

Filed Aug 19 - 1959

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WD 6.001 - 6.40

Pursuant to authority vested in the Industrial Commission by sections 101.01 - 101.29 Wisconsin Statutes, the Industrial Commission on August 14, 1959 voted to repeal orders Ind 6.001 - Ind 6.40 inclusive, known collectively as the Tunnel, Caisson and Trench Construction Code and adopt new orders Ind 6.01 - Ind 6.38 inclusive, to be known collectively as the Trench, Excavation and Tunnel Construction Code.

STATE OF WISCONSIN
DEPT. OF INDUSTRIAL COMMISSION } SS.

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Helen E. Gill, Secretary of the Industrial Commission, and custodian of the official records of said commission, do hereby certify that the attached rules and regulations relating to the Trench, Excavation and Tunnel Construction Code were duly approved and adopted by this commission on August 14, 1959.

I further certify that said copy has been compared by me with the original on file in this commission and that the same is a true copy thereof, and of the whole of such original.

IN TESTIMONY WHEREOF, I have here-
unto set my hand and affixed the
official seal of the department
at the Capitol, in the city of
Madison, this 18th day of
August, A. D., 1959.


Secretary

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PROPOSED CODE

ON

TRENCH, EXCAVATION AND TUNNEL CONSTRUCTION

PART I - GENERAL

Ind 6.01 Scope. These orders shall apply to all tunnels, caissons, accessory shafts and trenches while under construction with the exception of tunnel construction in connection with mines. The following types of construction are understood to be included: Lateral Trenches (House Connections), Water Taps and Connections, Sanitary and Storm Sewers, Welded Pipe Lines, Water Mains, Basements, Footings, Dry Well Excavations, Manholes, Shafts, Storage Tunnels, and all other Excavations.

Ind 6.02 Definitions. For the purpose of these orders the following items are defined. (1) TUNNEL is a subterranean passage or chamber constructed without the removal of a superincumbent material.

(2) SHAFT is an excavation made from the surface of the ground, the longer axis of which is steeper than 45 degrees. Widening of a trench to accommodate a manhole shall be considered a trench.

(3) TRENCH means a longitudinal excavation made from the surface of the ground.

(4) CONSTRUCTOR means a person, firm or body corporate in immediate control of the construction of any excavation and subsequent construction and as such responsible for the condition and management thereof.

(5) SUPERINTENDENT means a person resident on the work having general supervision and responsibility.

(6) FOREMAN means a person in charge of a subdivision of the work or of the entire work at any one time and under the instructions of the superintendent, or constructor.

(7) WORKS or WORKINGS means any or all parts of any project excavated or being excavated as well as shafts and approaches, power houses, lumber yards, storage yards and structures of all kinds, which are in the immediate vicinity of and used in connection with the excavation or the immediate disposal of excavated material or in connection with any phase of the construction project.

(8) PERSON means a firm or body corporate as well as natural persons.

(9) UNDERGROUND means within the limits of any shaft or tunnel.

(10) EMPLOYES or PERSONS EMPLOYED means all persons receiving compensation from the constructor or others for labor or services performed on the works.

(11) APPROVED (unless otherwise specified) means approval by the Industrial Commission.

(12) PRESSURE means gauge pressure in pounds per square inch.

(13) OPEN AIR shall be defined as well ventilated under normal atmospheric pressure.

(14) TIGHT SHEATHING means planks shall be abutting.

(15) SAFETY SCREEN is an air-tight diaphragm placed across the upper part of the tunnel between the shield and the emergency air lock. The function of the safety screen is to prevent flooding of the upper part of the tunnel between the screen and the lock by forming in effect a diving bell in which the air is retained, preventing the water from rising above a certain level. The lower edge of the screen should be placed at a horizontal plane below the entrance to the emergency lock.

Ind 6.03 Inspections. (1) All excavations, timbering and equipment shall be inspected daily. All dangerous conditions or defects shall be made safe. The constructor or his representative shall be responsible for these inspections and the safety of all

workmen at all times.

(2) Every reasonable precaution shall be taken to insure the safety of the workmen in all cases whether or not provided for in these orders.

(3) Frequent inspections of rock excavations, including tunnels, shafts and trenches shall be made by the constructor or his representative and loose rock which may fall shall be removed.

(4) After a blast is fired these requirements for inspection and removal of loose rock shall be complied with before proceeding with the work.

Ind 6.04 Care of the Injured. (1) It shall be the duty of employers to keep at such place or places as shall be convenient and accessible to employes in shafts or tunnels a wire basket stretcher and a woolen blanket for use in carrying any person who may be injured.

(2) An approved supply of first aid material shall be kept and maintained at all times in a dust and moisture-proof box.

(3) Information regarding emergency handling of the injured shall be posted whenever possible.

Ind 6.05 General Safety. (1) Projecting Nails. All spikes and nails with points projecting shall be bent down or removed from lumber lying in or about working places.

(2) Safety Belts. Approved, tested and regularly inspected safety belts or harnesses and ample lengths of 3/4 inch diameter rope shall be provided for emergency use.

Note: Lists of approved safety belts can be secured from the Industrial Commission.

(3) Protective Hats. All workers in tunnels, shafts, trenches, and caissons shall wear protective hats or caps of approved design and manufacture.

(4) Protective Footwear. It is recommended that approved hard toed boots or shoes be worn by all underground or surface workers exposed to toe injury hazards.

(5) Solitary Employment. No man shall be allowed to work in any trench except one which is properly side sloped), shaft, tunnel, caisson, or appurtenance over 4-1/2 feet in depth without another man being present at the surface.

Note: Any Casual entrance into an excavation such as retrieving fallen objects shall not be construed as work under this order.

(6) Blasting. All blasting procedure shall comply with the provisions of the Wisconsin Explosives Code, Chapter Ind 5.

(7) Housekeeping. All change houses, passageways, ladders and working areas shall be kept clean and unobstructed to provide reasonably secure footing according to the needs of the operation. Materials for distribution and use shall be piled and stacked as safe as circumstances will permit. Supplies, materials and tools shall not be stored in change houses.

(8) Every reasonable precaution shall be taken to insure the safety of the workman in all cases whether or not provided for in these orders.

Note: Attention is directed to the provision of Wisconsin Statute 66.047 relative to protecting underground facilities in streets, highways, etc., and informing the utility concerned.

informing the utility

PART II - TRENCHES AND EXCAVATIONS

Ind 6.06 Timbering Requirements and Procedures for Trenches and other Excavations. (1) Brace or Slope. All areas in trenches in which men are permitted to work shall be adequately and securely timbered or sloped as follows.

(a) Depth Exception. Trenches cut in hard solid soil need not be braced or sloped if less than 4-1/2 feet in depth. Trenches cut in loose or sandy soil need not be braced or sloped if less than 3 feet in depth.

(3) Rock Exception. Trenches need not be timbered if excavated in solid rock and if there have been no previous known excavations within the minimum lateral distance of the depth of the trench being excavated. The total depth of the trench must be in rock or any over burden must be sloped or braced.

Exception.

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(3) Rock Exception. Trenches need not be timbered if excavated in solid rock and if there have been no previous known excavations within the minimum lateral distance of the depth of the trench being excavated. The total depth of the trench must be in rock or any over burden must be sloped or braced.

(4) Sloping. Trenches need not be timbered if the sides are cut down to the angle of repose. The angle of repose shall not be considered greater than one to one-half (measuring one foot of rise

to each 1/2 foot horizontal) for dry or moist soils and not more than one to one for wet or heavy soils.

(5) Partial Slope with Benches. When the sloping of trenches to the angle of repose does not extend to the bottom of the trench, level benches 2 feet wide shall be provided adjacent to and between the top edges of the vertical walls and the toes of the slopes. The spoil bank adjacent to a side sloped trench shall be kept at least 2 feet from the top of the slope.

(6) Partial Slope and Braces. Uprights in all partially sloped excavations shall extend not less than 2 feet above the vertical portion. The vertical part of the trench shall be timbered in accordance with the trench bracing requirements. Toeboards with a total of 12 inches in ^{height} ~~width~~ shall be placed behind all uprights to prevent material from falling into the vertical portion of the trench.

(7) Undercutting. All trenches shall be cut with vertical walls unless side sloped to required minimums. Undercutting or trenches sloped to less than required minimums shall not be permitted.

(8) Basement Excavation. All ^{basement} building excavations ^{shall comply} ~~greater than~~ with the provisions of the Wisconsin Safety in Construction Code Chapter Ind 35 6 feet in depth shall be sidesloped or supported by ~~timbering or sheet steel piling.~~

(9) Timbering Tables. Timbers shall be installed according to tables of trench timbering requirements contained in this code.

(10) Good Installation. In using Tables 1, 2, 3, and 4, the maximum distance from the top of the trench to the top cross brace and from bottom of the trench to the bottom cross brace shall be 2 feet. All sheathing shall extend from the ground surface to at least within 6 inches of the bottom of the trench. If any cross braces are removed to install pipe or other conduits, men shall not be allowed to return to work in these unprotected areas, except to replace the cross braces.

(11) Good Timber. All timbers used for supporting sides of trenches shall be of good quality, reasonably straight grained and free from weakening knots and other defects.

(12) Driving Sheathing. When sheathing is driven by power equipment, drivers especially designed for the purpose shall be used.

(13) Plans for Approval. For trenches and other excavations exceeding 40 feet in depth or 12 feet in width, plans for timbering shall be submitted to the Industrial Commission for approval.

(14) Equivalency Approval. Other methods of supporting the walls of an excavation may be approved if designed and constructed to afford equivalent protection.

(15) Barricade. A temporary guard railing or other effective guard or barricade shall be provided at or near the sides of excavations and shall be kept in place at all times, except at such times when safe-guards will interfere with excavation or other work, except in places not frequented by the public.

(16) Night Lights. All trenches exposed at night shall have lighted red lanterns, or torches, placed along the exposed side or sides.

