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SUBCHAPTER V—MARINE OCCUPATIONAL SAFETY AND HEALTH STANDARDS

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Subpart A [Reserved]

Subpart B—Commercial Diving Operations

GENERAL

§ 197.200 Purpose of subpart.

This subpart prescribes rules for the design, construction, and use of equipment, and inspection, operation, and safety and health standards for commercial diving operations taking place from vessels and facilities under Coast Guard jurisdiction.

§ 197.202 Applicability.

(a) This subpart applies to commercial diving operations taking place at any deepwater port or the safety zone thereof as defined in 33 CFR part 150; from any artificial island, installation, or other device on the Outer Continental Shelf and the waters adjacent thereto as defined in 33 CFR part 147 or otherwise related to activities on the Outer Continental Shelf; and from all vessels required to have a certificate of inspection issued by the Coast Guard including mobile offshore drilling units regardless of their geographic location, or from any vessel connected with a deepwater port or within the deepwater port safety zone, or from any vessel engaged in activities related to the Outer Continental Shelf; except that this subpart does not apply to any diving operation—

(1) Performed solely for marine scientific research and development purposes by educational institutions;

(2) Performed solely for research and development for the advancement of diving equipment and technology; or

(3) Performed solely for search and rescue or related public safety purposes by or under the control of a governmental agency.

(b) Diving operations may deviate from the requirements of this subpart to the extent necessary to prevent or minimize a situation which is likely to cause death, injury, or major environmental damage. The circumstances leading to the situation, the deviations made, and the corrective action taken, if appropriate, to reduce the possibility of recurrence shall be recorded by the diving supervisor in the logbook as required by § 197.482(c).

§ 197.203 Right of appeal.

Any person directly affected by a decision or action taken under this subchapter, by or on behalf of the Coast Guard, may appeal therefrom in accordance with subpart 1.03 of this chapter.

[CGD 88–033, 54 FR 50382, Dec. 6, 1989]

§ 197.204 Definitions.

As used in this subpart:

ACFM means actual cubic feet per minute.

ANSI Code1 means the B31.1 American National Standards Institute ''Code for Pressure Piping, Power Piping.''

ASME Code means the American Society of Mechanical Engineers ''Boiler and Pressure Vessel Code.''

ASME PVHO–1 means the ANSI/ASME standard ''Safety Standard for Pressure Vessels for Human Occupancy.''

ATA means a measure of pressure expressed in terms of atmosphere absolute (includes barometric pressure).

Bell means a compartment either at ambient pressure (open bell) or pressurized (closed bell) that allows the diver to be transported to and from the underwater work site, allows the diver access to the surrounding environment, and is capable of being used as a refuge during diving operations.

Bottom time means the total elapsed time measured in minutes from the time the diver leaves the surface in descent to the time to the next whole minute that the diver begins ascent.

Breathing gas/breathing mixture means the mixed-gas, oxygen, or air as appropriate supplied to the diver for breathing.

Bursting pressure means the pressure at which a pressure containment device would fail structurally.

Commercial diver means a diver engaged in underwater work for hire excluding sport and recreational diving and the instruction thereof.

Commercial diving operation means all activities in support of a commercial diver.

Cylinder means a pressure vessel for the storage of gases under pressure.

Decompression chamber means a pressure vessel for human occupancy such

as a surface decompression chamber, closed bell, or deep diving system especially equipped to recompress, decompress, and treat divers.

Decompression sickness means a condition caused by the formation of gas or gas bubbles in the blood or body tissue as a result of pressure reduction.

Decompression table means a profile or set of profiles of ascent rates and breathing mixtures designed to reduce the pressure on a diver safely to atmospheric pressure after the diver has been exposed to a specific depth and bottom time.

Depth means the maximum pressure expressed in feet of seawater attained by a diver and is used to express the depth of a dive.

Dive location means that portion of a vessel or facility from which a diving operation is conducted.

Dive team means the divers and diver support personnel involved in a diving operation, including the diving supervisor.

Diver means a person working beneath the surface, exposed to hyperbaric conditions, and using underwater breathing apparatus.

Diver-carried reserve breathing gas means a supply of air or mixed-gas, as appropriate, carried by the diver in addition to the primary or secondary breathing gas supplied to the diver.

Diving installation means all of the equipment used in support of a commercial diving operation.

Diving mode means a type of diving requiring SCUBA, surface-supplied air, or surface-supplied mixed-gas equipment, with related procedures and techniques.

Diving stage means a suspended platform constructed to carry one or more divers and used for putting divers into the water and bringing them to the surface when in-water decompression or a heavy-weight diving outfit is used.

