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Chapter Ind 12

WORK UNDER COMPRESSED AIR

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Article 1.

APPLICATION

Ind 12.01 Application of orders. The following rules shall apply whenever men are employed in compressed air, exclusive of diving work. Machines, equipment, processes, and operations not specifically covered by these rules, shall be governed by other applicable administrative codes.

(1) EXCEPTIONS. (a) In cases of practical difficulty and unnecessary hardship, the department of industry, labor and human relations may grant a *variance* to literal requirements of this code and may permit the use of alternate devices or methods provided the variance proposed is clearly equal to code requirements in purpose and intent. A petition for modification must be filed with the department of industry, labor and human relations for any code variance sought.

(b) In cases of practical difficulty and unnecessary hardship, the department of industry, labor and human relations may grant a *waiver* of certain rules in this code when the rules apply to work in progress under contracts existing prior to the effective date of this code. Such waivers shall remain in effect for not more than 6 months.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.02 Inspections. (1) The authorized inspectors of the department upon presenting appropriate credentials to the owner, operator, or agent in charge, are authorized—

(a) To enter without delay and at reasonable times any factory, plant, establishment, construction site, or other area, workplace or environment where work is performed by an employee of an employer; and

(b) To inspect and investigate during regular working hours and at other reasonable times, and within reasonable limits and in a reasonable manner, any such place of employment and all pertinent conditions, structures, machines, apparatus, devices, equipment, and materials therein, and to question privately any such employer, owner, operator, agent or employee.

(2) The inspector before making his inspection shall contact a representative of the employer and a representative authorized by his employees who shall be given an opportunity to accompany the inspector during the physical inspection of any workplace under subsection (1) for the purpose of aiding such inspection.

(a) Where there is no authorized employee representative, the inspector shall consult with a reasonable number of employees concerning matters of health and safety in the workplace.

Note: The department policy is not to give advance notice, but in the scheduling and in the act of inspecting it may not always be possible to avoid advance notice or to obtain accompaniment as, for example, inside boilers or in precarious locations of elevator installations, but otherwise these rules will be diligently observed.

History: Cr. Register, April, 1973, No. 208, eff. 5-1-73.

Article 2.

DEFINITIONS

Ind 12.04 Definitions. The following definitions shall apply in the application of these rules. The singular number includes the plural and the plural the singular.

(1) **AIR MASTER.** That competent individual designated by the employer and licensed by the department of industry, labor and human relations in immediate charge of the work.

(2) **BULKHEAD.** An airtight structure separating the working chamber from free air or from another chamber under a lesser pressure than the working pressure.

(3) **COMBINATION LOCK.** An air lock which serves both as materials and man lock.

(4) **COMPRESSED AIR CAISSON.** A vertical structure extended below the water or earth surface through which men may descend through a lock into an air pressure greater than atmospheric. The pressurized atmosphere opposes the water pressure and permits men to work at the bottom of the caisson.

(5) **DECANTING.** A method used for decompressing under certain circumstances. In this procedure the workers are brought to atmospheric pressure with a very high gas tension in the tissues and then immediately recompressed in a second and separate chamber or lock. The period of time that the workers spend at atmospheric pressure

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between the decompression following the shift and recompression must not exceed 5 minutes.

(6) **EMPLOYER.** The contractor, firm, corporation or other organization carrying out the work.

(7) **FREE AIR.** Normal atmospheric pressure.

(8) **HIGH AIR.** Air pressure used to supply power to pneumatic tools and devices.

(9) **LOW AIR.** Air supplied to pressurize working chambers and locks.

(10) **MAN LOCK.** A chamber through which men pass from one air pressure environment into another.

(11) **MATERIALS LOCK.** A chamber through which materials and equipment pass from one air pressure environment into another.

(12) **MEDICAL LOCK.** A special chamber in which men are treated for decompression illness. It may also be used in preemployment physical examinations to determine the adaptability of the prospective employe to changes in pressure.

(13) **PRESSURE.** A force acting on a unit area. Usually shown as pounds per square inch (psi).

(a) *Absolute pressure* (psia). The sum of the atmospheric pressure and gauge pressure (psig).

(b) *Atmospheric pressure.* The pressure of air at sea level, usually 14.7 psia (one atmosphere), or 0 psig.

(c) *Gauge pressure* (psig). That pressure measured by a gauge and indicating the pressure exceeding atmospheric.

(14) **RETAINED PHYSICIAN.** The licensed physician appointed by the employer to supervise the medical program described herein.

(15) **SAFETY SCREEN.** An airtight 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.

(16) **SHAFT.** A passage made from the surface of the ground to a point underground, the longer axis of which makes an angle greater than 45 degrees with the horizontal.

(17) **SPECIAL DECOMPRESSION CHAMBER.** A chamber to provide greater comfort for employes when the total decompression time exceeds 75 minutes.

(18) **THRESHOLD LIMIT VALUES.** The values for airborne toxic materials which are to be used as criteria in the control of health hazards and represent time weighted concentrations to which nearly all workers may be exposed 8 hours per day over extended periods of time without adverse effects. Recognized standards or guides include, but are not limited to, the most recent edition of Threshold Limit Values adopted by the American Conference of Governmental Industrial Hygienists, Hygienic Guides published by the American Industrial Hygiene Association and American National Standards Institute. Additional criteria for compressed breathing air for working chambers and man locks subject to pressures of 14.0 psig or greater are specified in section 12.40 (11) of this code. Standards for designated contaminants of section 12.40 (11) shall take precedence when working areas are under pressures of 14.0 psig or greater. Conformity with recognized standards (TLV) shall be prima facie evidence that such concentrations are reasonably safe.

(19) **TUNNEL.** An excavation beneath the ground, the longer axis of which makes an angle not greater than 45 degrees with the horizontal.

(20) **WET GLOBE TEMPERATURE.** The reading of a wet globe thermometer when at thermal equilibrium with the surrounding environment. This reading or arbitrary index combines into a single value the effects of temperature, humidity, thermal radiation and wind or air involvement in a meaningful way that is directly related to human response.

(21) **WET GLOBE THERMOMETER.** Any thermometer having the bulb or other sensing portion enclosed by a hollow copper sphere 2 3/8" in diameter which has a flat black surface completely covered with black cloth that is saturated with water. Interruption of the continuity of the wet spherical surface for insertion of the thermometer sensor, provision of a continuous water supply, reservoir, handle or other purpose shall be confined to a single circular area of the surface no larger than 5/8" in diameter and shall be accomplished so as

not to affect the temperature of the sphere significantly. An instrument meeting these requirements is discussed in the articles "A Wet Globe Thermometer for Environmental Heat Measurement" by J. Botsford and "Comparison of Heat Stress Indices" by R. Brief and R. Confer which were published in the January 1971 issue of the "American Industrial Hygiene Association Journal."

(22) **WORKING CHAMBER.** The space or compartment under air pressure in which the work is being done.

(23) **WORKING PRESSURE.** The air pressure established at any time by the air master to be the desired air pressure in the working chamber.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 3.

GENERAL PROVISIONS

Ind 12.05 General provisions. (1) **DEPARTMENT NOTIFICATION.** No work, where men are employed in compressed air, shall be started until 7 days after the firm, corporation, commission, or person undertaking such work has notified, in writing, the department of industry, labor and human relations of such contemplated work.

(2) **MEDICAL NOTIFICATION.** No compressed air work shall be started until the employer has given written notification to local fire authorities and the local compressed air medical treatment facility. Such notifications shall include the name, address and telephone number of the employer and shall include the location and the telephone number of the foreman's office on the job site. The employer shall also notify the retained physician and the local physician.

(3) **AIR MASTER.** The employer shall designate one competent individual to be in immediate charge of the work, hereinafter called the air master. The air master shall have passed a licensing examination given by the department of industry, labor and human relations. The air master shall be familiar with all applicable rules of this code, and shall comply with them. The air master, or a duly authorized competent licensed alternate air master, shall be on the job site at all times while work is being performed in the working chamber.

(4) **MAXIMUM WORKING PRESSURE.** No persons shall be exposed to an air pressure greater than 50 psig except in the event of emergency, or while in the medical lock under the supervision of the physician. Pressures over 50 psig may be allowed by supplementing the provisions of this code.

(5) **INSTRUCTION OF WORKMEN.** The air master shall insure that every employe is instructed in the safe performance of his work, and require that each employe observe the rules of this code.

(6) **EMPLOYE IDENTIFICATION.** The employer shall furnish each compressed air employe with a durable identification bracelet. The bracelet shall bear employe's name and social security number and shall identify the employe as a compressed air worker, shall bear the location and telephone number of the compressed air medical treatment facility and shall bear instructions that in the event of compressed air

illness or illness of unknown or doubtful cause, the wearer shall be taken to the medical lock without delay. Each compressed air employe shall be instructed by the employer to have his identification bracelet in his personal possession at all times, both on and off the job. A permanent record of identification used and issued shall be kept on file.

(7) **POSTING OF INSTRUCTIONS.** The instructions contained in appendix C entitled, "Suggestions for the Guidance of Compressed Air Workers," as well as such other instructions as may be deemed necessary, shall be printed and posted conspicuously under a transparent, protective covering, in the change house, and in each man lock.

(8) **PERIODIC INSPECTION.** The air master shall designate competent individuals to inspect all emergency equipment and structures on the job site *at least once each workday* when work in compressed air is in progress. Reports of such inspection shall be recorded.

(9) **AVAILABILITY OF RULES AND REGULATIONS.** This safety code and other rules and regulations which may be applicable shall be kept on the job site in the custody of the air master.

(10) **SOLITARY EMPLOYMENT.** No employe shall be permitted to work alone.

(11) **ENTERING AND LEAVING THE WORKING CHAMBER.** (a) Persons entering or leaving the working chamber are subject to the provisions of this code. When working chambers are at pressures greater than atmospheric, the air master shall train competent individuals, hereinafter called *man lock attendants*, to operate the air locks through which men may pass. No persons shall be permitted to enter the working chamber except through a working man lock or combination lock.

(b) *Use of explosives:* The use of explosives in compressed air shall be governed by the rules of blasting in compressed air as specified in Wis. Adm. Code, chapter Ind 5 "Explosives."

NOTE: Every reasonable effort should be taken to insure the safety of workmen in all situations whether or not covered by these rules.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 4.

COMPRESSION

Ind 12.10 Compression rate. During the compression of workmen, the pressure shall not be increased to more than 5 psig within the first minute. The pressure shall be held at 5 psig and again at 8 psig sufficiently long to determine if any individuals are experiencing discomfort. After the first minute the pressure is to be raised uniformly and at a rate not to exceed 10 psi per minute. If any workman complains of discomfort, the pressure shall be held to determine if the symptoms are relieved. If after 5 minutes the discomfort does not disappear, the lock attendant shall gradually reduce the pressure until the workman signals that the discomfort has ceased. If he does not indicate that the discomfort has disappeared, the lock attendant shall reduce the pressure to atmospheric and the workman shall be released from the lock.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 5.