(17) Ladders. A substantial ladder shall be provided for access to all trenches greater than 8 feet in depth.

(18) Brace Removal. While removing trench bracing, workers shall may be required to work only in that portion of the trench where bracing is still in place.

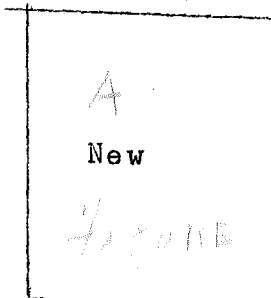


Fig. 1 Trench Timbering -
Solid Soil

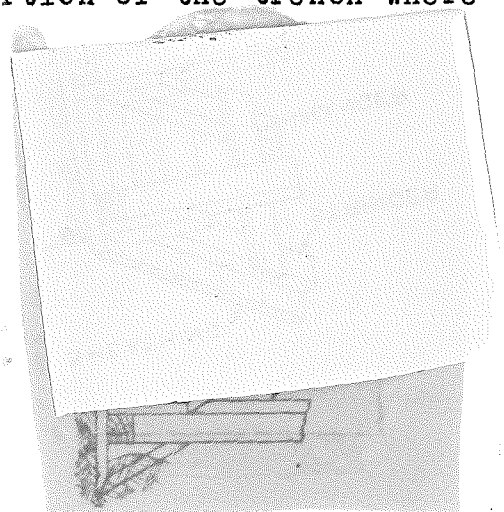


Fig. 2 Trench Timbering
Loose Soil

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(15) Barricade. A temporary guard railing or other effective guard or barricade shall be provided at or near the sides of excavations and shall be kept in place at all times, except at such times when safe-guards will interfere with excavation or other work, except in places not frequented by the public.

(16) Night Lights. All trenches exposed at night shall have lighted red lanterns, or torches, placed at intervals of 25 feet or less on the sides.

(17) Ladders. A substantial ladder shall be provided for access to all trenches greater than 8 feet in depth.

(18) Brace Removal. While removing bracing, workers shall be required to work only in that position where bracing is still in place.

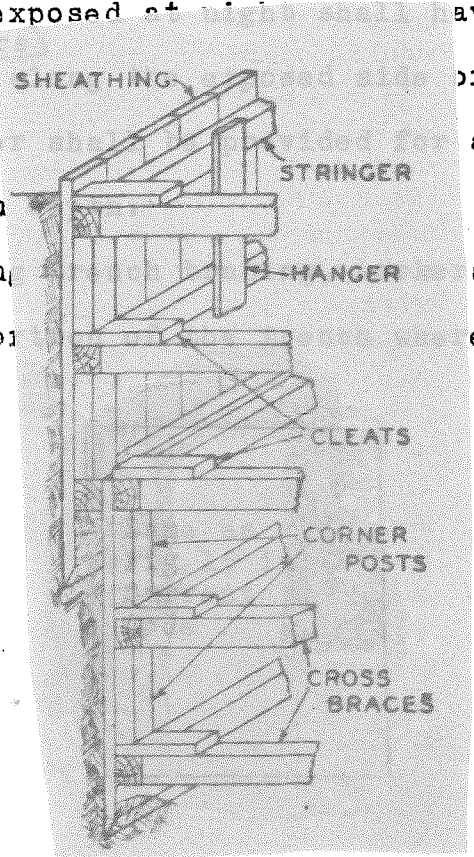
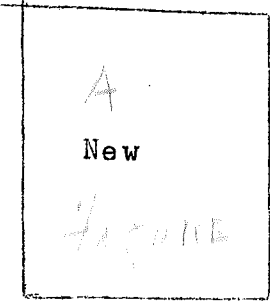


Fig. 1 Trench Timbering - Solid Soil

Fig. 2 Trench Timbering Loose Soil

TABLE 1 TRENCH TIMBERING REQUIREMENTS

For Trenches Not Exceeding 10 feet in Depth and Width Not Exceeding 42 Inches

| | Kind of Soil | Uprights | Cross Braces | Stringers** |
|---|------------------------------|-----------------------------------|--|---|
| Where no parallel excavations exist or have existed within 10 ft. | Hard, solid soil | 2x6 inch planks spaced 6 ft. c--c | *2--2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. | None |
| Previous excavations 5-10 ft. from trench | Hard, solid soil | 2x6 inch planks spaced 4 ft. c--c | *2--2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. | None |
| Previous excavations less than 5 ft. from trench | Hard, solid soil | 2x6 inch planks spaced 3 ft. c--c | *2--2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. | None |
| Irrespective of any previous excavation | Soil that splits easily | 2x6 inch planks spaced 3 ft. c--c | *2--2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. | 1x6 inch boards placed back of uprights near top of trench |
| Irrespective of any previous excavation | Gravelly or filled in ground | 2x6 inch planks spaced 2 ft. c--c | *2--2x6 inch planks or equivalent for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. | 1x6 inch boards placed back of uprights near top of trench |
| Irrespective of any previous excavation | Sand or very wet soil | 2 inch tight sheathing | 3x6 inch timbers or equivalent horizontally spaced not exceeding 6 feet | 3x6 inch timbers or equivalent --2 for depths under 7 ft.; 3 for depths 7 ft. to 10 ft. |

Note: c--c means center to center.

* In lieu of these cross braces for each upright, 3x6 inch stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

** Where stringers are used they shall be properly supported by posts or cleats.

TABLE 2 TRENCH TIMBERING REQUIREMENTS

For Trenches Over 10 Feet and Not Exceeding 15 Feet in Depth and Width Not Exceeding 42 Inches

| | Kind of Soil | Uprights | Cross Braces | Stringers** |
|--|--|-----------------------------------|---|---|
| Where no parallel excavations exist or have existed within 15 feet | Hard, solid soil | 2x6 inch planks spaced 4 ft. c--c | *3--2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft. | None |
| Previous excavations 10 to 15 feet from trench | Hard, solid soil | 2x6 inch planks spaced 3 ft. c--c | *3--2x6 inch planks or equivalent for depths under 13 feet; 4 for depths 13 ft. to 15 ft. | None |
| Previous excavations less than 10 ft. from trench | Hard, solid soil | 2x6 inch planks spaced 2 ft. c--c | *3--2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft. | None |
| Irrespective of any previous excavations | Soil that splits easily | 2x6 inch planks spaced 2 ft. c--c | *3--2x6 inch planks or equivalent for depths under 13 ft.; 4 for depths 13 ft. to 15 ft. | 1x6 inch boards placed back of uprights near top of trench |
| Irrespective of any previous excavations | Sand, gravel filled in ground or very wet soil | 2 inch tight sheathing | 3x6 inch timbers or equivalent, spaced 6 ft. c--c | 6x6 inch timbers or equivalent - 3 for depths under 13 ft.; 4 for depths 13 ft. to 15 ft. |

For Trenches Over 15 feet in Depth and Width Not Exceeding 42 Inches

| | | | | |
|--|---|-----------------------|--|---------------------------------|
| Irrespective of any previous excavations | Hard, solid soil | 2"x6" 2' c--c 15'-17' | 6x6 inch timbers or equivalent horizontally spaced 4 ft. c-c | 6x6 inch timbers 48 inches c--c |
| | | 2"x6" 1' c--c 17'-20' | | |
| | Soil that splits easily, sand, gravel, filled in ground, or very wet soil | 2" tight sheathing | | |
| | | | | |
| | | | | |

Note: c--c means center to center.

* In lieu of these cross braces for each upright, 3x6 inch stringers may be used with substantial cross braces spaced horizontally sufficient to give equivalent protection, but in no case exceeding 6 feet.

** Where stringers are used they shall be properly supported by posts or cleats.

TABLE 3 TRENCH TIMBERING REQUIREMENTS

For Trenches Over 42 Inches In Width Up To And Including 12 Feet In Width

| Depth of Trench | Uprights | Cross Braces | Stringers |
|--------------------------------|----------|---|---|
| Over 4½ ft. to 10 ft. incl. | (1) | 4x6 inch timbers spaced horizontally 7 ft. face to face | 4x6 inch timbers spaced 4 ft. c--c |
| | | 6x6 inch timbers spaced horizontally 11 ft. face to face | 6x6 inch timbers spaced 4 ft. c--c |
| Over 10 ft. to 20 ft. incl. | (1) | 6x6 inch timbers spaced horizontally 7 ft. face to face | 6x6 inch timbers spaced 4 ft. c--c |
| | | 8x8 inch timbers spaced horizontally 11 ft. face to face | 8x8 inch timbers spaced 4 ft. c--c |
| Over 20 ft. to 30 ft. incl. | (1) | 6x8 inch timbers spaced horizontally 7 ft. face to face | 6x8 inch timbers spaced 3 ft. c--c |
| | | 8x8 inch timbers spaced horizontally 11 ft. face to face | 8x8 inch timbers spaced 3 ft. c--c |
| Over 30 ft. to 40 ft. incl. | (1) | 8x8 inch timbers spaced horizontally 7 ft. face to face | 8x8 inch timbers spaced 3 ft. c--c |
| | | 12x12 inch timbers spaced horizontally 11 ft. face to face | 12x12 inch timbers spaced 3 ft. c--c |

*
(1) Uprights shall consist of 2 inch planks and spaced to comply with specifications for trenches less than 42 inches in width.

