WAC 296-155-745 Compressed air. (1) **General provisions.**

(a) There must be present, at all times, at least one competent person designated by and representing the employer, who must be familiar with this part in all respects and responsible for full compliance with these and other applicable parts.

(b) You must instruct every employee in the rules and regulations which concern their safety or the safety of others.

(2) **Medical attendance, examination, and regulations.**

(a) You must retain one or more licensed physicians familiar with and experienced in the physical requirements and the medical aspects of compressed air work and the treatment of decompression illness. They must be available at all times while work is in progress in order to provide medical supervision of employees employed in compressed air work. They must be physically qualified and be willing to enter a pressurized environment.

(b) You must not permit any employee to enter a compressed air environment until they have been examined by the physician and reported to be physically qualified to engage in such work.

(c) In the event an employee is absent from work for 10 days, or is absent due to sickness or injury, they must not resume work until they are reexamined by the physician, and their physical condition reported, as provided in this subsection, to be such as to permit them to work in compressed air.

(d) After an employee has been employed continuously in compressed air for a period designated by the physician, but not to exceed one year, the employee must be reexamined by the physician to determine if they are still physically qualified to engage in compressed air work.

(e) Such physician must at all times keep a complete and full record of examinations made by themselves. The physician must also keep an accurate record of any decompression illness or other illness or injury incapacitating any employee for work, and of all loss of life that occurs in the operation of a tunnel, caisson, or other compartment in which compressed air is used.

(f) Records must be available for the inspection by the director or their representatives, and a copy thereof must be forwarded to the department within 48 hours following the occurrence of the accident, death, injury, or decompression illness. It must state as fully as possible the cause of said death or decompression illness, and the place where the injured or sick employee was taken, and such other relative information as may be required by the director.

(g) You must provide a fully equipped first-aid station at each tunnel project regardless of the number of persons employed. An ambulance or transportation suitable for a litter case must be at each project.

(h) Where tunnels are being excavated from portals more than 5 road miles apart, you must provide a first-aid station and transportation facilities at each portal.

(i) You must establish and maintain a medical lock in immediate working order whenever air pressure in the working chamber is increased above the normal atmosphere.

(j) The medical lock must:

(i) Have at least 6 feet of clear headroom at the center, and be subdivided into not less than two compartments;

(ii) Be readily accessible to employees working under compressed air;

(iii) Be kept ready for immediate use for at least 5 hours subsequent to the emergence of any employee from the working chamber;

(iv) Be properly heated, lighted and ventilated;

(v) Be maintained in a sanitary condition;

(vi) Have a nonshatterable port through which the occupant(s) may be kept under constant observation;

(vii) Be designed for a working pressure of 75 p.s.i.g.;

(viii) Be equipped with internal controls which may be overridden by external controls;

(ix) Be provided with air pressure gauges to show the air pressure within each compartment to observers inside and outside the medical lock;

(x) Be equipped with a manual type sprinkler system that can be activated inside the lock or by the outside lock tender;

(xi) Be provided with oxygen lines and fittings leading into external tanks. The lines must be fitted with check valves to prevent reverse flow. The oxygen system inside the chamber must be of a closed circuit design and be so designed as to automatically shut off the oxygen supply whenever the fire system is activated.

(xii) Be in constant charge of an attendant under the direct control of the retained physician. You must train the attendant in the use of the lock and suitably instructed regarding steps to be taken in the treatment of employee exhibiting symptoms compatible with a diagnosis of decompression illness;

(xiii) Be adjacent to an adequate emergency medical facility;

(xiv) The medical facility must be equipped with demand-type oxygen inhalation equipment approved by the U.S. Bureau of Mines or Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH);

(xv) Be capable of being maintained at a temperature, in use, not to exceed 90°F. nor be less than 70°F.; and

(xvi) Be provided with sources of air, free of oil and carbon monoxide, for normal and emergency use, which are capable of raising the air pressure in the lock from 0 to 75 p.s.i.g. in 5 minutes.

(k) You must furnish identification badges to all employees, indicating that the wearer is a compressed air worker. You must keep a permanent record of all identification badges issued. The badge must give the employee's name, address of the medical lock, the telephone number of the licensed physician for the compressed air project, and contain instructions that in case of emergency of unknown or doubtful cause or illness, the wearer must be rushed to the medical lock. The badge must be worn at all times—off the job, as well as on the job.

(3) **Telephone and signal communication.** You must maintain effective and reliable means of communication, such as bells, whistles, or telephones, at all times between all the following locations;

(a) The working chamber face;

(b) The working chamber side of the man lock near the door;

(c) The interior of the man lock;

(d) Lock attendant's station;

(e) The compressor plant;

(f) The first-aid station;

(g) The emergency lock (if one is required); and

(h) The special decompression chamber (if one is required).

