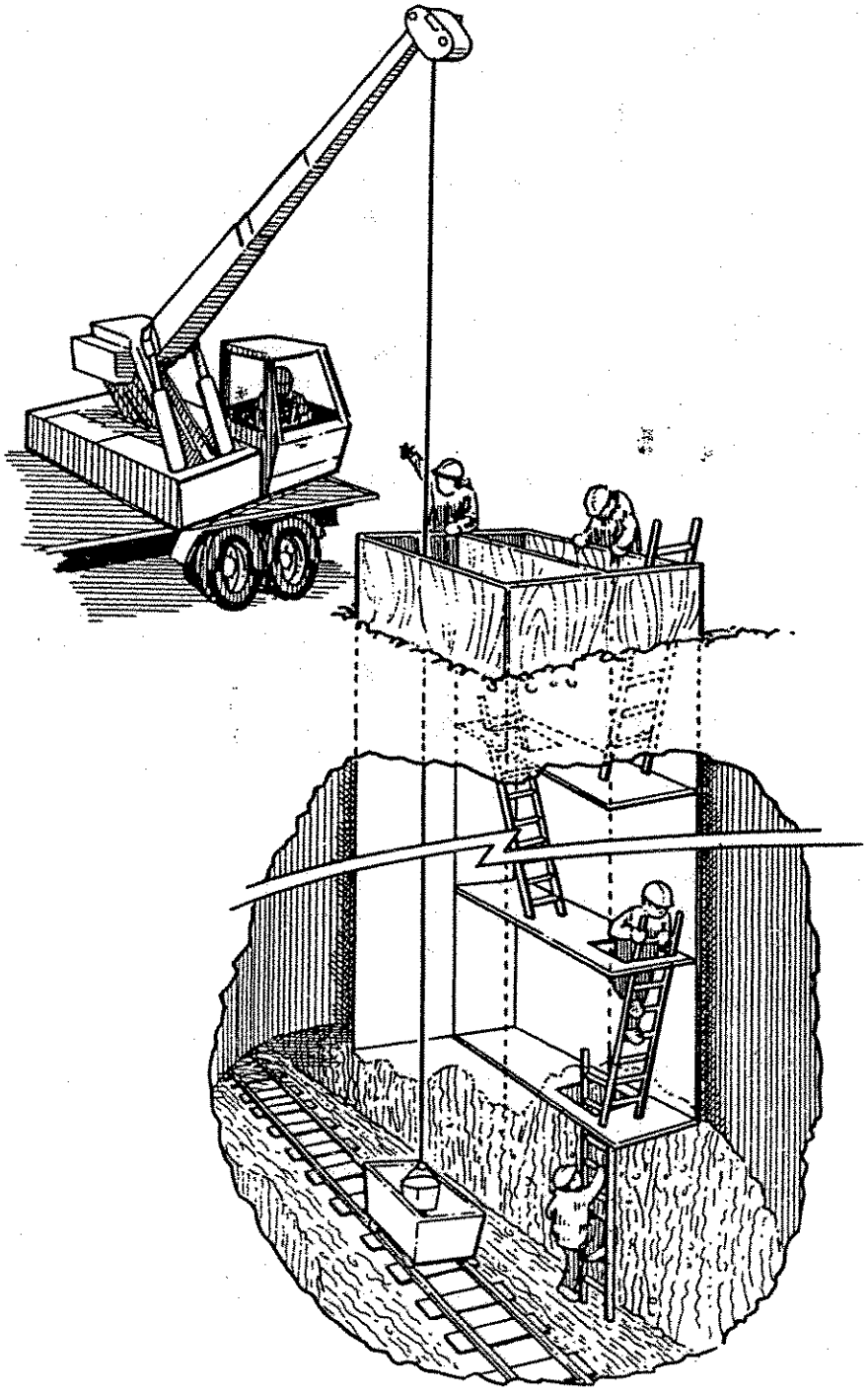
BE AWARE! An open excavation may become a trench excavation as the project proceeds. A concrete basement wall constructed in an open excavation 2.0 metres (6.6 feet) deep, now requires shoring or veeing-out if workers are required to work on the outside wall between the concrete and earth.