TABLE 4 TRENCH TIMBERING REQUIREMENTS

For Trenches $4\frac{1}{2}$ To 12 Feet In Depth, $3\frac{1}{2}$ To 12 Feet In Width, And Cut In Hard Soil *

| Depth (Ft.) | Width (Ft.) | Uprights | Cross Braces |
|--------------------|--------------------|--------------------------------------|--|
| $4\frac{1}{2}$ - 8 | $3\frac{1}{2}$ - 6 | 2x6 inch planks spaced 3 ft. c--c | 2 - 3x6 inch struts spaced 4 ft. c--c |
| | | 2x6 inch planks spaced 4 ft. c--c | 2 - 4x6 inch struts spaced 4 ft. c--c |
| | 6 - 12 | 2x6 inch planks spaced 3 ft. c--c | 2 - 4x6 inch struts spaced 4 ft. c--c |
| | | 2x6 inch planks spaced 4 ft. c--c | 2 - 6x6 inch struts spaced 4 ft. c--c |
| 8 - 12 | $3\frac{1}{2}$ - 6 | 2x6 inch planks spaced 3 ft. c--c | 3 - 4x6 inch struts spaced 4 ft. c--c |
| | | 2x6 inch planks spaced 4 ft. c--c | 3 - 4x6 inch struts spaced 4 ft. c--c |
| | 6 - 12 | 2x6 inch planks spaced 3 ft. c--c | 3 - 6x6 inch struts spaced 4 ft. c--c |
| | | 2x6 inch planks spaced 4 ft. c--c | 3 - 6x6 inch struts spaced 4 ft. c--c |

* In case unstable ground is encountered, bracing shall immediately revert back to that outlined in Table 3.

PART III - SHAFTS AND TUNNELS

Ind 6.07 Flammable Material and Fire Protection. (1) Every

reasonable precaution shall be taken against fire in and about tunnels and adequate fire protection shall be provided as hereafter required.

(2) Gasoline, naphtha, distillate, fuel oils and other dangerous flammable materials shall be stored in a building kept solely for such storage and the location of which is at least 100 feet away from any shaft, tunnel or approaches, or any building directly connected with the tunnel opening and at least 300 feet distant from any explosive magazine.

(3) If oil or gasoline storage places are so located that leakage would permit oil or gasoline to flow in the direction of the shaft means to prevent such flows shall be provided.

(4) Not more than a one day supply of lubricating oil or grease shall be kept in underground workings.

(5) The storage of gasoline, naphtha and other distillates in underground workings is prohibited.

(6) Waste or decayed timbers shall not be stored in the tunnel, but shall be promptly removed therefrom. Empty boxes, wooden chips, paper and combustible rubbish of all kinds shall not be allowed to accumulate underground.

(7) In all shafts and tunnels, no naked lights or smoking shall be permitted.

(8) Combustible materials in an amount greater than a one day normal requirement shall not be stored or kept within 20 feet of tunnel shafts.

(9) Any container used for pouring gasoline shall be provided with a closed top, flexible spout and a safety screen and no open light shall be permitted within a 10 foot radius of the gasoline

tank, while filling operations are in progress.

(10) Fire hose connections with at least 50 feet of hose attached shall be provided at the shaft opening if water pressure is available.

(11) Fire extinguishers of 2-1/2 gallon capacity protected against freezing shall be installed in all power plants and at shaft openings.

(12) Head frames built of combustible material shall be of open framework. At or about the surface landing there may be a head house if built of fire resistive material.

(13) Where fire is used for heating hoppers, any enclosure shall be of incombustible material.

(14) All incandescent lamps shall be so placed that they cannot come in contact with any combustible material.

Ind 6.08 Shaft and Tunnel Lighting. (1) All lighting in tunnels and shafts shall be by electricity only. While work is in progress tunnels, stairways, shafts, ladderways and all places on the surface shall be illuminated by bulbs of no less than 60 watts at intervals of no less than 25 feet. All incandescent lamps shall be enclosed in a protective basket guard.

(2) The exterior of all lamp sockets shall be entirely non-metallic with the exception that for flood lamps the supporting shell may be of metal.

(3) Lamp cord, where used for temporary lighting connections, shall have extra heavy insulation. Portable electric hand lamps if used shall be equipped with a keyless socket ^{of} non-combustible, non-absorbent insulating material, ~~fused~~ large handle of non-absorbent insulating material and a basket guard.

(4) When wires used for light and power in tunnels and shafts are uncased, heavy type S rubber covered cable ^{or equivalent} shall be used. Cables shall be supported on insulators except when not possible to do so in tunnel headings or when used in connection with portable hand lamps.

(5) On a tunneling project, wires which are not armored shall have mechanical protection wherever exposed to injury.

Ind 6.09 Electrical Equipment. (1) ^{Definitions:} ~~DEFINITIONS.~~

(a) VOLTAGE of a CIRCUIT. The greatest effective difference of potential between any two conductors of the circuit concerned.

(b) GROUNDING. Grounding any part of an electrical system shall consist in so connecting such part to the earth that there shall be no material difference of potential between such part and the earth.

(c) UNDERGROUND STATION. The term "underground station" as used herein shall mean any place where electrical machinery is permanently installed in a tunnel.

(d) CARRYING CAPACITY. The term "carrying capacity" shall mean the current carrying capacity of a given wire as limited by the Wisconsin State Electrical Code.

(e) GUARDED. The term "guarded" shall mean effectually covered, enclosed or otherwise guarded by means of suitable covers, casings, screens or barriers so as to prevent accidental contact with live parts of apparatus or circuits. Wires which are insulated, but not otherwise protected are not construed to be guarded.

(2) Scope. Except where the provisions of section Ind 6.09 apply the provisions of the Wisconsin State Electrical Code shall apply.

(3) Care of Equipment and Practices. No person shall be allowed to install or handle electric lights, or conductors, or work on or with electrically driven apparatus, unless he shall be competent and shall have been previously instructed in the performance of his duties by the tunnel superintendent, tunnel foreman, or a person authorized by either.

(4) Grounding. All non-current carrying metal parts of electrical equipment, including frames and bed plates of generators,

transformers, compensators, rheostats and motors shall be permanently and effectively grounded. All metallic fittings coverings and armor-
ing of cables are included. The neutral conductor of a three wire system and some point of any low voltage system (300 volts or less) shall be grounded. See Wisconsin State Electrical Code.

Note: This order requires the grounding of the non-current carrying parts of portable tools, such as drills. An additional conductor in the portable cord and a grounding contact in the plug and receptacle will provide the best means of permanent and effective grounding.

(5) Support of Cables and Wires. All underground cables and wires, unless provided with grounded metallic covering, shall be supported by insulators. The conductors connecting lamps to the power supply shall in all cases be insulated.

(6) Overhead Lines Aboveground. Overhead transmission lines between the generating station or sub-station and the tunnel entrance shall be supported upon insulators which shall be adequate in quality, size and design for the voltage transmitted. Where such line is more than 500 feet in length, lightning arresters shall be installed in connection therewith. All overhead lines, except in the case of trolley wires, shall be maintained not less than 14 feet above the ground at the lowest point, except at the point of entrance to the tunnel.

Note: If wires cross areas accessible to vehicles or if the voltage exceeds 300, greater clearances shall be provided as required by the Wisconsin State Electrical Code.

(7) Branch Circuits. Every branch circuit shall be provided with a switch and ~~fuses~~ ^{and suitable fuses} of ample carrying capacity on each phase within 50 feet of the point where it leaves the main circuit.

(8) Power Wires and Cables. (a) In all shafts, ^{whose} the angle of inclination which is ^{more than} above 45 degrees from the horizontal, and in all hoisting shafts or manway compartments, all power wires and cables shall be amply protected by insulation and substantially fixed in

-15-

position. All shaft cables shall be supported on insulators that cannot cause abrasion of the covering or ^{insulation} insulators, so spaced that no part of the cable shall be under a tension greater than one-fourth of its ultimate strength. The cable shall be held in position at points between the insulators by grips or cleats that cannot cause abrasion of the covering or insulation. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft so that they may yield and lessen a blow from falling material.

Note: Section Ind 6.09(8)(a) shall not be construed to prevent the installations of insulated wires in metal conduit to transmit power underground.

(b) Where the cables or feed wires in tunnels cannot be kept at least 12 inches from any part of the tunnel, car or locomotive, they shall be protected by guards. Any trolley wires shall be guarded if less than 6 feet above track.

(9) Cables Entering Fittings. (a) The exposed ends of cables where they enter the fittings of any description shall be so protected and finished off that moisture cannot enter the cables or the insulating material leak out, if of an oily or viscous nature.

(b) Where unarmored cables or wires pass through metal frames or into boxes or motor castings, the holes shall be lined with insulating bushings.

(10) Joints in Conductors. All joints in conductors shall be mechanically and electrically efficient. Permanent joints shall be soldered. All joints in insulated wire shall, after the joint is complete, be reinsulated to the same extent as the remainder of the wire.

(11) Joints in Cables. Where cables are joined, suitable junction boxes shall be used or the joints shall be soldered and the insulation, armoring or lead covering replaced in as good condition as it was originally.

(12) Fuses, Circuit Breakers and Switches. (a) Fuses and automatic circuit breakers shall be constructed so as to interrupt the current when a short circuit occurs or when the current through them exceeds their rated capacity. No open type or link fuses shall be used.

(b) Fuses shall be stamped or marked, or shall have a label attached, indicating the maximum current that they are intended to carry. Fuses shall be adjusted or replaced only by an authorized and competent person.

(c) The capacity of fuses used to protect feeders shall not exceed the current capacity of the feeder by more than 10 per cent.

(d) All points at which a circuit has to be made or broken shall be provided with suitable switches, which shall be so installed that they cannot be closed by gravity.

(e) All switches, circuit breakers and fuses shall have non-combustible bases and shall be properly enclosed.

(f) All cartridge fuses, and plug fuses larger than 15 amperes capacity, shall always be so arranged that they may be disconnected from the supply circuit by properly placed switches. An individual switch shall be installed in each branch circuit of capacity larger than 15 amperes.

(g) All manual switches, including service switches, shall have suitable enclosures of such design as to permit of operation without opening the enclosure. Enclosures shall be locked, sealed or made inaccessible ~~to other than qualified persons by other suitable methods.~~ by other suitable methods to other than qualified persons.

Exception: Switches or switch boards and panel boards that are properly guarded or locked or located in underground stations or other similar places not accessible to other than qualified persons are exempt from provisions of section Ind 6.09(12)(g).