(4) Signs and records.

(a) You must post the time of decompression in each man lock as follows:

TIME OF DECOMPRESSION FOR THIS LOCK

..... pounds to ..... pounds in ..... minutes.

..... pounds to ..... pounds in ..... minutes.

(Signed by) .....

(Superintendent)

You must post this form in the man lock at all times.

(b) You must conspicuously post any code of signals used near workplace entrances and such other locations as may be necessary to bring them to the attention of all employees concerned.

(c) For each 8-hour shift, you must keep a record of employees employed under air pressure by an employee who must remain outside the lock near the entrance. This record must show the period each employee spends in the air chamber and the time taken from decompression. You must submit a copy to the appointed physician after each shift.

(5) **Compression.**

(a) You must instruct every employee going under air pressure for the first time on how to avoid excessive discomfort.

(b) During the compression of employees, you must not increase the pressure to more than 3 p.s.i.g. within the first minute. You must hold the pressure at 3 p.s.i.g. and again at 7 p.s.i.g. sufficiently long to determine if any employees are experiencing discomfort.

(c) After the first minute you must raise the pressure uniformly and at a rate not to exceed 10 p.s.i. per minute.

(d) If any employee complains of discomfort, you must hold the pressure to determine if the symptoms are relieved. If, after 5 minutes the discomfort does not disappear, the lock attendant must gradually reduce the pressure until the employee signals that the discomfort has ceased. If the employee does not indicate that the discomfort has disappeared, the lock attendant must reduce the pressure to atmospheric and the employee must be released from the lock.

(e) You must not subject any employee to pressure exceeding 50 pounds per square inch except in an emergency.

(6) **Decompression.**

(a) Decompression to normal condition must be in accordance with the decompression tables in Appendix A of this part.

(b) In the event it is necessary for an employee to be in compressed air more than once in a 24-hour period, the appointed physician must be responsible for the establishment of methods and procedures of decompression applicable to repetitive exposures.

(c) If decanting is necessary, the appointed physician must establish procedures before any employee is permitted to be decompressed by decanting methods. The period of time that the employees spend at atmospheric pressure between the decompression following the shift and recompression must not exceed 5 minutes.

(7) **Man locks and special decompression chambers.**

(a) Man locks.

(i) Except in emergency, you must not permit any employees employed in compressed air to pass from the working chamber to atmospheric pressure until after decompression, in accordance with the procedures in this part.

(ii) The lock attendant in charge of a man lock must be under the direct supervision of the appointed physician. The lock attendant must be stationed at the lock controls on the free air side during the period of compression and decompression and must remain at the lock con-

trol station whenever there are persons in the working chamber or in the man lock.

(iii) Except where air pressure in the working chamber is below 12 p.s.i.g., each man lock must be equipped with automatic controls which, through taped programs, cams, or similar apparatus, must automatically regulate decompressions. It must also be equipped with manual controls to permit the lock attendant to override the automatic mechanism in the event of an emergency, as provided in item (viii) of this subdivision.

(iv) A manual control, which can be used in the event of an emergency, must be placed inside the man lock.

(v) A clock, thermometer, and continuous recording pressure gauge with a 4-hour graph must be installed outside of each man lock and must be changed prior to each shift's decompression. The chart must be of sufficient size to register a legible record of variations in pressure within the man lock and must be visible to the lock attendant. You must submit a copy of each graph to the appointed physician after each shift. In addition, a pressure gauge, clock, and thermometer must also be installed in each man lock. Additional fittings must be provided so that the test gauges may be attached whenever necessary

(vi) Except where air pressure is below 12 p.s.i.g. 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, must have at least two locks in perfect working condition, one of which must be used exclusively as a man lock, the other, as a materials lock.

(vii) Where only a combination man-and-materials lock is required, this single lock must be of sufficient capacity to hold the employees constituting two successive shifts.

(viii) Emergency locks must be large enough to hold an entire heading shift and a limit maintained of 12 p.s.i.g. There must be a chamber available for oxygen decompression therapy to 28 p.s.i.g.

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

(x) Locks on caissons must be so located that the bottom door must be not less than 3 feet above the water level surrounding the caisson on the outside. (The water level, where it is affected by tides, is construed to mean high tide.)

(xi) In addition to the pressure gauge in the locks, you must maintain an accurate pressure gauge on the outer and inner side of each bulkhead. These gauges must be accessible at all times and you must keep them in accurate working order.

(xii) Man locks must have an observation port at least 4 inches in diameter located in such a position that all occupants of the man lock may be observed from the working chamber and from the free air side of the lock.

(xiii) You must provide adequate ventilation in the lock.