PART VI

SHAFT AND TUNNEL EXCAVATIONS

Shaft and tunnel excavations are used primarily in sewer, water, and other utility work and include such procedures as vertical circular shafts, "hand" tunneling operations and fully mechanized excavating systems ("moles").



1. GENERAL REQUIREMENTS

The requirements outlined in Part III and Part IV of this guideline apply to shaft and tunnel excavations. It is especially important to ensure that the following requirements are actioned.

A. CONFINED ENTRY

Shaft and tunnel excavations are to be considered confined entry situations and a hazard assessment and risk control analysis must be undertaken.

Where monitoring of hazardous atmospheres is required, the job site supervisor must be equipped with suitable testing equipment (i.e. explosive meter, oxygen, and toxic gas detectors) and be trained in proper monitoring procedures. It is recommended that continuous monitoring devices be used where monitoring is necessary.

Ventilation systems must be put in place to provide a safe atmosphere where there may be a lack of oxygen or unsafe accumulations of toxic vapours, gases, dusts, or other harmful substances.

> The ventilation rate at the work face of the tunnel shall not be less than 2.75 cubic metre/second per square metre of face area (50 cubic feet/minute per square foot of face area).

B. FIRST AID FACILITIES/EMERGENCY PROCEDURES

Due to the nature of the work, it is important that proper first aid supplies be provided at the excavation worksite. A first aid kit shall be provided at each shaft location. It is recommended that at least one worker on each shift shall be a certified first aider with CPR training. A basket stretcher and blankets must also be provided at each worksite, as well as a "parachute-type" full body harness for hoisting a worker to the surface, if necessary.

Workers shall be instructed on rescue procedures to be undertaken in case of a serious accident or injury occurring in a shaft or tunnel.

C. SANITARY FACILITIES

The wash-up facilities at excavation worksites must be kept in a sanitary condition. Provisions must be made to provide a supply of clean and warm running water, hand cleaners, soap, and towels for the workers to use.

D. LIGHTING/ELECTRICAL INSTALLATIONS

Underground excavations must be provided with a source of electrical illumination for the full length of the tunnel and at the working face of the tunnel excavation [minimum 25 lux (2.5 foot-candles) of illumination]. In the event of electrical failure, an emergency lighting system must be in place. This may consist of battery operated flashlights suitably sized and located to assist workers in exiting the tunnels.

All electrical circuits in underground excavations must be installed in accordance with the Manitoba Electrical Code. Light bulbs shall be caged to protect them from physical damage. Due to the moisture accumulations in such excavations, it is essential that electrical wiring systems be properly grounded. Only electrical equipment and tools that are doubly

insulated or properly grounded can be used. It is recommended that GFCI's (Ground Fault Circuit Interrupters) be used for electrical circuits underground.

E. FIRE PROTECTION

A minimum of two, 2A-10BC rated multi-purpose type fire extinguishers shall be provided in each shaft and tunnel excavation. Any flammable or combustible liquids must be stored in compliance with the Manitoba Fire Code and dispensed only from safety containers meeting the requirements of CSA Standard B376, "Portable Containers for Gasoline and other Petroleum Fuels".

Combustible scrap materials, such as wood shoring components, shall not be allowed to accumulate in the excavation. These shall be removed at least daily.

F. USE OF EXPLOSIVES

All blasting operations must be undertaken by a certified blaster who is qualified to handle and use explosives. Explosives must be stored and transported in accordance with both Transport Canada and Energy Mines and Resources Canada regulations.

G. ACCESS/EGRESS

(i) Vertical Circular Shafts

Vertical drilled shafts, shored with steel sleeves, are normally provided access by a straight fixed vertical ladder. Where the ladder exceeds 5 metres (15 feet) in length a rest platform or proper fall protection must be provided. This can be done by providing a worker with a full-body safety harness secured with a lifeline to a fall-arresting device.

(ii) Shafts with Hoistways

In shaft and tunnel operations, the worker accessway to a shaft must extend the full length of the shaft and be **completely** separated from the hoistway in a manner so that the load or hoisting device cannot come in contact with the workers. The accessway must be equipped with a vertical ladder having rungs spaced at 300 mm (12 inches) on centre with a clear space of 150 mm behind each rung, and rest platforms (landings) located every 5 metres (15 feet).