(13) Motors. Every motor together with its starting device shall be protected by fuses or a circuit breaking device on at least one line of direct current systems and on two phases of three-phase

alternating current system and by switches arranged to cut off entirely the power from the motor. The above devices shall be installed in a convenient position near the motor and in sight of it.

Ind 6.10 Sanitation. (1) One outside toilet and urinal shall be provided for every 20 men employed on each shift and protection from the weather shall be provided.

Potable

(2) ~~Portable~~ drinking water shall be provided for all employes. Drinking water shall be protected from contamination. Common drinking cups are prohibited.

(3) A dressing room or change house shall be provided for the purpose of drying clothing of persons employed in and about the tunnel. Not less than 4 square feet of floor area shall be available for each employe. Adequate means of heating and lighting shall be provided and a temperature of not less than 70 degrees F. shall be maintained at all times. Dressing rooms or change houses shall be cleaned daily. Lockers or hangers shall be provided for clothing. Tools, equipment or other supplies shall not be kept in change houses.

~~During all shifts and after blasting~~

Ind 6.11 Ventilation.

(1) During all shifts and after blasting the atmosphere shall be tested for explosive gases and sufficient oxygen with a safety lamp. If any indication of air pollution appears, tests shall be taken to determine the amount of noxious gases. At no time when men are working in the shaft or tunnel will the gases exceed the following concentration.

~~the following concentration.~~

| | |
|-----------------------------------|--------|
| Carbon Monoxide to be less than | .01% |
| Carbon Dioxide to be less than | .50% |
| Methane to be less than | .25% |
| Hydrogen Sulphide to be less than | .001% |
| Oxygen to be more than | 19.00% |

repeated

(2) If tests show an excess of these concentrations for any of

the gases, mechanical ventilation shall be provided and operated which will give a minimum of 1,000 cubic feet of free air per minute in each tunnel and sufficient air in addition to dilute said gases with free air to comply with the limitations of the above table.

Internal combustion

(4) Gasoline engines shall be so located that the exhaust gases will not enter the shaft or the air intake of compressors. Gasoline engines shall not be operated in any tunnel or shaft.

Internal combustion

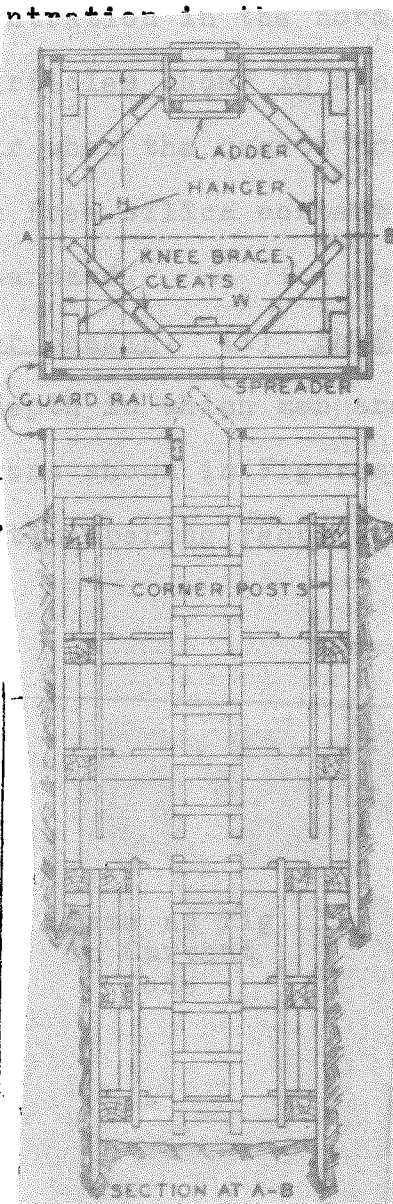
(5) Harmful dust concentrations shall be controlled to maintain safe air in the breathing zone.

(6) The maximum silica dust concentration in any breathing zone shall not exceed 15 million per cubic foot of air in its longest dimensions per cubic foot of air. Variations in the dust is 35 per cent. Variations in dust concentration will make proportional inverse changes in this standard.

Ind 6.12 Timbering Requirements for Shafts

Timber

Required. Shafts exceeding 6 feet in diameter shall be timbered. Shaft sections may be used in accordance with the shaft timbering requirements as follows.



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nts as

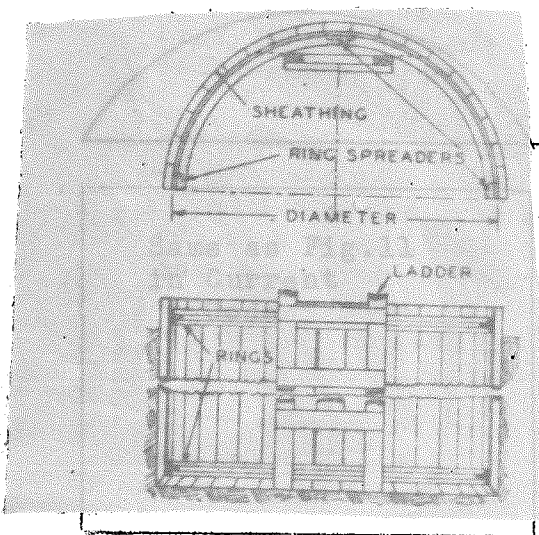


Fig. 3 Circular Shaft

Fig. 4 Rectangular Shaft Timbering

the gases, mechanical ventilation shall be provided and operated which will give a minimum of 1,000 cubic feet of free air per minute in each tunnel and sufficient air in addition to dilute said gases with free air to comply with the limitations of the above table.

Internal combustion

(4) Gasoline engines shall be so located that the exhaust gases will not enter the shaft or the air intake of compressors. Internal combustion Gasoline engines shall not be operated in any tunnel or shaft.

(5) Harmful dust concentrations shall be controlled to maintain safe air in the breathing zone.

(6) The maximum silica dust concentration in the normal breathing zone shall not exceed 15 million particles under 10 microns in longest dimensions per cubic foot of air when the quartz content of the dust is 35 per cent. Variations in free silica content will make proportional inverse changes in this standard.

Ind 6.12 Timbering Requirements for Shafts. (1) Shaft Timber Required. Shafts exceeding 6 feet in depth in which men are permitted to work shall be timbered. Shaft sections shown in Figures 9 and 10 may be used in accordance with the shaft timbering requirements as follows.

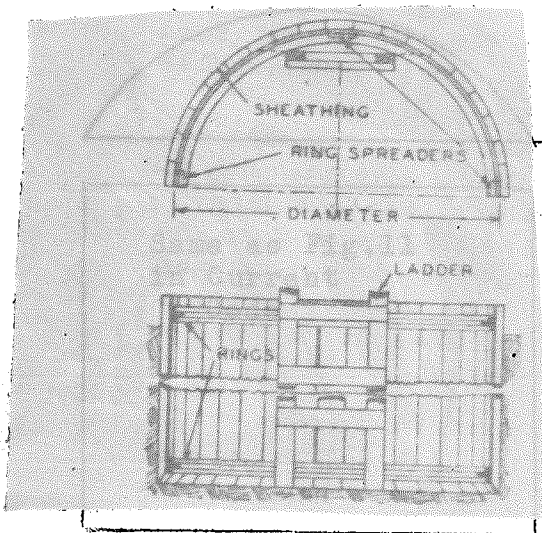


Fig. 3 Circular Shaft

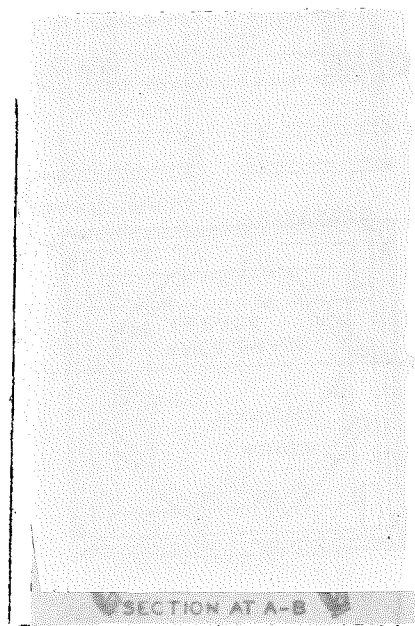


Fig. 4 Rectangular Shaft
Timbering

TABLE 5 BRACING OF CIRCULAR SHAFTS

| Diameter | Depth | Steel Rings Required 4 feet O.C. |
|-------------|-------------|--|
| 8' Maximum | 16' Maximum | \angle 2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " x 1/4" |
| 10' Maximum | 16' Maximum | \angle 2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " x 5/16" |
| 12' Maximum | 16' Maximum | \angle 3" x 3" x 1/4" |
| 8' Maximum | Over 16' | \angle 2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " x 1/4" |
| 10' Maximum | Over 16' | \angle 3" x 3" x 1/4" |
| 12' Maximum | Over 16' | \angle 3" x 3" x 5/16" |

Note #1: For depths over 16 feet, decrease ring spacing when unusually wet or unstable soil is encountered. The top ring shall be placed not more than 2 feet below ground surface.

Note #2: Other member sections may be used if it would provide equivalent section modulus.

TABLE 6. BRACING OF RECTANGULAR SHAFTS

| Longest Dimension of Timber Between Knee Braces or Cross Braces ** | Depth | Timber or Steel Beam Req'd 4' O.C. | Timber or Steel Beam Req'd 3' O.C. | Timber Knee Braces |
|--|-------------|--|--|-------------------------------------|
| 3' Maximum | 10' Maximum | 4"x6" Hardwood or 6"x6" Softwood | 4"x6" Hardwood or 6"x6" Softwood | 6"x6" Hardwood |
| 4' Maximum | 16' Maximum | 6"x6" Hardwood or 8"x8" Softwood | 6"x6" Hardwood or 8"x8" Softwood | 6"x6" Hardwood |
| 6' Maximum | 14' Maximum | 10"x10" Hardwood or 10"x10" Softwood | 10"x10" Hardwood or 10"x10" Softwood | 6"x6" Hardwood |
| 6' Maximum | Over 14' | 10"x10" Hardwood or 12"x12" Softwood | 10"x10" Hardwood or 12"x12" Softwood | 6"x6" Hardwood |
| 8' Maximum | Any | 8 WF 20* 12"x12" Hardwood or 8 WF 31* | 6 WF 20* 12"x12" Hardwood or 8 WF 24* | 6"x6" Hardwood |
| 10' Maximum | Any | 12 WF 36* | 12 WF 27* | 8"x8" Hardwood (6l 12.5 or 6C13) |

* WF beams shall be pladed with web horizontal.