DECOMPRESSION

Ind 12.15 Normal condition. (1) A normal condition is one during which exposure to compressed air is limited to a single continuous working period followed by a single decompression in any given 24-hour period; the total time of exposure to compressed air during the single continuous working period is not interrupted by exposure to normal atmospheric pressure, and a second exposure to compressed air does not occur until at least 12 consecutive hours of exposure to normal atmospheric pressure has elapsed since the workman has been under pressure.

(2) Decompression for normal condition shall be in accordance with the decompression tables. (See decompression table No. 1 and No. 2 in appendix A.)

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.16 Repetitive exposures. In the event it is necessary for an employe to be in compressed air more than 3 times in a 24-hour period, the *air master* shall be responsible for the establishment of methods and procedures of decompression applicable to repetitive exposure tables. (See repetitive exposure tables No. 3, 4 and 5 in appendix B.)

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71; am. Register, February, 1972, No. 194, eff. 3-1-72.

Ind 12.17 Decanting. If decanting is to be used, the appointed physician shall submit his procedures to the department of industry, labor and human relations for approval before anyone is permitted to be decompressed by decanting methods.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 6.

MAN LOCKS AND SPECIAL DECOMPRESSION CHAMBER

Ind 12.20 Man locks. (1) Except in emergency, no person employed in compressed air shall be permitted to pass from the working chamber to atmospheric pressure until after decompression in accordance with the procedures in either appendix A, appendix B, or as provided in section Ind 12.17.

(2) Time of decompression shall be posted in each man lock or special decompression chamber.

(3) Except where air pressure is below 12 psig and there is no danger of rapid flooding, all caissons having a working area greater than 150 square feet and each bulkhead in tunnels of 14 feet or more in diameter, or equivalent area, shall have at least 2 locks in perfect working condition, 1 of which shall be used exclusively as a man lock, the other as a materials lock. Where only a combination man and materials lock is required, this single lock shall be of sufficient capacity to hold the men constituting 2 successive shifts.

(4) The man lock shall be large enough so that those using it are not compelled to be in a cramped position, and shall not have less than 5 feet clear head room at the center and a minimum of 30 cubic feet of air space per occupant.

(5) Locks on caissons shall be so located that the bottom door shall be not less than 3 feet above the water level surrounding the caisson on the outside.

(6) In addition to the pressure gauge in the locks, an accurate pressure gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and shall be kept in accurate working order. These gauges shall be tested and certified by a state licensed boiler inspector at 12 month intervals.

(7) Every man lock shall be adequately lighted by electricity and shall have observation ports at least 4 inches in diameter so that occupants of the lock can be observed from the working chamber and from the free air side of the lock.

(8) Adequate ventilation in the lock shall be provided. Air quality criteria shall be the same as required in working chambers.

(9) Man locks shall be maintained at a minimum temperature of 70 degrees F., dry bulb.

(10) When locks are not in use and men are in the working chamber, lock doors shall be kept closed to the working chamber except where there are separate man and muck locks. In this case at least one door to the working chamber shall be closed.

(11) There shall be effective voice communication at all times between the following:

- (a) The working chamber face.
- (b) The working chamber side of the man locks near the door.
- (c) The interior of the man lock.
- (d) Lock attendant's station.
- (e) The compressor plant.
- (f) At the surface or shaft opening.

(12) All locks shall be constructed in accordance with the provisions of Wis. Adm. Code, chapter 41 and 42, Boiler and Unfired Pressure Vessel.

(13) Whenever vertical locks are to be installed both a man lock and a materials lock shall be incorporated.

(14) Vertical man locks shall be at least 7 feet in height and shall provide at least 30 cubic feet of space per man unless decompression time exceeds 75 minutes in which case 50 cubic feet of space per occupant shall be provided.

(15) Vertical man locks shall have sufficient space to contain an entire shift of workmen.

(16) Doors on vertical man locks shall be readily openable, but when shut shall seal tight.

(17) Vertical man locks shall seal tight under a pressure of one-half pound.

(18) Doors in vertical man locks shall be leakproof.

(19) Subsections (1) through (12) also apply to vertical man locks.

(20) Effective silencers shall be provided where air noises exceed the noise standards established in the Wis. Adm. Code, chapter 11, Occupational Noise Exposure.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.21 Man lock attendant. (1) When working chambers are at pressures greater than atmospheric, a man lock attendant shall be on duty at the man lock attendant's station at all times when workmen are in the working chamber.

(a) When working chambers are at pressures greater than atmospheric, each working man lock or combination lock shall be operated by the man lock attendant. The man lock attendant shall control the entrance of persons into the working chamber, shall supervise compression and decompression of working man locks, and shall keep such records as are required by the department of industry, labor and human relations. The man lock attendant shall perform his duties at the man lock attendant's station, which shall be equipped as hereinafter provided.

(b) The man lock attendant may delegate to a competent person who is to be compressed in the man lock, the duty to regulate admission of air into the lock during compression.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.22 Man lock attendant station. (1) When working chambers are at pressures greater than atmospheric, a man lock attendant's station shall be provided, and shall be equipped with the following:

(a) A continuous recording pressure gauge or gauges indicating the air pressure in the working chamber(s). The gauge shall be of such sensitivity and the chart shall be of such size that changes in air pressure of 0.5 psig in 5 minutes shall be readily discernible. The recording graph alternately may be located in the compressor plant.

(b) A continuous recording pressure gauge or gauges indicating the air pressure(s) in the working man lock. The gauge and charts shall be as described in paragraph (a). The recording graph alternately may be located in the compressor plant.

(c) Air pressure gauges indicating the air pressure in each working chamber and in the working man locks.

(d) A clock.

(e) A thermometer(s) indicating the temperature inside the working man locks.

(f) Valves and piping to enable the man lock attendant to control the supply and discharge of air to and from the man locks.

(g) Devices that will permit automatic control of decompression in the working man locks. (When pressures in the working chamber are 12 psig or greater.)

(h) Manual controls that will enable the man lock attendant to override the automatic controls in an emergency.

(i) A manual control, that can be used in the event of an emergency, shall be placed inside the man lock.

(j) A lock register.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.23 Lock register. (1) When working chambers are at pressures greater than atmospheric, the man lock attendant on duty shall maintain a written lock register of the movements into and out of each working chamber on Form SB-250.

(a) *Exposure Time:* The exposure time for a single exposure shall be equal to the number of hours in the working chamber inclusive of compression time but exclusive of decompression time.

(b) *Exposure Pressure*: The exposure pressure for a single exposure shall ordinarily be the highest air pressure to which the workmen have been subjected during the exposure time.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.25 Special decompression chamber. (1) **WHEN REQUIRED.** A special decompression chamber of sufficient size to accommodate the entire force of workmen being decompressed at the end of a shift shall be provided whenever the regularly established working period requires a total time of decompression exceeding 75 minutes.

(a) All provisions for safety and comfort applying to man locks (Section Ind 12.20) shall also apply to special decompression chambers.

(2) **SIZE, CAPACITY, AND CONSTRUCTION.** The headroom in the special decompression chamber shall be not less than 7 feet. The cubical content shall be at least 50 cubic feet of air space for each person. For each occupant there shall be provided 4 square feet of free walking area and 3 square feet of seating space exclusive of area required for lavatory and toilet facilities. The rated capacity shall be based on the stated minimum space per person and shall be posted at the chamber entrance. The posted capacity shall not be exceeded, except in case of emergency. The chamber shall be constructed in accordance with the provisions of Wis. Adm. Code, chapters 41 and 42, Boiler and Unfired Pressure Vessel.

(3) **EQUIPMENT.** Each special decompression chamber shall be equipped with the following:

(a) A clock or clocks suitably placed so that the attendant and the chamber occupants can readily ascertain the time;

(b) Pressure gauges which will indicate to the attendants and to the chamber occupants the pressure in the chamber;

(c) Valves to enable the attendant to control the supply and discharge of compressed air into and from the chamber;

(d) Valves and pipes in connection with the air supply and exhaust arranged so that the chamber pressure can be controlled from within and without;

(e) Effective means of oral intercommunication between the attendant, occupants of the chamber, and the air compressor plant;

(f) An observation port at the entrance to permit observation of the chamber occupants.

(4) **SEATING FACILITIES.** Seating facilities in special decompression chambers shall be so arranged as to permit a normal sitting posture without cramping. Seating space not less than 18 inches by 24 inches wide shall be provided per occupant.

(5) **LIGHTING AND HEATING.** Lighting and heating shall comply with section Ind 12.20 (7) and (9).

(6) **VENTILATION.** Ventilation shall comply with section Ind 12.20 (8).

(7) **RECORD OF DECOMPRESSION.** Decompression in the special chamber shall be part of the records required by section Ind 12.23.

(8) **AUTOMATIC CONTROLS.** Special decompression chambers shall be equipped with automatic controls complying with section Ind 12.22 (g).

(9) **SANITATION.** Adequate toilet facilities shall be provided. Water closets shall be provided with an air gap between seat and fixture. If a bucket is used it shall be vented to prevent explosion or implosion. Fresh and pure drinking water shall be available. This may be accomplished by either piping water into the special decompression chamber and providing drinking fountains, or by providing individual canteens or by some other sanitary means. Community drinking vessels are prohibited. No refuse or discarded material of any kind shall be permitted to accumulate, and the chamber shall be kept clean.

(10) **LOCATION.** Unless the special decompression chamber is serving as the man lock to atmospheric pressure that special decompression chamber shall be situated where practicable, adjacent to the man lock on the atmospheric pressure side of the bulkhead. A passageway shall be provided connecting the special chamber with the man lock to permit workmen in the process of decompression to move from the man lock to the special chamber without a reduction in the ambient pressure from that designated for the next stage of decompression. The passageway shall be so arranged as to not interfere with the normal operation of the man lock nor with the release of the occupants of the special chamber to atmospheric pressure upon the completion of the decompression procedure.

(11) **FIRE PROTECTION.** All applicable provisions of article 10, fire protection, shall apply to special decompression chambers.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 7.

TEMPERATURE, ELECTRICITY AND SANITATION

Ind 12.30 Temperature, electricity and sanitation. (1) The following provisions shall be observed in the conduct of compressed air work:

(a) Temperature of all working chambers that are subjected to compressed air shall, by means of aftercoolers or other suitable devices, be maintained not exceeding "wet globe temperatures" listed in the following table:

Maximum Wet Globe Temperature °F

Exposure Time	Rest or Sedentary	Moderate Work	Heavy Work
Continuous Daily Work			
Intermittent Work—Rest	83	79	73
3 Hours	87	82	77
2 Hours	89	84	79
1 Hour	93	88	83
30 Minutes	99	94	88
20 Minutes	104	98	93

(b) All lighting in compressed air chambers shall be by electricity exclusively, and 2 independent electric lighting systems with independent sources of supply shall be used. The emergency source shall be arranged to become automatically operative in the event of failure of the regularly used source.

(c) The minimum intensity of light on any walkway, ladder, stairway, or working level shall be not less than 10 foot candles, and in all work places the lighting shall at all times be such as to enable employes to see clearly.