Both accessways and hoistways shall be provided at the surface with proper guardrails having a top rail, mid-rail and toeboard. The accessway must have a secured cover to prevent unauthorized entry and the cover is to be locked at all times when not in use.

2. SHORING

All shafts and tunnel support structures shall be designed and approved by a professional engineer in accordance with the provisions of Part III and Part IV.

A. SHAFT AND TUNNEL OPERATIONS

A shaft that is to be excavated to a depth of 1.8 metres (6 feet) or more shall have shoring installed continuously from 300 mm (12 inches) above the surface of the excavation to the bottom of the shaft.

Soil shall not be exposed in lifts greater than 1.8 metres (6 feet) where workers may enter, without the immediate installation of proper shoring.

Subject to confirmation by a professional engineer, vertical shoring must be equivalent to full 75 mm x 200 mm (3" x 8") close shored timbers supported by 200 mm x 200 mm (8" x 8") horizontal wales [maximum 2.5 metres (8 feet) span] not more than 1.8 metres (6 feet) on center and posted at the corners. For spans greater than 2.5 metres (8 feet), the wales must be increased in size in accordance with engineering specifications.

Subject to confirmation by a professional engineer, crown shoring shall not be less than full 75 mm x 200 mm (3" x 8") timbers that extend from the 10 o'clock position around the roof to the 2 o'clock position. The shoring shall be put in place as digging proceeds and as soon as possible after the "monkey hole" has been excavated. Planks shall be fully over lapped at connection points. [75 mm (3") minimum]

Crown shoring shall extend a maximum of 900 mm (3 feet) beyond the concrete framing for the next "push". The maximum length for crown shoring is 3.0 metres (10 feet) under stable soil conditions.

"Face" shoring is to be installed in all tunnels greater than 1.8 metres (6 feet) in diameter and in tunnels at a lesser diameter where soil conditions may be unstable.

B. VERTICAL CIRCULAR SHAFTS

Steel sleeves are often used to shore vertical drilled circular shafts in cohesive soils. The sleeves are usually made from unreinforced steel plate and have proved to successfully prevent local "cave-ins" of blocks of soil and wet silt layers. Subject to confirmation by a professional engineer, the following minimum criteria apply;

i) The steel sleeves must be in good condition, circular in shape when standing upright, and the plates should have no cracks, bends, or buckles.

ii) The shaft must be drilled, and its diameter should not be more than 50 mm (2") greater than the outside diameter of the sleeve.

iii) The sleeve plate thickness should not be less than 10 mm (3/8").

iv) For shafts up to 2.4 m (8 feet) in diameter, adjoining sections of sleeves may be of the same diameter, simply butted at the joints. For holes greater than 2.4 m (8 feet) in diameter, sleeve sections should be of varying diameter, allowing successively lower sections to be placed inside upper sections in the manner of a telescope. Sections of sleeves should have a minimum overlap of 300 mm (1 foot).

v) The drilling of shafts and installation of sleeves should take place on the same day. Holes should not be left unsleeved overnight.

Note: This type of shoring is temporary and should not be utilized for periods longer than 30 days and should not be used for holes larger in diameter than 4.5 m (15 feet).

C. HOISTING OPERATIONS

All cranes and hoisting equipment used for excavation work shall be inspected and maintained in accordance with the manufacturer's maintenance procedures. Records of such inspection and maintenance shall be kept in a crane log book.

All ropes, cables, chains, blocks, and other hoisting equipment shall be rated as hoisting equipment and regularly inspected to ensure that the equipment is not damaged and can continue to be used safely.

The employer shall establish a system of clearly communicated signals which shall be used for all hoisting operations. Workers appointed by the employer and trained in proper hoisting procedures shall be located at both the top and bottom of a shaft at all times hoisting operations are to be undertaken.

D. HAULAGE EQUIPMENT

A motorized locomotive with an internal combustion engine must be equipped with a properly maintained exhaust conditioner and serviced regularly in order to control hazardous exhaust gases and other emissions (i.e. carbon monoxide, nitrogen oxides).

All haulage locomotives must be equipped with properly maintained braking systems and operator "dead-man" power controls that are operational from the driver's station only. The locomotive must also have an audible horn and warning lights.