** Assuming knee braces shall lap 1/4 of the span on each leg of the corner, the maximum outside dimensions of sheathing will be approximately 6', 10', 14', 18' and 23'.

Note #1: For depths over 16 feet, decrease spacing of timber or steel sets when unusually wet or unstable soil is encountered.

Note #2: For intermediate sizes of sets, members providing proportionate area and section modulus may be used.

(2) Sheathing (tight). Under normal conditions, 2"x6" hardwood shall be used. When unusually wet or unstable soil is encountered, steel sheathing shall be used.

(3) Shaft Cutting. Shaft excavation shall be cut to substantially the shaft size. Overcutting and backfilling behind the sheathing shall not be permitted.

(4) Unusual Conditions and Alternate Designs. The requirements set forth in section Ind ^{6.12} 6.13 are minimum. Bracing of greater strength shall be used when unusual soil conditions prevail. If shafts are constructed of greater dimensions than those set forth in this section Ind ^{6.12} 6.13, a design for bracing shall be presented for approval to the Industrial Commission. Alternate designs for those set forth in this section also shall be presented to the Industrial Commission for approval.

(5) Timber Sizes. Timber sizes required in ^{this code} section Ind 6.12 are stated as nominal sizes.

(6) Staging and Scaffolds. Staging or scaffolds shall be provided in shafts for workers when installing equipment or driving sheathing. All scaffolds shall be constructed or installed so as to support any maximum material load which may be placed on them as well as weight of the men.

(7) Clam Shell Buckets. No man shall be permitted to work in a shaft when excavation is being done with a clam shell bucket unless the least dimension of the shaft is twice the length of the bucket when fully opened.

Ind 6.13 Shaft Protection. (1) During shaft sinking operations, the tops of all shafts shall be guarded by a suitable barricade that will keep unauthorized persons away from the opening. At night there shall be an additional protection of torches or red lights. When a depth of 16 feet has been reached, a standard railing and toeboard, equipped with necessary gates shall be provided. The gates shall be kept closed when not used for access to the shaft.

(2) Where cages are installed in shafts, automatic gates shall be used at the top landing. All intermediate landings shall be provided with a fence and gate or gates, the members of which shall not be more than 4 inches apart and not less than 5 feet high. The gates at such landings shall be not more than 12 inches from the openings. The gates shall be kept closed at all times except when persons or material are entering or leaving the cage.

(3) Cars shall be blocked at all landings and on the cage.

(4) Landing dogs shall be provided at all landings where cars enter or leave cage or where material is taken on or off cages.

(5) The tops of all bins or hoppers around which men are required to work shall be provided with a guardrail.

(6) Guardrail installations, if of wood construction, ^{shall} will comply with ~~section Ind 6.14(5), if made according to~~ the following specifications:

(a) Guardrails of not less than nominal 2x4 inch material fastened to posts and not more than 42 inches or less than 36 inches above the working level;

(b) Posts of not less than nominal 2x4 inch material, spaced not more than 8 feet apart, fastened and braced in place;

(c) Where the top of the guardrail is more than 36 inches above the working level, and intermediate rail of not less than nominal 1x6 inch material is to be placed midway between the top guardrail and the working level.

(d) Equivalent strength and stiffness is to be provided if material other than wood is used.

(7) Collars of all shafts shall be provided with efficient dams to prevent influx of water during heavy rains. Dams shall be formed by extending shaft lining not less than 10 inches above surface ground level and banking with clay or other plastic material.

Ind 6.14 Ladders, Stairways, and Cages in Shafts and Caissons.

(1) All shafts leading to tunnels, and all shafts in caissons where men are working, except such as are intended only for manholes, shall be provided with ladders, stairways, or cages as required in this code and are to be kept clean and in good condition at all times. In shafts intended for manholes, ladders shall be provided as required in subsection (2).

(2) Where the depth of a shaft is greater than 10 feet and less than 30 feet in depth, a ladder shall be provided with an enclosed metal backrest. The backrest shall have not less than 24 inches nor more than 36 inches clear distance to the ladder. Horizontal platforms shall be provided with offsets to the next section of the ladder at maximum intervals of 20 feet. A shaft less than 10 feet in depth shall be provided with an inclined portable ladder.

(3) The distance between the centers of rungs of a ladder shall not exceed 14 inches and shall not vary more than one inch in any one ladder length. The rungs of the ladder shall in no case be less than 6 inches from the wall or any obstruction in the shaft or opening in which the ladder is used. Under no circumstances shall a ladder inclining backward from the vertical be installed. Should it be necessary to offset any section of a ladderway, the top of the ladder section shall extend not less than 3 feet above the bottom of the section above, or hand holds shall be provided.

(4) Where the depth of a shaft is in excess of 25 feet but less than 45 feet, an inclined or spiral stairway shall be provided for the full depth of the shaft. This stairway shall be equipped with standard handrails and shall have horizontal platforms each with an area not less than 3 feet by 3 feet at intervals no greater than every 10 feet of depth of shaft.

(5) Where the depth of a shaft is in excess of 45 feet, a cage for access shall be provided. This cage shall conform to the requirements of section Ind 6.20.

(6) In no case will side sloping or stepping down be allowed to be used to reduce the depth of a shaft.

(7) Fixed ladders of standard construction shall be provided for access to cable sheaves on head frames located over tunnel shafts. A runway or platform equipped with guardrails and toeboards shall also be provided next to cable sheaves.

Ind 6.15 Hoists for Workmen. Hoists on which workmen are permitted to ride shall be of approved design. Approval shall be obtained in advance of installation from the Wisconsin Industrial Commission.

Ind 6.15 Hoisting Engineer. Only experienced operators familiar with details of hoisting equipment shall be employed to operate and be responsible for such equipment. Learners shall be prohibited from operating of hoisting equipment when any person is on the cage.

Ind 6.16 Hoisting Rules and Equipment. (1) All power driven equipment shall be maintained and adjusted in a ^{reasonably} safe mechanical condition. This includes booms, drums, clutches, brakes, sheaves and gears.

(2) When hoisting signals are used the signal code shall be posted in the engine room in sight of the hoisting engineer.

(3) The hoist shall be provided with brakes and distance marks on hoisting ropes or cables.

(4) No unauthorized persons shall be permitted in the hoist room.

(5) There shall be no conversation in the engine room while the engine is in motion or while signals are being given or received.

(6) Men shall not be hoisted or lowered into any tunnel or shaft at a speed greater than the rate posted in the engine room.

(7) After any stoppage of hoisting for repairs, the bucket, skip, cage or other conveyance, shall be run ^{up and} down the working part of the shaft at least once. The bucket, skip, cage or other conveyance shall not be used for hoisting or lowering men during this test nor until the hoisting machinery and shaft shall have been found to be safe.

(8) There shall be no hoisting in any compartment of a shaft while under repair except as may be necessary for the repair work.

(9) The hoisting engineer shall not change/^{shift}while the bucket, skip, cage or other conveyance is in motion.

(10) The superintendent of the tunnel shall establish for each shaft rates of speed for the cages, skips, bucket or other conveyances. Established speed shall not be exceeded in the hoisting or lowering of men. The superintendent shall post a notice of such established speed in a conspicuous place near each hoisting engine; such rates of speed shall not exceed the maximum approved by the Industrial Commission.

(11) The superintendent of the tunnel shall determine the maximum number of men that in his judgment may safely ride on each cage, skip, bucket, or other conveyance used in the tunnel under his supervision, and shall post in a conspicuous place near each shaft a notice stating the maximum number of persons so permitted to ride and forbidding the carrying of any greater number. The number of persons permitted to ride, as determined by the superintendent, shall not exceed the maximum approved by the Industrial Commission.

(12) No person shall ride upon any cage, skip or bucket that is loaded with tools, timber, powder or other material, except for the purpose of handling such material while in transit and then only after a special signal has been given. When tools, timber or other material are being lowered or hoisted in a shaft, means shall be taken to prevent their shifting while the car, skip, cage or bucket is in motion.

Ind 6.17 Communications. (1) Every shaft shall be provided with an efficient means of interchanging distinct and definite communications between the top of the shaft and the lowest level and the intermediate levels from which hoisting is being done.

(2) When signals are used a code shall be printed and copies

thereof shall be kept posted in a conspicuous place near entrances to work places and in such other places as may be necessary to bring them to the attention of all persons affected thereby.

Ind 6.18 Hoisting Ropes, Hooks and Sheaves. (1) Ropes or cables for hoisting or lowering men, when such hoisting or lowering is done by power hoists, shall be composed of metal wires.

(2) The factor of safety of all such ropes or cables shall be not less than five.

(3) No head or angle sheave of a diameter less than 40 times the diameter of the rope or cable shall be used for hoisting or lowering men.

Exception: This subsection does not apply to sheaves on standard equipment approved for hoisting and lowering men.

(4) Cables are considered unsafe and shall be removed when through broken wires, wear, rust, undue strain, or other deterioration the strength has decreased 25 per cent.

(5) All ropes or cables used for hoisting or lowering men shall be thoroughly inspected once each week by some competent person designated for the purpose by the superintendent. If upon an inspection such hoisting rope, or cable shall be found to be below the requirements set forth in these orders, it shall be discontinued for such purpose forthwith.