(d) All electrical equipment, and wiring for light and power circuits, shall comply with requirements of the Wisconsin electrical code for use in damp, hazardous, high temperature, and compressed air environments.

(e) External parts of lighting fixtures and all other electrical equipment, when within 8 feet of the floor, shall be constructed of non-combustible, nonabsorptive, insulating materials, except that metal may be used if it is effectively grounded.

(f) Portable lamps shall be equipped with noncombustible, non-absorptive, insulating sockets, approved handles, basket guards, and approved cords.

(g) The use of worn or defective portable and pendant conductors is prohibited.

(h) Properly heated, lighted, and ventilated dressing rooms and drying rooms shall be provided for all employes engaged in compressed air work. Such rooms shall contain suitable benches and lockers. Bathing accommodations (showers at the ratio of 1 to 8 men per shift) equipped with running hot and cold water and suitable and adequate toilet accommodations shall be provided. Where practicable, the ratio of one toilet and one urinal for each 15 employes, or fractional part thereof, shall be provided.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 8.

COMPRESSOR PLANT, AIR SUPPLY AND TELEPHONE COMMUNICATION

Ind 12.40 Compressor plant, air supply and telephone communication. (1) There shall at all times be a thoroughly experienced, competent and reliable person on duty at the air control valves as a compressor man who shall regulate the pressure in the working areas as directed by the air master.

(a) During tunneling operations, one compressor man may regulate the pressure in not more than 2 headings provided that the gauges and controls are all in one location. In caisson work there shall be a compressor man for each caisson.

(2) The low air compressor plant shall be of sufficient capacity to not only permit the work to be done safely, but shall provide a margin to meet emergencies and repairs.

(3) Low air compressor units shall have at least 2 independent and separate sources of power supply. Each independent and separate source of power supply shall be capable of operating the entire low air plant and its accessory systems.

(4) The capacity, arrangements, and number of compressors shall be sufficient to maintain the necessary pressure without overloading the equipment and to assure maintenance of such pressure in the working chamber during periods of breakdown, repair, or emergency.

(5) Switching from one independent source of power supply to the other shall be done periodically to ensure the workability of the apparatus in an emergency.

(6) In tunneling operations the low-pressure air supply lines shall extend to a point within 25 feet of the mining equipment at the tunnel face. Outlets shall be installed at intermediate points along the main low-pressure air supply line to the heading to eliminate pockets of dead air. All supply outlets shall be equipped with check valves. Ventilating air shall be not less than 30 cfm per man. A duplicate air supply line shall extend from the air source to a point beyond the locks.

(7) All high and low-pressure air supply lines shall be equipped with check valves.

(8) Low-pressure air shall be regulated automatically. In addition, manually operated valves shall be provided for emergency conditions.

(9) The air intakes for all air compressors shall be located at a place where fumes, exhaust gases, and other contaminants will be at a minimum.

(10) Gauges indicating the pressure in the working chamber shall be installed in the compressor building and the lock attendants' station, and the employer's field office.

(11) The working chamber shall be well ventilated, and there shall be no pockets of dead air. Contaminants shall be kept below threshold limit values as defined.

(12) PURITY STANDARDS FOR COMPRESSED BREATHING AIR AT 14.0 psig OR GREATER:

Contaminant	Maximum Permissible Concentration in Breathing Air
Carbon Monoxide.....	20 parts per million, by volume
Carbon Dioxide.....	2,500 parts per million, by volume
Oil or particulate matter (as sampled by method that does not collect vapor).....	5 milligrams per cubic meter for environments between 14.0 psig and 2 atmospheres gauge pressure; 3 milligrams per cubic meter for environments above 2 atmospheres gauge.
Methane.....	Less than 10% of lower explosive limit.
Oxygen.....	More than 20%

(a) The air in the work place shall be analyzed by the employer over each shift. Contents to be determined will be specified by the department of industry, labor and human relations. Records shall be kept.

(13) Men shall not be required to resume work after a blast from explosives until smoke and gases have been cleared. See Wis. Adm. Code, chapter Ind 5, "Explosives."

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 9.

BULKHEADS AND SCREENS

Ind 12.50 Bulkheads and screens. (1) When a tunnel is subject to rapid flooding, safety screens or bulkheads shall be installed.

(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 than 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the workman.

(3) In tunnels 16 feet or more in finished diameter, hanging walkways shall be provided from the face to the man lock, as high in the tunnel as practicable, with at least 6 feet of head room. Walkways shall be constructed of noncombustible material. Standard railings shall be securely installed throughout the length of all walkways on open sides. Where walkways are ramped under safety screens, the walkway's surface shall be skidproofed by cleats or otherwise.

(4) Bulkheads used to contain compressed air shall be tested, where practicable, to prove their ability to resist the highest air pressure which may be expected to be used.

(5) Pressure gauges shall be installed in accordance with section Ind 12.20 (6).

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 10.

FIRE PREVENTION

Ind 12.70 Fire prevention. (1) Every tunnel shall be provided with a water line, 2-inch minimum diameter, extending into the working chamber and man lock or combination lock, and to within 100 feet of the working face. The water line shall have hose outlets with 100 feet of fire hose properly attached and maintained at:

- (a) The working face.
- (b) The working chamber side of each bulkhead.
- (c) The outside of each bulkhead.
- (d) Hose outlets shall be provided at 200 foot intervals throughout the length of the tunnel, and 100 feet of fire hose shall be attached to the hose outlet nearest to any location where flammable material is being kept or stored or where any flame is being used.
- (e) Actual pipe size used shall provide a capacity of 140 gallons per minute at most distant outlet when used with standard fire pumps.

(2) A hose shall also be provided within the man or combination lock of sufficient length to serve all areas of these locks.

(3) Fire hose shall be at least 1½ inches in nominal diameter. It shall be rot and mildew resistant. Water pressure shall be available for efficient operation of the type of nozzle used, having due regard to the air pressure in the working chamber.

(a) When a municipal water supply is available, it shall be connected to the waterline to provide the necessary water for immediate extinguishing capability. Provision shall be made to prevent freezing of any exposed piping. In addition, a single inlet fire department con-

nection shall be provided to augment the pressure available. This connection shall be provided with a check valve to prevent a flow of water back into the municipal water supply.

(4) In addition to required fire hose protection, there shall be provided a suitable number of fire extinguishers of adequate size approved for the class of hazard involved. Prohibited are extinguishers containing CO² (except for use as a propellant), vaporizing liquids or halogenated extinguishing agents. Extinguishers shall be so located as to be readily available but yet protected from damage.

(5) No person shall smoke or carry smoking materials in compressed air.

(6) When welding or flame cutting has been done in compressed air, a worker with a fire hose or suitable extinguisher shall stand by until one hour after the welding or flame cutting has been completed. Devices to prevent reverse flow of compressed air shall be installed on oxygen and acetylene regulating equipment.

(7) The compressor building shall be constructed of noncombustible materials.

(8) Equipment, fixtures, and furniture in man locks and special decompression chambers shall be constructed of noncombustible materials. Bedding and other furnishings shall be chemically treated so as to be fire-resistant. The treating compound and process shall be acceptable to the department of industry, labor and human relations.

(9) Respirators using pure oxygen as the breathing medium are prohibited. Respirators using compressed air shall be used.

(10) 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.

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

(12) 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.

(13) Headframes built of combustible material shall be of open framework. At or about the surface landing there may be a headhouse if built of fire-resistive material.

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

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Article 11.

MEDICAL CARE OF EMPLOYEES

Ind 12.80 Medical attendance. (1) **RETAINED PHYSICIAN.** In addition to the duties and responsibilities delegated to the retained physician in other sections of this code, the physician, aided by associates as necessary, shall assume the following duties and responsibilities:

(a) Supervise all matters pertaining to the occupational health of employees, including treatment of illness or injury, and the preparation of appropriate treatment records.

(b) Shall be immediately available in the event of accident or emergency.

(c) Supervise the work of licensed air master and first aid personnel as it pertains to occupational health.

(d) Shall instruct personnel in the use of all medical and first aid equipment.

(e) Shall make or supervise each physical examination required by this code.

(f) Shall supervise the preparation of and sign the medical reports required by this code.

(g) Shall conduct periodic inspections of the work with the view to eliminating conditions which may constitute a potential hazard to the health of any employe.

(h) Shall inspect the lock register and the decompression record at least twice each week.

(i) Shall instruct and provide such technical assistance as deemed necessary to the local fire department so fire and rescue personnel are properly oriented to the problems involved in a compressed air atmosphere.

(2) **MEDICAL ATTENDANT.** When air pressure greater than atmospheric are employed, the retained physician shall appoint medical attendants, 2 of whom shall be on immediate call at the chamber facility during the time workmen are employed in compressed air. When required, the medical attendant shall operate the controls of the medical lock under the supervision and direction of a qualified physician. Each medical attendant shall be under the direct supervision and control of a physician, and shall serve in such capacity only at the pleasure of the retained physician.

(3) **FIRST AID PERSONNEL.** Certain employes as selected by the employer shall be trained to the satisfaction of the retained physician in administering first aid.

(4) **FIRST AID MEETINGS.** All designated first aid personnel shall meet prior to start of compressed air work and thereafter at intervals not exceeding 3 months for first aid instruction by the retained physician.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.81 Medical facilities. (1) **FIRST AID STATION.** A first aid station shall be established in the proximity of the principal entrance to the underground work. The first aid station shall be properly heated and maintained. The first aid station shall contain first aid supplies, portable first aid kits and medical supplies and equipment as recommended by either the department of industry, labor and human relations or the retained physician or both.

(2) **SURFACE TRANSPORTATION.** Suitable means of surface transportation for injured personnel shall be provided, where the services of an ambulance cannot be secured within 30 minutes.

(3) **FIRST AID STATION UNDERGROUND.** First aid stations shall be established underground in the following locations:

(a) In tunnels, one station shall be established in a convenient location within 100 yards of the working face and within the decompression lock.

(b) In caissons, one station shall be established in a convenient location in the working chamber.

(c) Each first aid station underground, at the working face and on the surface, shall be provided with a mine type stretcher, a woolen blanket or equally warm covering, a waterproof covering for injured employes, at least 20 feet of one-half inch rope, or equivalent, for securing the injured man in the stretcher, and such other first aid supplies and equipment as recommended by the department of industry, labor and human relations or the retained physician or both.

(d) First aid supplies and equipment shall be kept in dry, sanitary and usable condition.

(e) Each first aid station shall be plainly identified with a red cross and the words "FIRST AID," each of which shall be marked with fluorescent paint on a background of sharply contrasting color.

(f) Each first aid station shall be inspected periodically to ensure that the stocks of first aid supplies and equipment are not below the required level.

(4) **MEDICAL LOCK REQUIRED.** (a) When air pressures greater than atmospheric are used, a medical lock and accessory equipment conforming to the provisions of this code shall be provided in a convenient location no more than 30 minutes normal travel time by motor vehicle from the job site.

(b) The medical lock shall be maintained in immediate working order, and shall be kept ready for use at least 8 hours subsequent to the emergence of any person from the working chamber.