No workers shall ride on haulage locomotives, except in seats provided for that purpose. A worker may only ride in a vehicle designed specifically for the transportation of workers. Workers are not allowed to ride in a haulage bucket that is being hoisted to the surface in a shaft.

Haulage buckets shall not be overloaded with mud in a manner where the material is likely to fall out of the bucket.

It is important that rail track placed for haulage locomotives and buckets is constructed in a straight manner, located at a uniform height to the established tunnel grade, and securely fastened to the foundation ties.

PART VII

CAISSON EXCAVATIONS

1. GENERAL REQUIREMENTS

A. SAFE WORK PROCEDURES

Due to the nature of the risks involved in a worker entering a caisson or similar type of deep foundation excavation, it is essential that the employer develop a documented safe work procedure for this type of confined entry work. A documented method of access and egress for a worker is to be available at the worksite prior to a worker entering the excavation.

It is also essential that the excavation be under constant supervision at all times when a worker is in the caisson. An "observer" must be at the surface near the top opening at all times when a worker is in the caisson.

B. CONFINED ENTRY SITUATION

The principles established in Part III and IV of this guideline regarding confined entry apply to caisson excavations. Procedures must be developed to deal with a number of potential hazards. The risk assessment must include, but may not be limited, to the following;

i) the presence of toxic gases, vapours, fumes, or other hazardous materials that maybe in the excavation;

ii) the lack of oxygen;

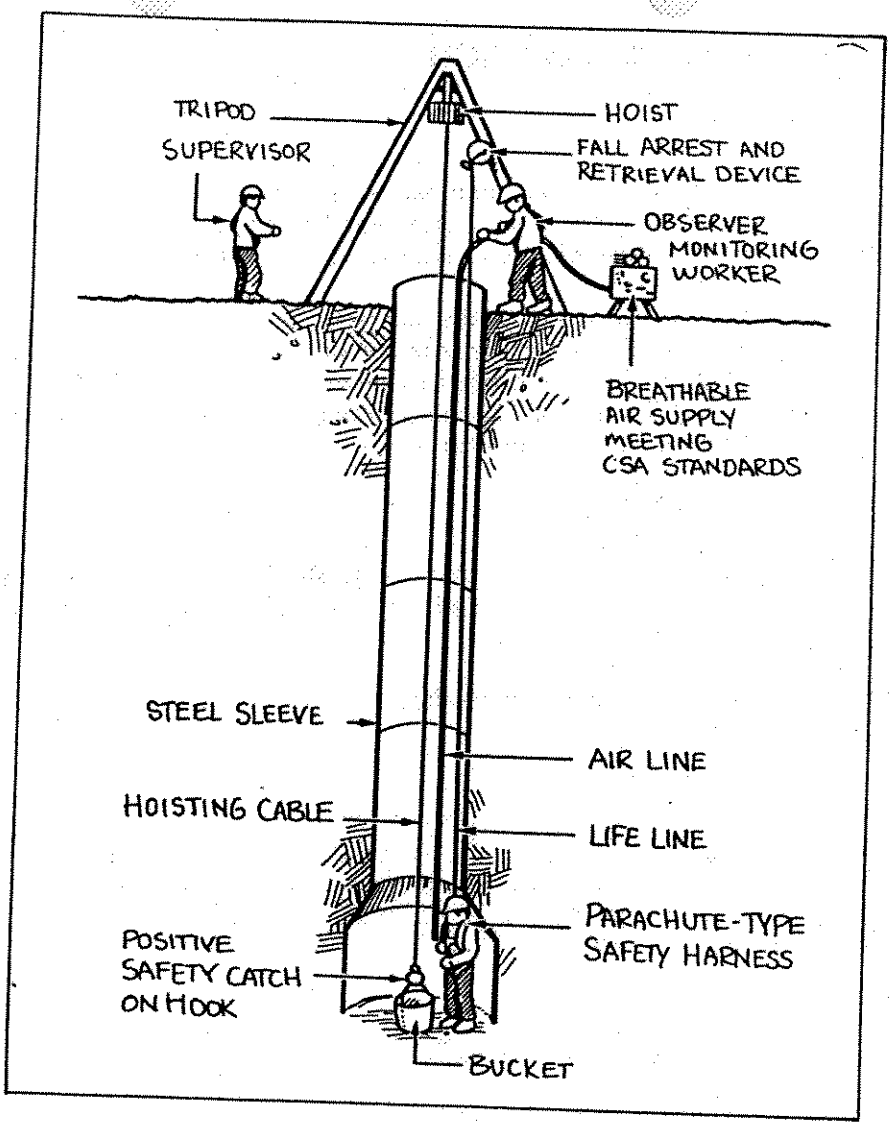
iii) the restrictive dimensions (size) of the excavation; and