(6) Every rope or cable used for hoisting or lowering men shall be securely fastened at both ends and when in use shall never be fully unwound; at least 2 full turns shall remain always on the drum or reel. The end of the rope attached to the conveyance in the shaft shall be bound around an oval thimble and then fastened to itself by the use of three or more clamps, or shall be securely fastened with a tapered socket.

(7) No open hook shall be used with a bucket, cage, or skip in hoisting, but some approved form of safety hook or shackle hook shall be used.

(8) Every sheave and every idler under which is led any hoisting cable shall be provided with a guard that will keep the cable on the sheave or idler if the cable becomes slack.

Ind 6.19 Cages for Hoisting. (1) In all shafts or excavations over 45 feet in depth cages shall be provided for hoisting and lowering men. The cage requirement, however, does not apply to the following:

(a) Shafts in the process of sinking.

(b) Shafts being dismantled after work in tunnel is substantially completed.

(c) In caissons or vertical locks.

(2) In all shafts under 45 feet in depth cages are not required, but approved ladders and stairways shall be provided.

(3) In any ^{caisson} ~~shaft~~ or excavation regardless of depth, too small to accommodate a cage, a ladder or a stairway, men may be lowered or hoisted by a bucket or other device but only when approved by the Industrial Commission.

(4) Cages shall be provided with bonnets consisting of 2 steel plates not less than 3/16 of an inch in thickness sloping toward each other and so arranged that they may be readily pushed upward to afford egress to persons therein, and such bonnet shall cover the top of the cage in such manner as to protect the persons on the cage from falling object.

(5) Cages shall be entirely enclosed on two sides with solid partitions or wire mesh not less than No. 8 U. S. standard gauge, no opening in which shall exceed 2 inches.

(6) Cages shall be provided with hanging chains or similar devices for hand holds.

(7) Every cage shall be provided with an approved safety catch of sufficient strength to hold the cage with its maximum load at any

point in the shaft.

(8) Cars shall be blocked while on cage.

(9) All parts of hoisting apparatus, cables, brakes, guides and fastenings shall be of the most substantial design and shall be arranged for convenient inspection. The efficiency of all safety devices shall be established by satisfactory tests before the cages are put in service and at least once every three months thereafter and a record thereof kept.

(10) The test of the safety catch shall consist of releasing the cage suddenly in such manner that the safety catches shall have an opportunity to grip the guides.

or tunnel

Ind 6.20 Timbering Requirements for Tunnels. (1) Every shaft/
excavation
excavated not located in solid rock in which men are permitted to work shall be kept adequately and securely timbered to prevent injury to any person from falling materials, or collapse of the sides or roof of the working place.

(2) All timbers used in the support of shafts and tunnels shall be of good quality, reasonably straight grained and free from weakening knots and other defects.

(3) All timbers shall, when placed for the support of the roof and sides of the tunnel or in the shaft, be properly fitted and wedged in place. Timber sets in tunnels and sheathing planks in shafts shall be abutting. All void spaces in back of timbers shall be filled with blocking or other suitable material.

(4) Face boards shall be placed in all tunnel headings at end of mining shifts.

Exception: Face boards need not be placed in stable ground if mining operations are continued without interruption by the succeeding shift.

(5) Knee braces, cleats and spreaders shall be nailed in place with not less than two nails for any one piece. No nail

smaller than the following shall be used for the various thicknesses of materials as follows:

| | | |
|------------------|-----------|-----------------------|
| 1 inch (nominal) | 8d common | (2½ inches x No. 10¼) |
| 2 inch (nominal) | 16d " | (3½ inches x No. 8) |
| 3 inch (nominal) | 30d " | (4½ inches x No. 5) |
| 4 inch (nominal) | 50d " | (5½ inches x No. 3) |

(6) No tunnel excavation shall be carried more than 24 inches in advance of the timbering.

(7) In solid situations shown in figures 1 to 6 may be used if timbering limitations.

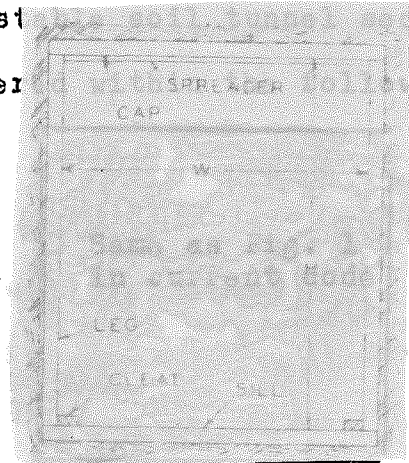


Fig. 5 Box Type of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | | | |
|----------------------------------|-----------------------------------|---------------------------------------|--------------------------------|---|------------------|
| | | Caps, Sills Thickness in Inches | Legs Thickness in Inches | Spreaders (One in every set) Inches | Cleats Inches |
| 3 | 4 | 2 | 2 | 1 x 4 | 2 x 4 |
| 4 | 4 | 3 | 2 | 1 x 4 | 2 x 4 |
| 5 | 5 | 3 | 3 | 1 x 4 | 2 x 4 |
| 5 | 6 | 3 | 3 | 1 x 4 | 2 x 4 |

Note: The use of either spreaders or cleats in Figure 5 is required. Cleats shall consist of 2 x 4 inch lumber not exceeding 3 feet in length.

smaller than the following shall be used for the various thicknesses of materials as follows:

| | | |
|------------------|-----------|-----------------------|
| 1 inch (nominal) | 8d common | (2½ inches x No. 10¼) |
| 2 inch (nominal) | 16d " | (3½ inches x No. 8) |
| 3 inch (nominal) | 30d " | (4½ inches x No. 5) |
| 4 inch (nominal) | 50d " | (5½ inches x No. 3) |

(6) No tunnel excavation shall be carried more than 24 inches in advance of the timbering.

(7) In solid stable soil tunnel sections shown in figures 1 to 6 may be used if timbered within the following limitations.



Fig. 5 Box Type of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | | | |
|----------------------------------|-----------------------------------|---------------------------------------|--------------------------------|---|------------------|
| | | Caps, Sills Thickness in Inches | Legs Thickness in Inches | Spreaders (One in every set) inches | Cleats Inches |
| 3 | 4 | 2 | 2 | 1 x 4 | 2 x 4 |
| 4 | 4 | 3 | 2 | 1 x 4 | 2 x 4 |
| 5 | 5 | 3 | 3 | 1 x 4 | 2 x 4 |
| 5 | 6 | 3 | 3 | 1 x 4 | 2 x 4 |

Note: The use of either spreaders or cleats in Figure 5 is required. Cleats shall consist of 2 x 4 inch lumber not exceeding 3 feet in length.

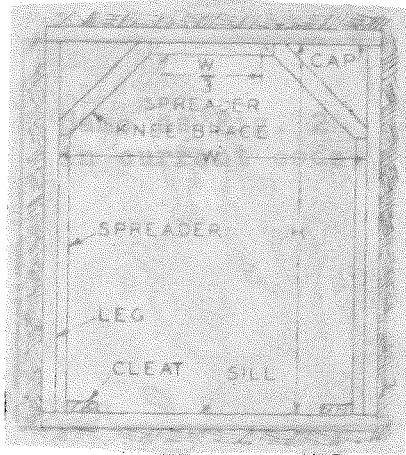


Fig. 6 Box Type of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | | |
|----------------------------------|-----------------------------------|---|---|------------------|
| | | Caps, Legs, Sills, Knee Braces, Thick- ness in Inches | Spreaders (One to every set) Inches | Cleats Inches |
| 8 | 8 | 3 | 2 x 6 | 2 x 6 |
| 10 | 10 | 4 | 2 x 6 | 2 x 6 |

Note: Knee braces shall be spaced not exceeding 2 feet center to center and may be removed immediately preceding concrete or masonry work at that point.

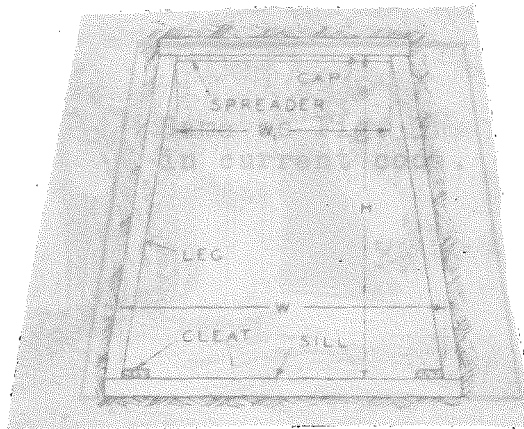


Fig. 7 Modified Box Type of Timbering

| Width Maximum in Feet W ₁ , W | Height Maximum in Feet H | Dimensions of Timbering | | |
|---|-----------------------------------|---|---|------------------|
| | | Caps, Legs, Sills Thickness in Inches | Spreaders (One to every set) Inches | Cleats Inches |
| 3, 5 | 4 ₀ | 2 | 1 x 4 | 2 x 4 |
| 5, 7 | 7 | 3 | 2 x 6 | 2 x 6 |
| 8, 10 | 10 | 4 | 2 x 6 | 2 x 6 |

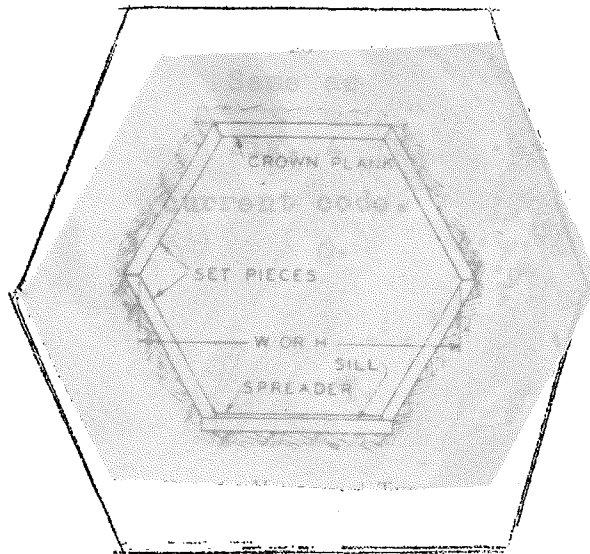


Fig. 8 Hexagonal Type of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | |
|----------------------------------|-----------------------------------|---|---|
| | | Crown Planks, Set Pieces, Sills Thickness in Inches | Spreaders (One to every set) Inches |
| 10 | 10 | 3 | 2 x 6 |