(5) **CONSTRUCTION OF MEDICAL LOCK.** (a) Each medical lock shall contain an inner and outer compartment, with doors so arranged that an individual can pass from atmospheric pressure through the outer compartment into the inner compartment, or out again, without change of air pressure in the inner compartment. An instrument lock shall be provided so that the small objects can be passed from atmospheric pressure to the inner compartment, or out again, without change of pressure in the inner compartment.

(b) The medical lock shall be designed and fabricated in accordance with the provisions of Wis. Adm. Code, chapters 41 and 42, Boiler and Unfired Pressure Vessel. The medical lock shall be designed for service at an internal air pressure of not less than 75 psig in the inner compartment or in both compartments.

(c) Each material used in the construction or maintenance of the medical lock, including such items as gaskets, lubricants, sealants, shall be nonflammable. Items of furnishings, such as mattresses, blankets, coverings, shall be manufactured of inert nonflammable materials.

(d) The medical lock shall have at least 6 feet clear headroom at the center and shall have room sufficient to contain 2 cots, each 2 feet by 7 feet, within the inner compartment.

(e) The bulkhead doors shall provide 2 feet 6 inch clear width and 4 feet 0 inch clear height, with a corner radius not to exceed 4 inches. The bulkhead doors shall be so arranged that they shall be seated and sealed by air pressure. The doors shall be so arranged and mounted that they will readily seat and seal properly despite the variations in gasket thickness which may take place due to the

passage of time or the application of pressure. The installation of dogs or mechanical devices for seating bulkhead doors will neither be required nor permitted.

(f) Circular viewports shall be installed in each bulkhead door and in each side of the inner and outer compartments. Each viewport shall have an effective viewing diameter of not less than 6 inches.

(g) Each compartment of the medical lock shall be provided with fire protection sprinkler nozzles, so located that effective sprinkler protection is afforded to all points below the centerline of the medical lock, making due allowances for the reduction in sprinkler coverage due to the increased density of compressed air. The sprinkler system shall be approved by the department of industry, labor and human relations.

(h) Each compartment of the medical lock shall be provided with a valve, fire hose, and spray nozzle not less than $\frac{3}{4}$ of an inch nominal diameter.

(i) Each compartment of the medical lock shall be provided with internal controls governing the supply and exhaust of compressed air and the supply of fire protection water. Each such control shall be subject to override from outside the medical lock.

(j) Each compartment of the medical lock shall be provided with a floor drain operated by a valve located outside the lock. The valve shall be protected from damage by a guard or screen.

(k) Each compartment of the medical lock shall be illuminated by electric lamps. The electrical supply to the medical lock shall be an underground system, with all enclosures and conduits grounded to the medical lock as specified in the Wisconsin State Electrical Code. All enclosures and equipment in the medical lock shall be approved for use in Group C atmospheres as defined in the Wisconsin State Electrical Code. Switches or other lighting controls shall not be installed within the medical lock.

(l) Each compartment of the medical lock shall be provided with piping connected to an external supply of breathable gas, and not less than four quick connect disconnect fittings with double-end shutoff.

(m) The inner compartment of the medical lock shall be provided with piping connected to an external supply of oxygen, and not less than 2 quick connect disconnect fittings with double-end shutoff, of the same construction as the breathable gas fittings.

(n) Each compartment of the medical lock shall be provided with 4 respiratory protective units with demand type regulators. The air supply hoses shall be provided with fittings matching the breathable gas and oxygen fittings. The air supply hoses shall be long enough to permit the wearer to lie on the floor of the medical lock.

(o) The floor of the medical lock shall be impervious, sparkproof, and nonskid.

(p) The medical lock shall be provided with sources of oil free air, both normal and emergency, capable of raising the air pressure in the inner compartment of the lock from atmospheric pressure to 75 psig within 5 minutes.

(q) Each compartment of the medical lock shall be provided with an air pressure gauge, a thermometer, and a clock, all of which are visible from the inside of the compartment.

(r) Sealants and lubricants shall be nonflammable and nonvaporizing under normal medical lock operating conditions.

(s) The medical lock shall be painted inside and out with a paint which will not burn or give off fumes when heated to a temperature of 250 degrees F.

(t) Each compartment of the medical lock shall be provided with adequate means of verbal communication between the compartments, and between each compartment and the outside of the medical lock.

(u) Each compartment of the medical lock shall be provided with an explosive-proof telephone set connected to the public telephone system either directly or through a manned switchboard.

(6) MAINTENANCE OF MEDICAL LOCK. (a) The medical lock shall be maintained in a sanitary condition.

(b) The medical lock shall be maintained, in use, at a temperature not to exceed 90 degrees F. nor be less than 70 degrees F.

(c) The medical lock shall be properly illuminated and ventilated. Ventilation capacity shall be sufficient to keep the oxygen level in the lock below 25% by volume in the air. Analytical instrumentation suitable to department of industry, labor and human relations for monitoring the oxygen content shall be connected to the lock air system.

(7) MEDICAL SERVICE AND FIRST AID. (a) The employer shall insure the availability of medical personnel for advice and consultation on matters of occupational health.

(b) In the absence of an infirmary, clinic, or hospital in proximity to the work site which is available for the treatment of injured employes, a person or persons who have a valid certificate in first aid training from the U. S. Bureau of Mines or the American Red Cross shall be available to render first aid.

(c) 1. First aid supplies recommended by the consulting physician shall be easily accessible when required.

2. The first aid kit shall consist of materials recommended by the consulting physician in a weatherproof container with individual sealed packages for each type of item. The contents of the first aid kit shall be checked by the employer before being sent out on each job and at least weekly on each job to insure that the expended items are replaced.

(d) Provisions shall be made prior to commencement of the project for prompt medical attention in case of serious injury.

(e) Proper equipment for prompt transportation of the injured person to a physician or hospital, or a communication system for contacting necessary ambulance service, shall be provided.

(f) The telephone numbers of the doctors, hospital and ambulances shall be conspicuously posted.

(g) There shall be at least one person, with a valid certification in first aid training from the U. S. Bureau of Mines or the American Red Cross, to administer emergency first aid at any isolated location, or area of difficult access, and where medical treatment is not available.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.82 Physical examination. (1) No person shall be permitted to enter the working chamber unless he has been examined by the physician. At the option of the air master this provision may be waived for casual visitors having previous knowledge and experience with compressed air work.

(2) In this event Form SB-249 must be completed and signed by the visitor prior to entering compressed air. If any question on this form is answered in the affirmative, entry shall be denied.

(3) This provision shall be waived for emergency entry, exit, inspection and enforcement by fire departments and other emergency services.

(4) The physical examination shall include the following:

(a) Serological test for syphilis.

(b) Blood test for sickle cell anemia trait. No person with this trait may be employed under compressed air.

(c) X-rays of the chest, anterior views of both shoulders, both hips and anterior and lateral views of both knees. These films must be interpreted by a radiologist intimately familiar with the lesions of aseptic necrosis. Pelvic and gonad shielding shall be used for X-ray of the hips.

NOTE: The physician may recommend that persons in the following categories not be employed in compressed air:

Persons who cannot readily equalize air pressure in their ears.

Persons who are addicted to the excessive use of intoxicants.

Persons addicted to the use of narcotics.

Persons with an impairing physical deformity or abnormality, including gross obesity.

Persons with a disease of the ear.

Persons with any systemic disease which may be aggravated by exposure to, or work in, compressed air, or which may represent a danger to the person, or to others in compressed air.

(5) Physician's recommendation. The recommendation of the physician as to employability shall be in writing, and shall be signed by the physician. A copy of the recommendation shall be submitted to the air master and shall be kept on file in the air master's office. Forms SB-247-A and SB-248 shall be completed. Copies shall be kept in the retained physician's file.

(6) Valid period of physician's recommendation. The physician's recommendation shall be valid for a period of 14 days from the date of physical examination.

(7) Temporary recommendation. When work in compressed air is urgently required to be done, during a period when the retained physician has not been appointed or is otherwise unavailable, the required physical examination may be performed by any physician licensed to practice in the state or district exercising jurisdiction, who may then issue a temporary recommendation as to employability. A physical examination shall be performed by the retained physician at the earliest practicable date.

(8) Periodic reexamination. Each person reported by the physician to be physically qualified for employment in compressed air shall be reexamined by the physician within one year of the date of the preceding physical examination, or sooner as the physician may deem necessary, to determine whether or not he continues to be physically qualified for such work. A new recommendation as to the employ-

ability shall be prepared as provided for in subsection Ind 12.82 (5). Forms SB-247 and SB-247-A shall be completed for this examination. Completed forms shall be submitted to the employer and the air master. Copies shall be kept in the retained physician's file.

(9) Reexamination due to absence from work. Each person working in compressed air who has been absent from work for 10 or more consecutive working days shall be reexamined by the retained physician to determine whether or not he is yet physically qualified to resume work in compressed air. A new recommendation as to employability shall be prepared as provided for in section Ind 12.82 (5).

Note: Forms SB-247, SB-247-A and SB-248 are available from Industry, Labor and Human Relations, Post Office Box 2209, Madison, Wisconsin, 53701.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71; am. (8), Register, February, 1972, No. 194, eff. 3-1-72.

Ind 12.83 Reporting of illness of employes. (1) Each person employed in compressed air shall be instructed by the retained physician to recognize the symptoms of decompression illness and to report immediately to the first aid room for examination and treatment upon noticing any symptom of decompression illness.

(2) Each person employed in compressed air shall be instructed by the retained physician to report to him when suffering from a cold, sore throat, earache, or other ailment which may be aggravated or which may result in harm to the person when exposed to compressed air.

(3) After each such report to the retained physician, a new recommendation as to employability shall be prepared as provided for in section Ind 12.82 (5).

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.84 Treatment of decompression illness and air embolism. (1) Treatment of decompression illness and air embolism shall be rendered promptly as directed by the retained physician. Recompression in the medical lock or working chamber shall be performed only at the direction of the retained physician. Breathable gases such as oxygen or helium/oxygen mixtures shall be administered only at the direction of the retained physician. Treatment for decompression sickness shall be carried out on U.S. Navy Low Pressure Oxygen Treatment tables V and VI (appendix D) or their equivalent as a minimum directed by the retained physician. Treatment for air embolism shall be carried out on U.S. Navy Low Pressure Oxygen Treatment tables 5A and 6A or their equivalent as a minimum directed by the retained physician.

(2) Use of medical lock. No person shall be treated in a medical lock except at the direction of the retained physician.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71; am. (1), Register, February, 1972, No. 194, eff. 3-1-72.

Ind 12.85 Medical records. (1) **GENERAL.** The retained physician shall maintain a complete medical record of all physical examinations and reexaminations performed. The retained physician shall, in addition, maintain a complete medical record, on such forms and in such manner as the department of industry, labor and human relations

may prescribe, of the incidence of decompression illness, or other illness or injury which may incapacitate a person for work, and the loss of life which may occur during the construction of tunnels, shafts, or caissons under compressed air. The medical record shall include a description of the treatment provided. The medical records shall be available for inspection by authorized representatives of the department of industry, labor and human relations. A copy of the medical record shall be forwarded to the department of industry, labor and human relations within 48 hours following the occurrence of any decompression illness, accident, injury, or death to any person, stating as fully as possible the cause of such decompression illness, accident, injury or death, the place where the ill or injured person

has been taken, and such further information bearing on the occurrence as may be required by the department of industry, labor and human relations. Form SB-251 shall be filed regardless of time lost from work in all cases of decompression sickness or air embolism.