(xiv) You must maintain man locks at a minimum temperature of 70°F.

(xv) When locks are not in use and employees are in the working chamber, you must keep lock doors open to the working chamber, where practicable.

(xvi) You must make provisions to allow for rescue parties to enter the tunnel if the working force is disabled.

(xvii) You must provide a special decompression chamber of sufficient size to accommodate the entire force of employees being decompressed at the end of a shift whenever the regularly established working period requires total time of decompression exceeding 75 minutes.

(b) Special decompression chamber.

(i) The headroom in the special decompression chamber must be not less than a minimum 7 feet and the cubical content must provide at least 50 cubic feet of airspace for each employee. For each occupant, you must provide 4 square feet of free walking area and 3 square feet of seating space, exclusive of area required for lavatory and toilet facilities. You must base the rated capacity on the stated minimum space per employee and you must post it at the chamber entrance. You must not exceed the posted capacity shall not be exceeded, except in case of emergency.

(ii) Each special decompression chamber must 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; and

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

(iii) Seating facilities in special decompression chambers must be so arranged as to permit a normal sitting posture without cramping. You must provide seating space, not less than 18 inches by 24 inches wide, per occupant.

(iv) You must provide adequate toilet and washing facilities, in a screened or enclosed recess. Toilet bowls must have a built-in protector on the rim so that an air space is created when the seat lid is closed.

(v) Fresh and pure drinking water must 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.

(vi) No refuse or discarded material of any kind must be permitted to accumulate, and you must keep the chamber clean.

(vii) Unless the special decompression chamber is serving as the man lock to atmospheric pressure, the special decompression chamber must be situated, where practicable, adjacent to the man lock on the atmospheric pressure side of the bulkhead. You must provide a passageway, connecting the special chamber with the man lock, to permit employees 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 must 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.

(8) **Compressor plant and air supply.**

(a) At all times there must be a thoroughly experienced, competent, and reliable person on duty at the air control valves as a gauge tender who must regulate the pressure in the working areas. During tunneling operations, one gauge tender may regulate the pressure in not more than two headings: Provided; That the gauges and controls are all in one location. In caisson work, there must be a gauge tender for each caisson.

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

(c) Low air compressor units must have at least two independent and separate sources of power supply and each must be capable of operating the entire low air plant and its accessory systems.

(d) The capacity, arrangement, and number of compressors must 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.

(e) You must periodically switch from one independent source of power supply to the other to ensure that workability of the apparatus in an emergency.

(f) You must provide duplicate low-pressure air feedlines and regulating valves between the source of air supply and a point beyond the locks with one of the lines extending to within 100 feet of the working face.

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

(h) Low-pressure air must be regulated automatically. In addition, you must provide manually operated valves for emergency conditions.

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

(j) Gauges indicating the pressure in the working chamber must be installed in the compressor building, the lock attendant's station, and at the employer's field office.

(9) **Ventilation and air quality.**

(a) You must provide and operate exhaust valves and exhaust pipes so that the working chamber is well ventilated, and there are no pockets of dead air. Outlets may be required at intermediate points along the main low-pressure air supply line to the heading to eliminate such pockets of dead air. The quantity of ventilation air must be not less than 30 cubic feet per minute.

(b) You must analyze the air in the workplace not less than once each shift, and you must keep records of such tests on file at the place where the work is in progress. The test results must be within the threshold limit values specified in part B of this chapter, for hazardous gases, and within 10 percent of the lower explosive limit of flammable gases. If these limits are not met, you must take immediate action to correct the situation.

(c) You must maintain the temperature of all working chambers which are subjected to air pressure, by means of after-coolers or other suitable devices, at a temperature not to exceed 85°F.

(d) You must provide forced ventilation during decompression. During the entire decompression period, you must provide forced ventilation through chemical or mechanical air purifying devices that will ensure a source of fresh air.

(e) Whenever heat-producing machines (moles, shields) are used in compressed air tunnel operations, you must provide a positive means of removing the heat build-up at the heading.

(10) **Electricity.**

(a) All lighting in compressed-air chambers must be by electricity exclusively, and you must use two independent electric-lighting systems with independent sources of supply. You must arrange the emergency source to become automatically operative in the event of failure of the regularly used source.

(b) The minimum intensity of light on any walkway, ladder, stairway, or working level must be not less than 10 foot-candles, and in all workplaces the lighting must at all times be such as to enable employees to see clearly.

(c) All electrical equipment, and wiring for light and power circuits, must comply with requirements of Part I, of this standard, for use in damp, hazardous, high temperature, and compressed air environments.

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

(e) Portable lamps must be equipped with noncombustible, nonabsorptive, insulating sockets, approved handles, basket guards, and approved cords.