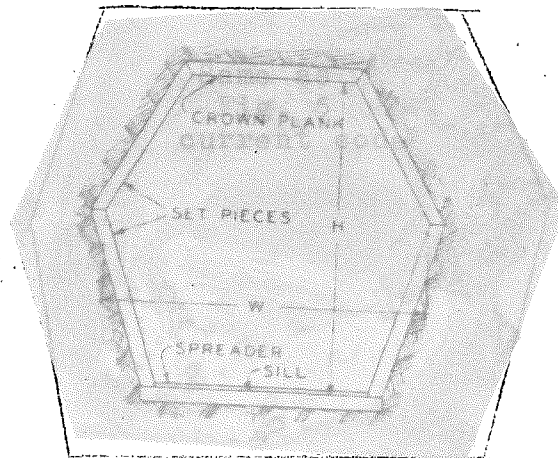


Fig. 9 Modified Hexagonal Type of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | |
|----------------------------------|-----------------------------------|---|---|
| | | Crown Planks, Set Pieces, Sills Thickness in Inches | Spreaders (One to every set) Inches |
| 10 | 10 | 3* | 2 x 6 |

Note: * Use 4 inch plank if length of any piece exceeds 6 feet.

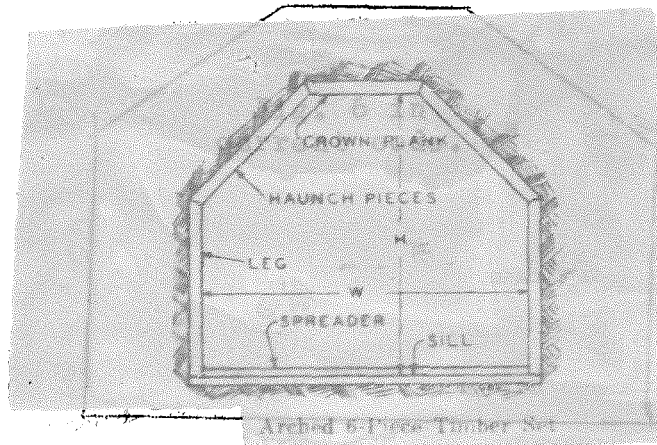


Fig. 10 Arched 6-Piece Timber Set

| Width Maximum in Feet W | Height Maximum in Feet H | Dimensions of Timbering | |
|----------------------------------|-----------------------------------|--|---|
| | | Crown Planks, Legs, Haunch Pieces, Sills Thickness in Inches | Spreaders (One to every set) Inches |
| 5 | 6 | 3* | 2 x 6 |
| 10 | 10 | 3* | 2 x 6 |

Note:* Use 4 inch plank if any piece exceeds 6 feet

(8) In excavating heavy soil which cannot be held in place with timber sections shown in Figures 5 to 10, inclusive, then timber sections shown in Figures 11 and 12 shall be used with the following limitations.

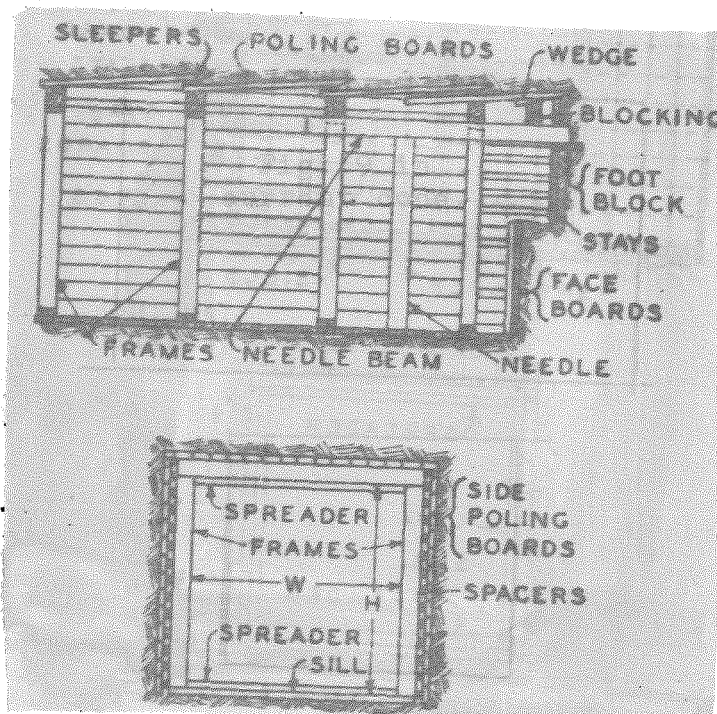


Fig. 11 Poling Board Method of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Sheathing Thickness in Inches | Framing Timbers | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|----------------------------|
| | | | Dimensions in Inches | Maximum Spacing in Feet |
| 5 | 5 | 2 | 6 x 6 | 4 |
| 7 | 7 | | | 4 |
| 8½ | 8½ | | | 4 |
| 10 | 10 | | | 3½ |

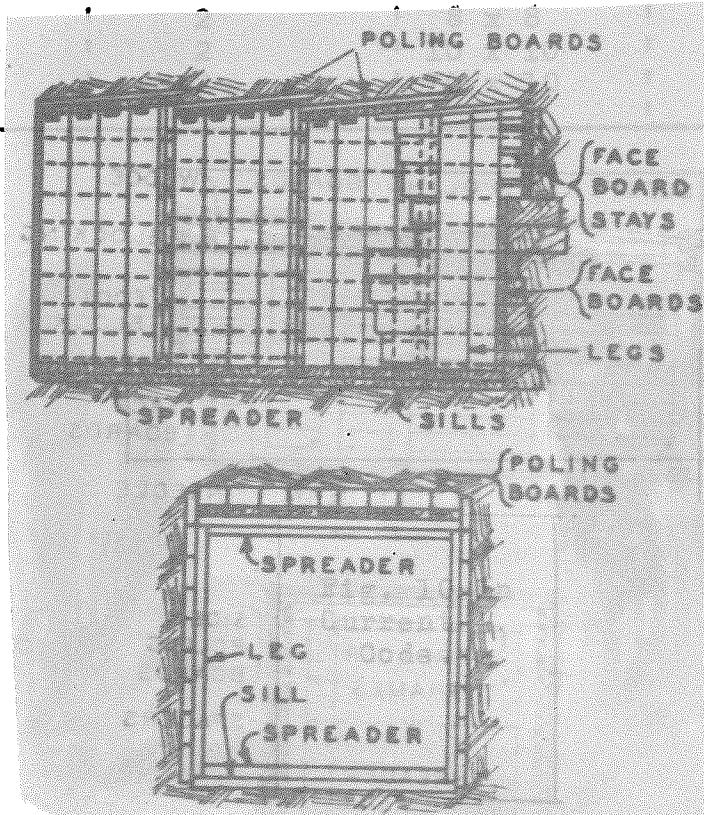


Fig. 12 Poling Board Method of Timbering

| Width Maximum in Feet W | Height Maximum in Feet H | Sheathing thickness in Inches | Set Pieces thickness in Inches | Spreaders Inches | Cleats Inches | Knee Braces Inches |
|----------------------------------|-----------------------------------|-------------------------------------|--------------------------------------|---------------------|------------------|--------------------------|
| 4 | 3 | 1 | 2 | 1x4 | 2x4 | --- |
| 5 | 6 | 1 | 3 | 1x4 | 2x4 | --- |
| 8 | 8 | 1 | 4 | 1x4 | 2x6 | 3 |
| 10 | 10 | 1 | 6 | 1x4 | 2x6 | 4 |

(9) For tunnels of greater dimensions than indicated in Figures 5 to 12 or for the modification or combination of sections of timbering for the same, or for the use of metal liners in lieu of timbering, plans and specifications shall be submitted to the Industrial Commission for approval.

(10) Tunnel excavations in which men are permitted to work shall not be less than 3 feet wide nor less than 4 feet in height. These measurements apply to distance between timbers.

(11) Any metal shield used for tunnel work shall be of a design subject to the approval of the Industrial Commission.

Ind 6.21 Mechanical Haulage. (1) When mechanical haulage is used, care shall be taken that the speed is not excessive depending upon the grades and condition of the tracks. No cars shall be pushed underground where it is practical to draw and all locomotives shall be equipped with headlights and gongs. Trolley poles shall be trailed whenever it is possible to do so. No locomotive shall be operated by a person under 18 years of age. No gas locomotive shall be used in any tunnel.

(2) Standing cars shall be blocked.

Ind 6.22 Sumps. All sumps shall be securely covered or fenced except when being cleaned or repaired.

PART IV - ADDITIONAL RULES FOR WORK WHEN DONE UNDER
COMPRESSED AIR

Ind 6.23 Hours of Labor. (1) No employe shall be permitted to work longer in compressed air than the hours established in Table 7.

(2) The limits of hours as established in Table 7 shall apply according to the maximum pressure attained at any time during a shift.

(3) Persons who have not previously worked in compressed air shall not work more than one shift in the first 24 hours. No person shall be subjected to pressure in excess of 50 pounds per square inch except in emergency.