(2) PRESERVATION OF MEDICAL RECORDS. (a) All records pertinent to medical examinations, employment dates, and decompressions shall be delivered to and placed in the custody of the department of industry, labor and human relations at the completion of the work. The employer shall cause such records to be preserved and properly filed with the department of industry, labor and human relations.

(b) No person shall maliciously alter, mutilate, destroy or remove any such record.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

Ind 12.86 Forms. Forms required by this code may be obtained from the Department of Industry, Labor and Human Relations, Post Office Box 2209, Madison, Wisconsin 53701. They are:

SB-247 Annual Physical Examination and History.

SB-247-A Physical Examination.

SB-248 Preemployment History for Work in Compressed Air.

SB-249 Visitor Medical History and Physical Examination.

SB-250 Lock Register.

SB-251 Report of Caisson Disease.

WC-12 First Report of Injury.

History: Cr. Register, August, 1971, No. 188, eff. 9-1-71.

APPENDIX A

Decompression Tables

1. **Explanation.** The decompression tables are computed for working chamber pressures from 0 to 14 pounds, and from 14 to 50 pounds per square inch gauge inclusive by 2-pound increments and for exposure times for each pressure extending from ½ to over 8 hours inclusive. Decompressions will be conducted by 2 or more stages with a maximum of 4 stages, the latter for a working chamber pressure of 40 pounds per square inch gauge or over.

Stage 1 consists of a reduction in ambient pressure ranging from 10 to a maximum of 16 pounds per square inch, but in no instance will the pressure be reduced below 4 pounds at the end of stage 1. This reduction in pressure in stage 1 will always take place at a rate not greater than 5 pounds per minute.

Further reduction in pressure will take place during stage 2 and subsequent stages as required at a slower rate, but in no event at a rate greater than 1 pound per minute.

Decompression Table No. 1 indicates in the body of the table the total decompression time in minutes for various combinations of working chamber pressure and exposure time.

Decompression Table No. 2 indicates for the same various combinations of working chamber pressure and exposure time the following:

- a. The number of stages required;
- b. The reduction in pressure and the terminal pressure for each required stage;
- c. The time in minutes through which the reduction in pressure is accomplished for each required stage;

d. The pressure reduction rate in minutes per pound for each required stage;

IMPORTANT NOTE: THE PRESSURE REDUCTION IN EACH STAGE IS ACCOMPLISHED AT A UNIFORM RATE. DO NOT INTERPOLATE BETWEEN VALUES SHOWN ON THE TABLES. USE THE NEXT HIGHER VALUE OF WORKING CHAMBER PRESSURE OR EXPOSURE TIME SHOULD THE ACTUAL WORKING CHAMBER PRESSURE OR THE ACTUAL EXPOSURE TIME, RESPECTIVELY, FALL BETWEEN THOSE FOR WHICH CALCULATED VALUES ARE SHOWN IN THE BODY OF THE TABLES.

Examples:

Example No. 1

4 hours working period at 20 pounds gage

Decompression Table No. 1

20 pounds for 4 hours,

Total Decompression Time.....

43 minutes

DECOMPRESSION TABLE NO. 1
Total Decompression Time—Minutes

Work Pressure psig	Working Period—Hours									
	½	1	1½	2	3	4	5	6	7	8
0-12.....	3	3	3	3	3	3	3	3	3	3
14.....	6	6	6	6	6	6	6	6	16	16
16.....	7	7	7	7	7	7	17	33	48	48
18.....	7	7	7	8	11	17	48	63	69	73
20.....	7	7	8	15	15	43	63	73	88	103
22.....	9	9	16	24	38	68	93	109	113	128
24.....	11	12	23	27	52	92	117	122	127	137
26.....	13	14	29	34	69	104	126	141	142	142
28.....	15	23	31	41	98	127	143	159	159	155
30.....	17	28	38	62	105	143	165	168	173	188
32.....	19	35	43	85	126	163	178	198	208	213
34.....	21	39	58	98	151	178	195	218	223	233
36.....	24	44	63	113	170	198	223	233	243	253
38.....	28	49	73	123	178	203	223	238	253	263
40.....	31	49	84	143	183	213	233	248	258	268
42.....	37	56	102	144	189	215	245	260	263	268
44.....	43	64	118	154	199	234	254	264	269	269
46.....	44	74	139	171	214	244	269	274	289	299
48.....	51	89	144	189	229	260	299	309	319	319
50.....	58	94	164	209	249	279	309	329	-----	-----

Decompression Table No. 2

Stage 1

Reduce pressure from 20 pounds to 4 pounds at the uniform rate of 5 pounds per minute

16

Elapsed time stage 1: 5.....

3 minutes

Stage 2 (final stage)

Reduce pressure at a uniform rate from 4 pounds to

0 pound gage over a period of 40 minutes

Rate—0.10 pounds per minute or 10.00 minutes per pound

Stage 2 (final) elapsed time.....

40 minutes

Total Time.....

43 minutes

Example No. 2

5-hour working period at 24 pounds gage

Decompression Table 1

24 pounds for 5 hours

Total Decompression Time.....

117 minutes

Decompression Table No. 2

Stage 1

Reduce pressure from 24 pounds to 8 pounds

at the uniform rate of 5 pounds per minute

16

Elapsed time stage 1: 5.....

3 minutes

Stage 2

Reduce pressure at a uniform rate from 8 pounds to 4 pounds over a period of 4 minutes

Rate—1 pound per minute

Elapsed time, stage 2.....

4 minutes

Transfer men to Special Decompression Chamber maintaining the 4-pound pressure during the transfer operation

Stage 3 (final stage)

In the Special Decompression Chamber, reduce the pressure at a uniform rate from 4 pounds to 0 pound gage over a period of 110 minutes

Rate—0.037 pounds per minute or 27.5 minutes per pound

Stage 3 (final) elapsed time.....

110 minutes

Total Time.....

117 minutes

DECOMPRESSION TABLE NO. 2

Working chamber pressure psig	Working period Hours	Decompression data					
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	Total time decompress Minutes
			From	To			
14	½	1	14	4	2	0.20	6
		2	4	0	4	1.00	
	1	1	14	4	2	0.20	
		2	4	0	4	1.00	
	1½	1	14	4	2	0.20	
		2	4	0	4	1.00	
	2	1	14	4	2	0.20	
		2	4	0	4	1.00	
	3	1	14	4	2	0.20	
		2	4	0	4	1.00	
	4	1	14	0	2	0.20	
		2	4	0	4	1.00	
	5	1	14	4	2	0.20	
		2	4	0	4	1.00	
	6	1	14	4	2	0.20	
		2	4	0	4	1.00	
7	1	14	4	2	0.20		
	2	4	0	14	3.50		
8	1	14	4	2	0.20		
	2	4	0	14	3.50		
Over 8	1	14	4	2	0.20		
	2	4	0	30	7.50		
16	½	1	16	4	3	0.20	7
		2	4	0	4	1.00	
	1	1	16	4	3	0.20	
		2	4	0	4	1.00	
	1½	1	16	4	3	0.20	
		2	4	0	4	1.00	
	2	1	16	4	3	0.20	
		2	4	0	4	1.00	
	3	1	16	4	3	0.20	
		2	4	0	4	1.00	
	4	1	16	4	3	0.20	
		2	4	0	4	1.00	
	5	1	16	4	3	0.20	
		2	4	0	4	3.50	

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	Total time decompress Minutes
			From	To			
18	6	1	16	4	3	0.20	33
		2	4	0	30	7.50	
	7	1	16	4	3	0.20	48
		2	4	0	45	11.25	
	8	1	16	4	3	0.20	48
		2	4	0	45	11.25	
	Over 8	1	16	4	3	0.20	63
		2	4	0	60	15.00	
	½	1	18	4	3	0.20	7
		2	4	0	4	1.00	
	1	1	18	4	3	0.20	7
		2	4	0	4	1.00	
	1½	1	18	4	3	0.20	7
		2	4	0	4	1.00	
	2	1	18	4	3	0.20	8
		2	4	0	5	1.25	
	3	1	18	4	3	0.20	11
		2	4	0	3	2.00	
4	1	18	4	3	0.20	17	
	2	4	0	14	3.50		
5	1	18	4	3	0.20	48	
	2	4	0	45	11.25		
6	1	18	4	3	0.20	63	
	2	4	0	60	15.00		
7	1	18	4	3	0.20	63	
	2	4	0	60	15.00		
8	1	18	4	3	0.20	73	
	2	4	0	70	17.50		
Over 8	1	18	4	3	0.20	87	
	2	4	0	84	21.00		
½	1	20	4	3	0.20	7	
	2	4	0	4	1.00		
1	1	20	4	3	0.20	7	
	2	4	0	4	1.00		
1½	1	20	4	3	0.20	8	
	2	4	0	5	1.25		
2	1	20	4	3	0.20	15	
	2	4	0	12	3.00		
3	1	20	4	3	0.20	15	
	2	4	0	12	3.00		
4	1	20	4	3	0.20	43	
	2	4	0	40	10.00		
5	1	20	4	3	0.20	63	
	2	4	0	60	15.00		
6	1	20	4	3	0.20	73	
	2	4	0	70	17.50		

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes										
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound											
			From	To													
22	7	1	20	4	3	0.20	88										
		2	4	0	80	20.00											
	8	1	20	4	3	0.20		103									
		2	4	0	100	25.00											
	Over 8	1	20	4	3	0.20			113								
		2	4	0	110	27.50											
	1/2	1	22	6	3	0.20				9							
		2	6	0	6	1.00											
	1	1	22	6	3	0.20					9						
		2	6	0	6	1.00											
	1 1/2	1	22	6	3	0.20						16					
		2	6	0	13	2.20											
	2	1	22	6	3	0.20							24				
		2	6	0	21	3.50											
	3	1	22	6	3	0.20								38			
		2	6	0	35	5.85											
	4	1	22	6	3	0.20									68		
		2	6	0	65	10.83											
	5	1	22	6	3	0.20										93	
		2	6	0	90	15.00											
	6	1	22	6	3	0.20											108
		2	6	0	100	16.67											
7	1	22	6	3	0.20	113											
	2	6	0	110	18.35												
8	1	22	6	3	0.20		128										
	2	6	0	125	20.80												
Over 8	1	22	6	3	0.20			133									
	2	6	0	130	21.70												
1/2	1	24	8	3	0.20				11								
	2	8	4	4	1.00												
	3	4	0	4	1.00												
1	1	24	8	3	0.20					12							
	2	8	4	4	1.00												
	3	4	0	5	1.25												
1 1/2	1	24	8	3	0.20						23						
	2	8	4	4	1.00												
	3	4	0	16	4.00												
2	1	24	8	3	0.20							27					
	2	8	4	4	1.00												
	3	4	0	20	5.00												
3	1	24	8	3	0.20								52				
	2	8	4	4	1.00												
	3	4	0	45	11.25												
4	1	24	8	3	0.20									92			
	2	8	4	4	1.00												
	3	4	0	85	21.25												
5	1	24	8	3	0.20	117											
	2	8	4	4	1.00												
	3	4	0	110	27.50												