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

(11) **Sanitation.**

(a) You must provide sanitary, heated, lighted, and ventilated dressing rooms and drying rooms for all employees engaged in compressed air work. Such rooms must contain suitable benches and lockers. You must provide bathing accommodations (showers at the ratio of one to 10 employees per shift), equipped with running hot and cold water, and suitable and adequate toilet accommodations. You must provide one toilet for each 15 employees, or fractional part thereof.

(b) When the toilet bowl is shut by a cover, there should be an air space so that the bowl or bucket does not implode when pressure is increased.

(c) You must keep all parts of caissons and other working compartments in a sanitary condition.

(12) **Fire prevention and protection.**

(a) Firefighting equipment must be available at all times and you must maintain it in working condition.

(b) While welding or flame-cutting is being done in compressed air, a firewatch with a fire hose or approved extinguisher must stand by until such operation is completed.

(c) You must provide shafts and caissons containing flammable material of any kind, either above or below ground, with a waterline and a fire hose connected thereto, so arranged that all points of the shaft or caisson are within reach of the hose stream.

(d) Fire hose must be at least 1 1/2 inches in nominal diameter; the water pressure must at all times be adequate for efficient operation of the type of nozzle used; and the water supply must be such as to ensure an uninterrupted flow. Fire hose, when not in use, must be located or guarded to prevent injury thereto.

(e) You must provide the power house, compressor house, and all buildings housing ventilating equipment, with at least one hose connection in the waterline, with a fire hose connected thereto. You must

maintain a fire hose within reach of structures of wood over or near shafts.

(f) Tunnels must be provided with a two-inch minimum diameter waterline extending into the working chamber and to within 100 feet of the working face. Such line must have hose outlets with 100 feet of fire hose attached and maintained as follows: One at the working face; one immediately inside of the bulkhead of the working chamber; and one immediately outside such bulkhead. In addition, hose outlets must be provided at 200-foot intervals throughout the length of the tunnel, and 100 feet of fire hose must be attached to the outlet nearest to any location where flammable material is being kept or stored or where any flame is being used.

(g) In addition to fire hose protection required by this part, on every floor of every building not under compressed air, but used in connection with the compressed air work, you must provide at least one approved fire extinguisher of the proper type for the hazards involved. You must provide at least two approved fire extinguishers in the working chamber as follows: One at the working face and one immediately inside the bulkhead (pressure side). Extinguishers in the working chamber must use water as the primary extinguishing agent and must not use any extinguishing agent which could be harmful to the employees in the working chamber. You must protect the fire extinguisher from damage.

(h) You must not use or store highly combustible materials in the working chamber. You must not use wood, paper, and similar combustible material in the working chamber in quantities which could cause a fire hazard. The compressor building must be constructed of noncombustible material.

(i) Man locks must be equipped with a manual type fire extinguisher system that can be activated inside the man lock and also by the outside lock attendant. In addition, you must provide a fire hose and portable fire extinguisher inside and outside the man lock. The portable fire extinguisher must be the dry chemical type.

Note: For additional requirements relating to portable fire extinguishers see WAC 296-800-300.

(j) Equipment, fixtures, and furniture in man locks and special decompression chambers must be constructed of noncombustible materials. Bedding, etc., must be chemically treated so as to be fire resistant.

(k) Head frames must be constructed of structural steel or open frame-work fireproofed timber. Head houses and other temporary surface buildings or structures within 100 feet of the shaft, caisson, or tunnel opening must be built of fire-resistant materials.

(l) You must not store any oil, gasoline, or other combustible materials within 100 feet of any shaft, caisson, or tunnel opening, except that oils may be stored in suitable tanks in isolated fireproof buildings, provided such buildings are not less than 50 feet from any shaft, caisson, or tunnel opening, or any building directly connected thereto.

(m) You must take positive means to prevent leaking flammable liquids from flowing into the areas specifically mentioned in the preceding subdivision.

(n) All explosives used in connection with compressed air work must be selected, stored, transported, and used as specified in part T of this chapter.

(13) **Bulkheads and safety screens.**

(a) Intermediate bulkheads with locks, or intermediate safety screens or both, are required where there is danger of rapid flooding.

(b) In tunnels 16 feet or more in diameter, you must provide hanging walkways from the face to the man lock as high in the tunnel as practicable, with at least 6 feet of head room. Walkways must be constructed of noncombustible material. You must securely install standard railings throughout the length of all walkways on open sides in accordance with Part C-1 of this chapter. Where walkways are ramped under safety screens, you must skidproof the walkway surface by cleats or by equivalent means.

(c) You must test bulkheads used to contain compressed air, where practicable, to prove their ability to resist the highest air pressure which may be expected to be used.

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