TABLE 7
SHIFTS AND INTERVALS OF WORK FOR EACH TWENTY-
FOUR HOUR PERIOD

| Minimum Number of Pounds | Maximum Number of Pounds | Maximum Total- Hours | Maximum First Shift in Compressed Air-Hours | Minimum Rest Interval in Open Air-Hours | Maximum Second Shift in Compressed Air-Hours |
|-----------------------------------|-----------------------------------|-------------------------------|--|---|---|
| Normal | 15 | 8 ³ / ₄ | ----- | ----- | ----- |
| 15 | 21 | 8 | 4 | 1 | 4 |
| 21 | 26 | 6 | 3 | 1 | 3 |
| 26 | 33 | 4 | 2 | 2 | 2 |
| 33 | 38 | 3 | 1 ¹ / ₂ | 3 | 1 ¹ / ₂ |
| 38 | 43 | 2 | 1 | 4 | 1 |
| 43 | 48 | 1 ¹ / ₂ | 3/4 | 5 | 3/4 |
| 48 | 50 | 1 | 1/2 | 6 | 1/2 |

* Rest period need not be spent in open air unless it is convenient to do so.

! Thirty minute rest period to be taken in middle of shift.

Ind 6.24 Period of Compression. (1) When workmen enter the lock, air pressure shall not exceed 5 pounds during the first minute, then the pressure shall be held constant for an interval long enough to ascertain whether workmen are affected, and a similar pause shall be made after each 5 pounds raise in pressure.

Ind 6.25 Decompression. (1) No person shall be permitted to pass from the place in which work is being done under pressure to normal air except after decompression in the intermediate lock as follows:

TABLE 8

DECOMPRESSION RATES

(Pressure in workings)

(Minimum time to decompress)

| | |
|-----------------------------|-------------------------------------|
| Normal to 15 pounds ----- | 5 minutes |
| 15 pounds to 20 pounds----- | 10 minutes |
| 20 pounds to 30 pounds----- | 20 minutes |
| 30 pounds and above ----- | 1 minute for each pound of pressure |

(2) The reduction of pressures during the time intervals required in the above table of decompression rates shall be accomplished at a rate as uniform as possible.

(3) The decompression table shall be posted conspicuously inside of and at the entrance to each man lock. Violations of the

above schedule shall be noted on the record of the individual involved.

Ind 6.26 Gauges. (1) A recording gauge to show the rate of decompression shall be connected to each man lock. The dial shall be of such size that the amount of rise or fall in the air pressure within any 5 minutes shall be readily shown.

(2) There shall be on the outer side of each working chamber at least one pressure gauge, which shall be accessible at all times and shall be kept in accurate working order. Additional fittings shall be provided so that test gauges may be attached at all necessary times. Pressure gauges shall be tested every 24 hours and a record kept of such test.

(3) Whenever men are working under a lake or stream a competent man shall be placed in charge of the valves and gauges which regulate and show the pressure in the working chamber. He shall not be employed more than 8 hours in any 24. At no time shall he operate more than two separate air lines.

Ind 6.27 Exhaust Valves. (1) Exhaust valves shall be provided, having risers extending to the upper part of chamber, if necessary, and shall be operated at such time as may be required and especially after a blast, and men shall not be required to resume work after a blast until the gas and smoke have cleared.

Ind 6.28 Communication. (1) Suitable means of communication shall be maintained at all times between the working chamber and the power house and the surface.

Ind 6.29 Safety Screens. (1) In the construction of tunnels, when the tunnel heading extends beyond the shore line, screens shall be installed when necessary, and ^{they} the screen shall at no time be at a distance of more than 200 feet behind the face.

(2) Whenever compressed air is employed in caisson work and the working chamber is less than 12 feet in length and when such

caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the workmen.

Ind 6.30 Locks. (1) Each bulkhead in tunnels of 12 feet or more in diameter or equivalent area, shall have at least two locks in perfect working condition, one of which shall be used as a man lock. An additional lock for use in case of an emergency may be required by the Industrial Commission.

(2) The man lock shall be large enough so that those using it are not compelled to be in a cramped position, and shall not be less than 7 feet in height. Emergency locks shall be large enough to hold an entire heading shift.

(3) All locks used for decompression shall be lighted by electricity and shall contain a pressure gauge, a timepiece, ^{and} a glass "bull's eye" in each door or in each end.

(4) Valves shall be so arranged that the locks can be operated both from within and from without.

(5) A suitable ladder shall be provided from the tops of all locks to the surface. The side rails of the ladder shall extend at least 3 feet above the landing.

(6) Vertical air locks used for the passage of men shall be provided with platforms of sufficient area to accommodate all men admitted to the lock.

Ind 6.31 Compressor Plants. (1) A good and sufficient air ^{compression} ~~compression~~ plant shall be provided to supply air for all conditions, including periods of repair or emergency.

(2) This plant shall be capable of furnishing to each working chamber a sufficient air supply for all pressures to enable work to be done as nearly as possible in the dry.

(3) There shall be two complete compressor plants to supply air for the compressed air work. The power supplies to each unit shall be from independent sources. The units shall be 10 feet apart and housed separately. The air intake of the units shall be 50 feet from the compressors.

(4) Duplicate air feed pipes shall be provided for the compressor plant to a point beyond the lock whenever work is being constructed under ponds, rivers and lakes or other bodies of water.

Ind 6.32 Sinking of Caissons. (1) No caisson shall be dropped by the method of removing the air pressure therein for a greater depth than 24 inches, and then only by the person in charge at the time.

Ind 6.33 Bracing of Caissons. (1) All caissons shall be properly and adequately braced before loading with concrete or other weight.

Ind 6.34 Sanitation and Ventilation. (1) An air chamber shall not be contaminated by any excretion or other nuisance. Containers shall be provided when necessary.

(2) No smoking shall be permitted in the air chamber.

(3) The supply of fresh air to the working chamber shall be sufficient at all times to permit work to be done without danger or discomfort. All air supply lines shall be equipped with check valves and carried as near to the face as practicable when used for ventilation. The air shall be analyzed as required and a record kept of the same.

(4) Care shall be taken to keep all parts of tunnel, caissons, and other working compartments, including lockers, dry rooms, rest rooms and other equipment in a sanitary condition and free from refuse, decaying, or other objectionable matter.

(5) When temperatures in underground workings exceed 95 degrees F., effective means shall be employed to reduce such temperatures. This requirement does not apply to tunnels extending less than 50 feet

from shafts.

Ind 6.25 Health Requirement for Compressed Air Operations. (1)

Changing Clothes. Men working in compressed air shall be required to change clothes at the start and termination of shifts. The change shanty as required in section Ind ^{6.106} 6.22 shall be located immediately adjacent to the shaft and access to it shall be protected by a canopy entrance from the shaft.

(2) Coffee and Utensils. A sufficient supply of hot coffee and sugar shall be supplied to men working in compressed air at the termination of shifts and during rest periods. Coffee shall be heated by means of other than direct steam. Coffee containers and cups shall be kept in a clean and sanitary condition at all times. All containers shall be kept covered at all times.

(3) Restricted Persons. The following persons shall not be permitted under compressed air:

(a) Persons addicted to the excessive use of intoxicants or drugs

(b) Persons suffering with general arteriosclerosis, high blood pressure, heart lesions (valvular or muscular), disturbances of blood circulation, chronic or acute respiratory diseases, or any disease of the kidneys. Every applicant for employment should submit a specimen of urine for analysis.

(c) Fat individuals, undernourished, or anemic persons.

Ind 6.36 Medical Attendance and Regulations. (1) Any person or corporation carrying on any work in the prosecution of which men are employed or permitted to work in compressed air, shall employ one or more qualified medical officers, who shall have had experience, or shall have familiarized himself with compressed air work, whose duty it shall be to strictly enforce the following:

(a) No person, including authorized inspectors, shall be permitted to enter compressed air zones unless he shall have been

examined and certified by a physician as being physically fit for activity in compressed air.

(b) In the event of absence from work of any employe for 5 or more successive days due to illness, he shall not be permitted to resume work until he has been re-examined by the physician and his physical condition reported to be such as to permit him to work in compressed air.

(c) After a person has been employed continuously in compressed air for a period of three months, he shall be re-examined by the physician and he shall not be permitted to work until such re-examination has been made and he has been reported as physically qualified to engage in compressed air work.

(d) A complete and full record of examinations made by the physician shall be maintained. A uniform examination blank, prescribed or furnished by the Industrial Commission, shall be used by each medical examiner, and the record of such examinations shall be available to the Industrial Commission. A list of the employes with the dates of their physical examinations shall be available at the location where the work is in progress.

(e) In cities and communities in which no hospital or health institution maintains a medical air lock, such a lock shall be established in connection with all work in compressed air when the maximum pressure exceeds 17 pounds. Such locks, if cylindrical, shall not be less than 5 feet in diameter, and if rectangular, shall not be less than 5 feet in width and 5 feet in height. The lock shall consist of two compartments, each compartment long enough to accommodate a cot with sufficient clearance to permit opening and closing of doors. Each door shall be provided with a bull's eye and fitted with air valve so arranged to be operated from within and without. Such lock shall be kept properly heated, lighted and ventilated, and shall

contain an air pressure gauge, a telephone and cot. Such lock shall be under the control of the physician in charge and there shall be maintained in close proximity a first-aid room, which shall contain medical and surgical appliances necessary for first aid in case of accident.

(f) A wrist identification tag shall be furnished by the employer to all employes advising police officials that the employe is a compressed air worker; stating location of medical lock, and stating that in case of emergency an ambulance surgeon shall remove the patient to the medical lock and not to the hospital.

(g) All cases of compressed air illness shall be reported, by the employer, to the Industrial Commission on a uniform blank furnished by the commission and copies of all such reports shall be kept on file at the plant where the work is in progress.

Ind 6.38 Forms. The following forms are listed in accordance with Sec. 227.013, Wis. Stats. The forms are issued by the Industrial Safety & Building Division and may be obtained from the Industrial Commission, 1 West Wilson Street, Madison.

- (1) SB-42 Report of Caisson Disease.
- (2) SB-43 Physician's Report of Physical Fitness for Workers Under Compressed Air.