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	
			From	To			
26	6	1	24	8	3	0.20	122
		2	8	4	4	1.00	
		3	4	0	115	23.30	
	7	1	24	8	3	0.20	127
		2	8	4	4	1.00	
		3	4	0	120	30.00	
	8	1	24	8	3	0.20	137
		2	8	4	4	1.00	
		3	4	0	130	32.50	
	Over 8	1	24	8	3	0.20	151
		2	8	4	8	2.00	
		3	4	0	140	35.00	
	½	1	26	10	3	0.20	13
		2	10	4	6	1.00	
		3	4	0	4	1.00	
	1	1	26	10	3	0.20	14
		2	10	4	6	1.00	
		3	4	0	5	1.25	
	1½	1	26	10	3	0.20	29
		2	10	4	6	1.00	
		3	4	0	20	5.00	
	2	1	26	10	3	0.20	34
		2	10	4	6	1.00	
		3	4	0	25	6.25	
	3	1	26	10	3	0.20	69
		2	10	4	6	1.00	
3		4	0	60	15.00		
4	1	26	10	3	0.20	104	
	2	10	4	6	1.00		
	3	4	0	95	23.75		
5	1	26	10	3	0.20	126	
	2	10	4	8	1.33		
	3	4	0	115	23.80		
6	1	26	10	3	0.20	141	
	2	10	4	8	1.33		
	3	4	0	130	32.50		
7	1	26	10	3	0.20	142	
	2	10	4	9	1.50		
	3	4	0	130	32.50		
8	1	26	10	3	0.20	142	
	2	10	4	9	1.50		
	3	4	0	130	32.50		
Over 8	1	26	10	3	0.20	163	
	2	10	4	30	5.00		
	3	4	0	130	32.50		
½	1	28	12	3	0.20	15	
	2	12	4	8	1.00		
	3	4	0	4	1.00		
1	1	28	12	3	0.20	23	
	2	12	4	8	1.00		
	3	4	0	12	3.00		
1½	1	28	12	3	0.20		

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	
			From	To			
30		2	12	4	8	1.00	31
		3	4	0	20	5.00	
	2	1	28	12	8	0.20	41
		2	12	4	8	1.00	
		3	4	0	30	7.50	
	3	1	28	12	8	0.20	98
		2	12	4	10	1.25	
		3	4	0	85	21.20	
	4	1	28	12	8	0.20	127
		2	12	4	14	1.75	
		3	4	0	110	27.50	
	5	1	28	12	8	0.20	143
		2	12	4	20	2.50	
		3	4	0	120	30.00	
	6	1	28	12	8	0.20	153
		2	12	4	20	2.50	
		3	4	0	180	32.50	
	7	1	28	12	8	0.20	153
		2	12	4	20	2.50	
		3	4	0	180	32.50	
	8	1	28	12	8	0.20	165
		2	12	4	32	4.00	
		3	4	0	180	32.50	
	Over 8	1	28	12	8	0.20	183
		2	12	4	50	6.25	
		3	4	0	180	32.50	
	½	1	30	14	8	0.20	17
		2	14	4	10	1.00	
		3	4	0	4	1.00	
	1	1	30	14	8	0.20	28
		2	14	4	10	1.00	
		3	4	0	15	3.75	
	1½	1	30	14	8	0.20	38
		2	14	4	10	1.00	
		3	4	0	25	6.25	
	2	1	30	14	8	0.20	62
		2	14	4	14	1.40	
		3	4	0	45	11.25	
	3	1	30	14	8	0.20	105
		2	14	4	17	1.70	
		3	4	0	85	21.20	
	4	1	30	14	8	0.20	143
2		14	4	30	3.00		
3		4	0	110	27.50		
5	1	30	14	8	0.20	165	
	2	14	4	35	3.50		
	3	4	0	180	32.50		
6	1	30	14	8	0.20	168	
	2	14	4	35	3.50		
	3	4	0	180	32.50		
7	1	30	14	8	0.20	178	
	2	14	4	45	4.50		
	3	4	0	180	32.50		

Do not interpolate, use next higher value for conditions not computed.

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DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes		
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound			
			From	To					
32	8	1	30	14	3	0.20	188		
		2	14	4	55	5.50			
		3	4	0	130	32.50			
	Over 8	1	30	14	3	0.20		204	
		2	14	4	71	7.10			
		3	4	0	130	32.50			
	½	1	32	16	3	0.20			19
		2	16	4	12	1.00			
		3	4	0	4	1.00			
	1	1	32	16	3	0.20	35		
		2	16	4	12	1.00			
		3	4	0	20	5.00			
	1½	1	32	16	3	0.20		43	
		2	16	4	15	1.25			
		3	4	0	25	6.25			
	2	1	32	16	3	0.20			85
		2	16	4	22	1.83			
		3	4	0	60	15.00			
	3	1	32	16	3	0.20	126		
		2	16	4	28	2.33			
		3	4	0	95	23.75			
	4	1	32	16	3	0.20		163	
		2	16	4	40	3.33			
		3	4	0	120	30.00			
5	1	32	16	3	0.20	178			
	2	16	4	45	3.75				
	3	4	0	130	32.50				
6	1	32	16	3	0.20		193		
	2	16	4	60	5.00				
	3	4	0	130	32.50				
7	1	32	16	3	0.20			203	
	2	16	4	70	5.83				
	3	4	0	130	32.50				
8	1	32	16	3	0.20	213			
	2	16	4	80	6.67				
	3	4	0	130	32.50				
Over 8	1	32	16	3	0.20		226		
	2	16	4	93	7.75				
	3	4	0	130	32.50				
½	1	34	18	3	0.20			21	
	2	18	4	14	1.00				
	3	4	0	4	1.00				
1	1	34	18	3	0.20	39			
	2	18	4	14	1.00				
	3	4	0	22	5.50				
1½	1	34	18	3	0.20		58		
	2	18	4	25	1.80				
	3	4	0	30	7.50				
2	1	34	18	3	0.20			98	
	2	18	4	35	2.50				
	3	4	0	60	15.00				
3	1	34	18	3	0.20				

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	Total time decompress Minutes
			From	To			
36		2	18	4	43	3.10	151
		3	4	0	105	26.25	
	4	1	34	18	3	0.20	178
		2	18	4	55	3.93	
		3	4	0	120	30.00	
	5	1	34	18	3	0.20	195
		2	18	4	62	4.43	
		3	4	0	130	32.50	
	6	1	34	18	3	0.20	218
		2	18	4	85	6.07	
		3	4	0	130	32.50	
	7	1	34	18	3	0.20	223
		2	18	4	90	6.43	
		3	4	0	130	32.50	
	8	1	34	18	3	0.20	233
		2	18	4	100	7.15	
		3	4	0	130	32.50	
	Over 8	1	34	18	3	0.20	248
		2	18	4	115	8.23	
		3	4	0	130	32.50	
	½	1	36	20	3	0.20	24
		2	20	4	16	1.00	
		3	4	0	5	1.25	
	1	1	36	20	3	0.20	44
		2	20	4	16	1.00	
		3	4	0	25	6.25	
	1½	1	36	20	3	0.20	63
		2	20	4	30	1.88	
		3	4	0	30	7.50	
	2	1	36	20	3	0.20	113
		2	20	4	40	2.50	
		3	4	0	70	17.50	
	3	1	36	20	3	0.20	170
		2	20	4	52	3.25	
		3	4	0	115	28.75	
	4	1	36	20	3	0.20	198
		2	20	4	65	4.06	
		3	4	0	130	32.50	
	5	1	36	20	3	0.20	223
		2	20	4	90	5.63	
		3	4	0	130	32.50	
	6	1	36	20	3	0.20	233
		2	20	4	100	6.25	
		3	4	0	130	32.50	
	7	1	36	20	3	0.20	243
		2	20	4	110	6.88	
		3	4	0	130	32.50	
	8	1	36	20	3	0.20	253
2		20	4	120	7.50		
3		4	0	130	32.50		
Over 8	1	36	20	3	0.20	273	
	2	20	4	140	8.75		
	3	4	0	130	32.50		

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data							
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	Total time decompress Minutes		
			From	To					
38	½	1	38	22	3	0.20	28		
		2	22	6	16	1.00			
		3	6	0	9	1.50			
	1	1	38	22	3	0.20			
		2	22	6	16	1.00			
		3	6	0	30	5.00			
	1½	1	38	22	3	0.20			
		2	22	6	20	1.25			
		3	6	0	50	8.34			
	2	1	38	22	3	0.20			
		2	22	6	30	1.88			
		3	6	0	95	15.88			
	3	1	38	22	3	0.20			
		2	22	6	35	2.19			
		3	6	0	140	23.35			
	4	1	38	22	3	0.20			
		2	22	6	50	3.12			
		3	6	0	150	25.00			
	5	1	38	22	3	0.20			
		2	22	6	55	3.44			
		3	6	0	165	27.50			
	6	1	38	22	3	0.20			
		2	22	6	70	4.38			
		3	6	0	165	27.50			
	7	1	38	22	3	0.20			
		2	22	6	85	5.32			
		3	6	0	165	27.50			
	8	1	38	22	3	0.20			
		2	22	6	95	5.93			
		3	6	0	165	27.50			
	Over 8	1	38	22	3	0.20			
		2	22	6	110	6.88			
		3	6	0	165	27.50			
	40	½	1	40	24	3		0.20	31
			2	24	8	16		1.00	
			3	8	4	4		1.00	
			4	4	0	8		2.00	
		1	1	40	24	3		0.20	
			2	24	8	16		1.00	
			3	8	4	5		1.25	
			4	4	0	25		6.25	
		1½	1	40	24	3		0.20	
			2	24	8	16		1.00	
			3	8	4	20		5.00	
			4	4	0	45		11.25	
		2	1	40	24	3		0.20	
			2	24	8	25		1.56	
			3	8	4	20		5.00	
4			4	0	95	23.75			
3		1	40	24	3	0.20			
		2	24	8	30	1.88			
		3	8	4	30	7.50			
		4	4	0	120	30.00			
4		1	40	24	3	0.20	183		