iv) the hoisting of materials and workers in a confined space.

A sufficient supply of air suitable for breathing must be provided in a caisson excavation. This is normally provided through a proper piping system from the surface to the working level. An adequate supply of uncontaminated breathable air must be provided throughout the period a worker is working in the excavation. Continuous electronic monitoring of the oxygen content of the air in a caisson must be undertaken prior to a worker entering the excavation and during the time the worker is in the caisson.

Where it is suspected that poisonous or flammable gases may exist in the caisson, continuous testing must also be undertaken.

Precautions must be taken to ensure that exhaust gases from the compressor or other internal combustion engines nearby do not enter the excavation.



2. SHORING SUPPORT STRUCTURE

A. ENGINEERING APPROVAL

The shoring support structure for a caisson excavation must be approved by a professional engineer, prior to a worker entering such an excavation. Steel sleeves of approved dimensions and material are normally used to shore a caisson.

B. DESIGN

The minimum diameter of a shoring support structure in a caisson is 700 mm (28 inches).

The shoring support structure must extend a minimum of 600 mm (2 feet) above ground level to the point where work is to be undertaken.

3. ACCESS/EGRESS TO THE EXCAVATION

A. HOISTING DEVICE

A worker entering a caisson excavation must be secured to a tripod-type hoist or similar device that is approved by a professional engineer. The tripod hoist must be of a sufficient height to raise the worker completely above the surface of the caisson.

The worker retrieval and fall-arrest device is separate from the "mud bucket" hoist and must be capable of supporting a worker with a 4 to 1 factor of safety. The device must be equipped with an adequate braking mechanism capable of arresting the fall of a worker with the same factor of safety. The retrieval system shall be capable of bringing the worker to the surface of the excavation in 2-1/2 minutes or less.

B. HOISTING COMPONENTS

All cables, hooks, shackles, and other components shall be rated by the manufacturer as hoisting components having a 10:1 safety factor. They shall be inspected on a regular basis to ensure that they are not damaged.

The correct number and spacing of wire clips and thimbles must be used when rigging hoisting components.

All hooks must be equipped with a positively secured safety latch. Simple spring-type safety latches that cannot be secured in a closed position are not acceptable.

C. PERSONAL PROTECTIVE EQUIPMENT

A worker entering a caisson must wear a full-body safety harness attached to an approved lifeline that is secured to a fall-arresting retrieval device located at the surface of the excavation.

The worker must wear CSA approved footwear and headwear at all times. Safety eyewear and other job-specific protective equipment may also be necessary.

APPENDIX - D

RECONCILIATION FORMS

WERI

TANDEM RECONCILIATION FORM
IQALUIT AIRPORT

SITE (location of impacted soil)_____ **DATE**_____

TRUCK IDENTIFICATION	COMPANY TRUCK REGISTERED TO	VOLUME PER LOAD (m^3)	NO. OF LOADS	EXTENDED VOLUME (m^3)
			TOTAL VOLUME (m^3)	

SIGNATURE OF CLIENT'S REPRESENTATIVE_____

SIGNATURE OF WERI REPRESENTATIVE _____

WERI

WATER TREATMENT RECONCILIATION FORM
IQALUIT AIRPORT

SITE (location of impacted water)_____

DATE	VOLUME OF TREATED GROUNDWATER (Imperial gallons)	VOLUME OF TREATED GROUNDWATER (L)
TOTAL VOLUME	Imperial gallons*	Litres*

SIGNATURE OF CLIENT'S REPRESENTATIVE_____

SIGNATURE OF WERInc REPRESENTATIVE _____

*NOTE:
1 Imperial Gallon=4.546L