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	
			From	To			
42	5	2	24	8	45	2.81	213
		3	8	4	35	8.75	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	6	2	24	8	47	2.94	233
		3	8	4	53	13.25	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	7	2	24	8	55	3.44	248
		3	8	4	60	15.00	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	8	2	24	8	65	4.06	258
		3	8	4	60	15.00	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	Over 8	2	24	8	75	4.70	268
		3	8	4	60	15.00	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	1/2	2	24	8	95	5.93	288
		3	8	4	60	15.00	
		4	4	0	130	32.50	
		1	40	24	3	0.20	
	1	2	26	10	16	1.00	37
		3	10	4	6	1.00	
		4	4	0	12	3.00	
		1	42	26	3	0.20	
	1 1/2	2	26	10	16	1.00	56
		3	10	4	23	3.33	
		4	4	0	60	15.00	
		1	42	26	3	0.20	
	2	2	26	10	16	1.00	102
		3	10	4	30	5.00	
		4	4	0	95	23.75	
		1	42	26	3	0.20	
	3	2	26	10	16	1.00	144
		3	10	4	50	8.34	
		4	4	0	120	30.00	
		1	42	26	3	0.20	
	4	2	26	10	17	1.06	189
		3	10	4	65	10.33	
4		4	0	130	32.50		
1		42	26	3	0.20		
5	2	26	10	27	1.69	215	
	3	10	4	85	14.18		
	4	4	0	130	32.50		
	1	42	26	3	0.20		
6	2	26	10	27	1.69	245	
	3	10	4	100	16.67		
	4	4	0	130	32.50		
	1	42	26	3	0.20		
7	2	26	10	27	1.69	260	
	3	10	4	100	16.67		
	4	4	0	130	32.50		
	1	42	26	3	0.20		

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes		
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound			
			From	To					
44	8	2	26	10	30	1.88	263		
		3	10	4	100	16.67			
		4	4	0	130	32.50			
		1	42	26	3	0.20			
		2	26	10	35	2.19			
		3	10	4	100	16.67			
		4	4	0	130	32.50			
		Over 8	1	42	26	3		0.20	268
			2	26	10	60		3.75	
			3	10	4	100		16.67	
			4	4	0	130		32.50	
		½	1	1	44	28		3	0.20
	2			28	12	16	1.00		
	3			12	4	8	1.00		
	4			4	0	16	4.00		
	2		1	44	28	3	0.20	64	
			2	28	12	16	1.00		
			3	12	4	20	2.50		
			4	4	0	25	6.25		
	1½		1	44	28	3	0.20	118	
			2	28	12	16	1.00		
			3	12	4	27	3.88		
			4	4	0	72	18.00		
	2	1	44	28	3	0.20	154		
		2	28	12	16	1.00			
		3	12	4	40	5.00			
		4	4	0	95	23.75			
	3	1	44	28	3	0.20	199		
		2	28	12	16	1.00			
		3	12	4	60	7.50			
		4	4	0	120	30.00			
	4	1	44	28	3	0.20	234		
		2	28	12	16	1.00			
		3	12	4	85	10.62			
		4	4	0	130	32.50			
	5	1	44	28	3	0.20	254		
		2	28	12	16	1.00			
		3	12	4	105	13.13			
		4	4	0	130	32.50			
	6	1	44	28	3	0.20	264		
		2	28	12	16	1.00			
		3	12	4	115	14.88			
		4	4	0	130	32.50			
	7	1	44	28	3	0.20	269		
		2	28	12	16	1.00			
		3	12	4	120	15.00			
		4	4	0	130	32.50			
	8	1	44	28	3	0.20	269		
2		28	12	16	1.00				
3		12	4	120	15.00				
4		4	0	130	32.50				
Over 8	1	44	28	3	0.20	293			
	2	28	12	40	2.50				
	3	12	4	120	15.00				
	4	4	0	130	32.50				
46	½	1	46	30	3	0.20			

Do not interpolate, use next higher value for conditions not computed.

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data							
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	Total time decompress Minutes		
			From	To					
48	1	2	30	14	16	1.00	44		
		3	14	4	10	1.00			
		4	4	0	15	3.75			
		1	46	30	3	0.20			
		2	30	14	16	1.00			
		3	14	4	25	2.50			
		4	4	0	30	7.50			
		1½	1	46	30	3		0.20	139
			2	30	14	16		1.00	
			3	14	4	35		9.50	
			4	4	0	85		21.20	
		2	1	46	30	3		0.20	171
	2		30	14	16	1.00			
	3		14	4	47	4.70			
	4		4	0	105	26.25			
	3	1	46	30	3	0.20	214		
		2	30	14	16	1.00			
		3	14	4	65	6.50			
		4	4	0	180	32.50			
	4	1	46	30	3	0.20	244		
		2	30	14	16	1.00			
		3	14	4	95	9.50			
		4	4	0	180	32.50			
	5	1	46	30	3	0.20	269		
		2	30	14	16	1.00			
		3	14	4	120	12.00			
		4	4	0	180	32.50			
	6	1	46	30	3	0.20	274		
		2	30	14	16	1.00			
		3	14	4	125	12.50			
		4	4	0	180	32.50			
	7	1	46	30	3	0.20	289		
		2	30	14	16	1.00			
		3	14	4	140	14.00			
		4	4	0	180	32.50			
	8	1	46	30	3	0.20	299		
		2	30	14	16	1.00			
		3	14	4	150	15.00			
		4	4	0	180	32.50			
	Over 8	1	46	30	3	0.20	318		
		2	30	14	25	1.56			
		3	14	4	160	16.00			
		4	4	0	180	32.50			
	½	1	1	48	32	3	0.20	51	
			2	32	16	16	1.00		
			3	16	4	12	1.00		
			4	4	0	20	5.00		
		1	1	48	32	3	0.20	89	
2			32	16	16	1.00			
3			16	4	35	2.92			
4			4	0	35	8.75			
1½		1	48	32	3	0.20	144		
		2	32	16	16	1.00			
		3	16	4	45	3.75			
		4	4	0	80	20.00			
2	1	48	32	3	0.20				
	2	32	16	16	1.00				

Do not interpolate, use next higher value for conditions not computed.

WISCONSIN ADMINISTRATIVE CODE

DECOMPRESSION TABLE NO. 2—(Continued)

Working chamber pressure psig	Working period Hours	Decompression data					Total time decompress Minutes
		Stage No.	Pressure reduction psig		Time in stage Minutes	Pressure reduction rate Min/Pound	
			From	To			
50		3	16	4	60	5.00	189
		4	4	0	110	27.50	
	3	1	48	32	3	0.20	229
		2	32	16	16	1.00	
		3	16	4	90	7.50	
		4	4	0	120	30.00	
	4	1	48	32	3	0.20	269
		2	32	16	16	1.00	
		3	16	4	120	10.00	
		4	4	0	180	32.50	
	5	1	48	32	3	0.20	299
		2	32	16	16	1.00	
		3	16	4	140	11.67	
		4	4	0	180	32.50	
	6	1	48	32	3	0.20	309
		2	32	16	16	1.00	
		3	16	4	160	13.33	
		4	4	0	180	32.50	
	7	1	48	32	3	0.20	319
		2	32	16	16	1.00	
		3	16	4	170	14.17	
		4	4	0	180	32.50	
	8	1	48	32	3	0.20	319
		2	32	16	16	1.00	
		3	16	4	170	14.17	
		4	4	0	180	32.50	
	½	1	50	34	3	0.20	58
		2	34	18	16	1.00	
		3	18	4	14	1.00	
		4	4	0	25	6.25	
	1	1	50	34	3	0.20	94
		2	34	18	16	1.00	
		3	18	4	40	2.86	
		4	4	0	35	8.75	
	1½	1	50	34	3	0.20	164
		2	34	18	16	1.00	
		3	18	4	55	3.93	
		4	4	0	90	22.50	
	2	1	50	34	3	0.20	209
		2	34	18	16	1.00	
		3	18	4	70	5.00	
		4	4	0	120	30.00	
	3	1	50	34	3	0.20	249
		2	34	18	16	1.00	
		3	18	4	100	7.15	
		4	4	0	180	32.50	
	4	1	50	34	3	0.20	279
		2	34	18	16	1.00	
		3	18	4	130	8.58	
		4	4	0	180	32.50	
5	1	50	34	3	0.20	309	
	2	34	18	16	1.00		
	3	18	4	160	11.42		
	4	4	0	180	32.50		
6	1	50	34	3	0.20	329	
	2	34	18	16	1.00		
	3	18	4	180	12.85		
	4	4	0	180	32.50		

Do not interpolate, use next higher value for conditions not computed.
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APPENDIX B

The information contained in the following pages is adapted from the U. S. Navy Diving Tables and is to be used when an employe will enter a compressed air environment more than once within a 12-hour period.

The Department of Industry, Labor and Human Relations may accept alternate methods of decompression for repetitive exposures provided the licensed physician submits his proposed procedures to the Department of Industry, Labor and Human Relations for its review and approval.

The Department of the Navy is in no way liable for the use or misuse of Tables 3, 4, and 5.

TABLE 3

Pressure (psig)	Repetitive Groups															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Z
4	60	120	210	300												
7	35	70	110	160	225	350										
9	25	50	75	100	135	180	240	325								
11	20	35	55	75	100	125	160	195	245	315						
13	15	30	45	60	75	95	120	145	170	205	250	310				
16	5	15	25	40	50	60	80	100	120	140	160	190	220	270	310	
18	5	15	25	30	40	50	70	80	100	110	130	150	170	230	270	300
22	--	10	15	25	30	40	50	60	70	80	90	110	140	160	200	240
27	--	10	15	20	25	30	40	50	55	60	70	80	100	120	140	200
31	--	5	10	15	20	30	35	40	45	50	60	70	80	100	130	170
36	--	5	10	15	20	25	30	35	40	--	50	60	70	90	110	150
40	--	5	10	12	15	20	25	30	--	40	--	50	60	80	90	130
45	--	5	7	10	15	20	22	25	30	--	40	50	--	60	80	120
49	--	--	5	10	13	15	20	25	--	30	--	40	50	60	70	100

INSTRUCTIONS FOR USE

The tabulated compressed air exposure times are in minutes. The times at the various pressures in each vertical column are the maximum exposures during which a compressed air worker will remain within the group listed at the head of the column.

To find the repetitive group designation enter the table on the exact or next greater working pressure than that to which exposed and select the listed exposure time exact or next greater than the actual exposure time. The repetitive group designation is indicated by the letter at the head of the vertical column where the selected exposure time is listed.

For example: An exposure in compressed air was for 45 minutes at 26 psig. To determine the repetitive group enter the table at 27 psig (the next higher pressure, as 26 psig is not listed) and move horizontally until 50 minutes (the next greater tabulated exposure time, as 45 minutes is not listed), then move vertically to the top of the column where "H" is shown as the repetitive group.

Open Air Interval Credit Table

REPETITIVE GROUP AT END OF OPEN AIR INTERVAL																
	Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
Z	0:10 0:22	0:23 0:34	0:35 0:48	0:49 1:02	1:03 1:18	1:19 1:36	1:37 1:55	1:56 2:17	2:18 2:42	2:43 3:10	3:11 3:45	3:46 4:29	4:30 5:27	5:28 6:56	6:57 10:05	10:00 12:00*
	O	0:10 0:23	0:24 0:36	0:37 0:51	0:52 1:07	1:08 1:24	1:25 1:43	1:44 2:04	2:05 2:29	2:30 2:59	3:00 3:33	3:34 4:17	4:18 5:16	5:17 6:44	6:45 9:54	9:55 12:00*
N		0:10 0:24	0:25 0:39	0:40 0:54	0:55 1:11	1:12 1:30	1:31 1:53	1:54 2:18	2:19 2:47	2:48 3:22	3:23 4:04	4:05 5:03	5:04 6:32	6:33 9:43	9:44 12:00*	
	M	0:10 0:25	0:26 0:42	0:43 0:59	1:00 1:18	1:19 1:39	1:40 2:05	2:06 2:34	2:35 3:08	3:09 3:52	3:53 4:49	4:50 6:18	6:19 9:28	9:29 12:00*		
L		0:10 0:26	0:27 0:45	0:46 1:04	1:05 1:25	1:26 1:49	1:50 2:19	2:20 2:53	2:54 3:36	3:37 4:35	4:36 6:02	6:03 9:12	9:13 12:00*			
	K	0:10 0:28	0:29 0:49	0:50 1:11	1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21	3:22 4:19	4:20 5:48	5:49 8:58	8:59 12:00*				
J		0:10 0:31	0:32 0:54	0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04	3:05 4:02	4:03 5:40	5:41 8:40	8:41 12:00*					
	I	0:10 0:33	0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44	2:45 3:43	3:44 5:12	5:13 8:21	8:22 12:00*						
H		0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23	2:24 3:20	3:21 4:49	4:50 7:59	8:00 12:00*							
	G	0:10 0:40	0:41 1:15	1:16 1:59	2:00 2:58	2:59 4:25	4:26 7:35	7:36 12:00*								
F		0:10 0:45	0:46 1:29	1:30 2:28	2:29 3:57	3:58 7:05	7:06 12:00*									
	E	0:10 0:54	0:55 1:57	1:58 3:22	3:23 6:32	6:33 12:00*										
D		0:10 1:09	1:10 2:38	2:39 5:48	5:49 12:00*											
	C	0:10 1:39	1:40 2:49	2:50 12:00*												
B		0:10 2:10	2:11 12:00*													
	A	0:10 12:00*														

REPETITIVE GROUP AT BEGINNING OF OPEN AIR INTERVAL (FROM TABLE 3)

INSTRUCTIONS FOR USE

Open air interval time in the table is in hours and minutes (7:59 means 7 hours and 59 minutes). The open air interval must be at least 10 minutes. An open air interval of more than 12 hours does not require additional decompression or the use of this table.

Find the repetitive group designation letter (from the previous shift) on the diagonal slope. Enter the table horizontally to select the open air interval time that is exactly between the actual open air times shown. The repetitive group designation for the end of the open air interval is at the head of the vertical column where the selected open air interval time is listed.

For example: A previous shift was at 35 psi for 1 hour. The worker remains in open air for 1 hour and 30 minutes and wishes to find the new repetitive group designation. The repetitive group from the Repetitive Group Designation Table is "L." Enter the open air interval credit table along the diagonal line labeled "L." The 1 hour and 30 minute open air interval lies between the times 1:26 and 1:49. Therefore, the worker is placed in group "H" (at the head of the vertical column selected).

TABLE 4

*NOTE: Compressed air exposures following open air intervals of more than 12 hours are not considered multiple exposures. ACTUAL compressed air exposure time will be used for the determination of decompression time for open air intervals greater than 12 hours.

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TABLE 5

Repet. Group	Repetitive Exposure Pressure (psig)							
	18	22	27	31	36	40	45	49
A	7	6	5	4	4	3	3	3
B	17	13	11	9	8	7	7	6
C	25	21	17	15	13	11	10	10
D	37	29	24	20	18	16	14	13
E	49	38	30	26	23	20	18	16
F	61	47	36	31	28	24	22	20
G	73	56	44	37	32	29	26	24
H	87	66	52	43	38	33	30	27
I	101	76	61	50	43	38	34	31
J	116	87	70	57	48	43	38	34
K	138	99	79	64	54	47	43	38
L	161	111	88	72	61	53	48	42
M	187	124	97	80	68	58	52	47
N	213	142	107	87	73	64	57	51
O	241	160	117	96	80	70	62	55
Z	257	169	122	100	84	73	64	57

INSTRUCTIONS FOR USE

The compressed air exposure times listed in this table are called "residual nitrogen times" and are the times a compressed air worker is to consider he has already spent in compressed air when he starts a repetitive exposure to a specific pressure. They are in minutes.

Enter the table horizontally with the repetitive group designation from the Open Air Interval Credit Table (Table 4). The time in each vertical column is the number of minutes that would be required (at the pressure listed at the head of the columns) to saturate to the particular group.

For example: The final group designation from the Open Air Interval Credit Table (Table 4) on the basis of a previous exposure and open air interval is "H." It is planned to reenter compressed air at a pressure of 42 psig. What time must be added to the actual time spent in compressed air? Enter Table 5 on row H. Since 42 psig is greater than 40 psig but less than 45 psig, use the longer time of 33 minutes. This means that the compressed air worker enters the compressed air environment as though he had already been at 42 psig for 33 minutes.

The exposure time listed in Table 5 is added to the actual time spent in compressed air. Decompression is carried out based on the sum of the actual exposure time and the time from Table 5 for the pressure encountered.

APPENDIX C

Suggestions for the Guidance of Compressed Air Workers.

1. Eat moderately before going on shift.
2. Be temperate. Avoid excessive alcoholic beverages the night before or within 8 hours of going on shift.
3. Sleep at least 7 hours daily.
4. Take extra outer clothing into the tunnel when going on shift and wear it during decompression to avoid chilling during that period.
5. Do not sit or rest in a cramped position during decompression.
6. Do not exercise during decompression. This does not mean you cannot move around to avoid sitting in one position. Decompress according to schedule, for this means safety and freedom from compressed air illness or air pains. It also safeguards against damage to the bones.
7. Do not do hard exercise immediately after decompression.
8. Do not take a *hot* bath or shower within 6 hours of decompressing. Moderately warm bath or shower is permissible.
9. Do not go to sleep in a cramped position after decompressing.
10. Do not allow yourself to become chilled within 6 hours after decompression.
11. Report at once to the physician in charge if you suspect you are suffering from air pains or decompression sickness. Do not give men suffering from compressed air illness any intoxicating liquors.
12. IF AFTER DECOMPRESSING YOU DEVELOP "NIGGLES" OR AIR PAINS THAT PERSIST LONGER THAN A HALF-HOUR, CALL THE MEDICAL LOCK AT ONCE
13. If you become ill away from the job site, communicate at once with the physician in charge.
Dr. ----- Telephone -----
14. Wear your identification bracelet so it will be known what to do with you in an emergency.
15. Stay within a 30 mile radius of the recompression facility for at least one hour after locking out.
16. Do not reenter the man lock if suffering from air pains or decompression sickness.
17. Do not engage in scuba diving at depths greater than 33 feet within 12 hours of coming off shift. Do not engage in any scuba diving within 12 hours of going on shift.
18. Do not fly in any aircraft for at least 12 hours after coming off shift.
19. See that you are reexamined as required by the Department of Industry, Labor and Human Relations.

*Appendix D created
Reg Feb 1972*

APPENDIX D

U.S. NAVY LOW PRESSURE OXYGEN TREATMENT TABLES

TABLE V

Method used when relief of symptoms is complete within 10 minutes at 27 pounds			
Depth (pounds)	Min.	Gas	Total Min.
27	20	O ₂	20
27	5	Air	25
27	20	O ₂	45
27-13.5	30	O ₂	75
13.5	5	Air	80
13.5	20	O ₂	100
13.5	5	Air	105
13.5-0	30	O ₂	135

For simple or "pain only" bends. If numbness, tingling or paralysis are present, use Table VI.

If other neurological symptoms are present or relief of "pain only" symptoms is not *complete* in 10 minutes at 27 pounds, use Table VI.

TABLE VI

Method used when relief of symptoms is not complete within 10 minutes at 27 pounds			
Depth (pounds)	Min.	Gas	Total Min.
27	20	O ₂	20
27	5	Air	25
27	20	O ₂	45
27	5	Air	50
27	20	O ₂	70
27	5	Air	75
27-13.5	30	O ₂	105
13.5	15	Air	120
13.5	60	O ₂	180
13.5	15	Air	195
13.5	60	O ₂	255
13.5-0	30	O ₂	285

For serious symptoms of bends such as numbness, tingling, paralysis or chokes. Use this table for all recurrences after treatment and for cases in which symptoms first appeared while the patient was decompressing (i.e., still under pressure).

EXPLANATION

Commence O₂ breathing prior to pressurization to 27 pounds—time schedules should be followed with care.

Compression: Rapid pressurization is desirable but do not exceed rate tolerated by patient. Pressurization time, usually 1-2 minutes, is not counted as time at 27 pounds. Do not halt the pressurization to verify a report of symptom relief.

Decompression: Depressurizations are continuous at uniform .445 pounds per minute. Do not compensate for slowing of the rate by subsequent acceleration. Do not compensate if the rate is exceeded. If necessary, halt depressurization and hold pressure while ventilating the chamber.

Inside Tender: Tender routinely breathes chamber air. If treatment schedule is lengthened (see below) or if the treatment constitutes a repetitive exposure to compressed air for the tender, he must breathe O₂ for the final 30 minutes, from (27 pounds—Table V) (13.5 pounds—Table VI) to atmospheric pressure.

Relief of Symptoms: If completeness of relief is at all doubtful after 10 minutes O₂ breathing at 27 pounds, use the 285 minute sched-

ule. If symptoms recur, fresh symptoms appear, or the patient's condition worsens, return to 27 pounds and use the 285 minute method.

A physician qualified in compressed air medicine can extend the 285 minute schedule with a fourth O₂-air sequence (20 minutes O₂-5 minutes air) at 27 pounds, or a third air-O₂ sequence (15 minutes air-60 minutes O₂) at 13.5 pounds or both.

Tables 5A and 6A for the treatment of air embolism.

TABLE 5A
PATIENT SYMPTOM FREE
WITHIN 15 MINUTES

Pressure (psig)	Time (min.)	Breathing Media	Total Time (min.)
73.5	15*	Air	15
73.5-27	4	Air	19
27	20	O ₂	89
27	5	Air	44
27	20	O ₂	64
27-13.5	30	O ₂	94
13.5	5	Air	99
13.5	20	O ₂	119
13.5	5	Air	124
13.5-0	30	O ₂	154

*Total time will vary as function of this stop. Medical attendant should take time to accomplish a thorough physical examination, since the ensuing treatment is based on patient's physical status.

TABLE 6A
PATIENT SYMPTOM FREE
WITHIN 30 MINUTES AND/OR
RAPIDLY IMPROVING

Pressure (psig)	Time (min.)	Breathing Media	Total Time (min.)
73.5	30	Air	30
73.5-27	4	Air	34
27	20	O ₂	54
27	5	Air	59
27	20	O ₂	79
27	5	Air	84
27	20	O ₂	104
27	5	Air	109
27-13.5	30	O ₂	139
13.5	15	Air	154
13.5	60	O ₂	214
13.5	15	Air	229
13.5	60	O ₂	289
13.5-0	30	O ₂	319