Diving supervisor means the person having complete responsibility for the safety of a commercial diving operation including the responsibility for the safety and health of all diving personnel in accordance with this subpart.

Facility means a deepwater port, or an artificial island, installation, or other device on the Outer Continental Shelf subject to Coast Guard jurisdiction.

Fsw means feet of seawater (or equivalent static pressure head).

Gas embolism means a condition caused by expanding gases, which have been taken into and retained in the lungs while breathing under pressure, being forced into the bloodstream or other tissues during ascent or decompression.

Heavy-weight diving outfit means diver-worn surface-supplied deep-sea dress.

Hyperbaric conditions means pressure conditions in excess of surface atmospheric pressure.

Injurious corrosion means an advanced state of corrosion which may impair the structural integrity or safe operation of the equipment.

Liveboating means the support of a surfaced-supplied diver from a vessel underway.

Maximum working pressure means the maximum pressure to which a pressure containment device can be exposed under operating conditions (usually the pressure setting of the pressure relief device).

No-decompression limits means the air depth and bottom time limits of appendix A.

Pressure vessel means a container capable of withstanding an internal maximum working pressure over 15 psig.

Psi(g) means pounds per square inch (gage).

PVHO means pressure vessel for human occupancy but does not include pressure vessels for human occupancy that may be subjected to external pressures in excess of 15 psig but can only be subjected to maximum internal pressures of 15 psig or less (*i.e.*, submersibles, or one atmosphere observation bells).

Saturation diving means saturating a diver's tissues with the inert gas in the breathing mixture to allow an extension of bottom time without additional decompression.

SCUBA diving means a diving mode in which the diver is supplied with a compressed breathing mixture from diver carried equipment.

Standby diver means a diver at the dive location available to assist a diver in the water.

Surface-supplied air diving means a diving mode in which the diver is supplied from the dive location or bell with compressed breathing air including oxygen or oxygen enriched air if supplied for treatment.

Surface-supplied mixed-gas diving means a diving mode in which the diver is supplied from the dive location or bell with a compressed breathing mixture other than air.

Timekeeping device means a device for measuring the time of a dive in minutes.

Treatment table means a depth, time, and breathing gas profile designed to treat a diver for decompression sickness.

Umbilical means the hose bundle between a dive location and a diver or bell, or between a diver and a bell, that supplies the diver or bell with a lifeline, breathing gas, communications, power, and heat as appropriate to the diving mode or conditions.

Vessel means any waterborne craft including mobile offshore drilling units required to have a Certificate of Inspection issued by the Coast Guard or any waterborne craft connected with a deepwater port or within the deepwater port safety zone, or any waterborne craft engaged in activities related to the Outer Continental Shelf.

Volume tank means a pressure vessel connected to the outlet of a compressor and used as an air reservoir.

Working pressure means the pressure to which a pressure containment device is exposed at any particular instant during normal operating conditions.

§ 197.205 Availability of standards.

(a) Several standards have been incorporated by reference in this subchapter. The incorporation by reference has been approved by the Director of the Federal Register under the provisions of 1 CFR part 51.

(b) The standards are available from the appropriate organizations whose addresses are listed below:

(1) American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

(2) American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by CGD 96–041, 61 FR 50735, Sept. 27, 1996]

§ 197.206 Substitutes for required equipment, materials, apparatus, arrangements, procedures, or tests.

(a) The Coast Guard may accept substitutes for equipment, materials, apparatus, arrangements, procedures, or tests required in this subpart if the substitute provides an equivalent level of safety.

(b) In any case where it is shown to the satisfaction of the Commandant that the use of any particular equipment, material, apparatus, arrangement, procedure, or test is unreasonable or impracticable, the Commandant may permit the use of alternate equipment, material, apparatus, arrangement, procedure, or test to such an extent and upon such condition as will insure, to his satisfaction, a degree of safety consistent with the minimum standards set forth in this subpart.

§ 197.208 Designation of person-in-charge.

(a) The owner or agent of a vessel or facility without a designated master shall designate, in writing, an individual to be the person-in-charge of the vessel or facility.

(b) Where a master is designated, the master is the person-in-charge.

§ 197.210 Designation of diving supervisor.

The name of the diving supervisor for each commercial diving operation shall be—

(a) Designated in writing; and

(b) Given to the person-in-charge prior to the commencement of any commercial diving operation.

EQUIPMENT

§ 197.300 Applicability.

(a) Each diving installation used on each vessel or facility subject to this subpart must meet the requirements of this subpart.

(b) In addition to the requirements of this subpart, equipment which is permanently installed on vessels and is part of the diving installation must meet Subchapters F and J of this chapter.

(c) All repairs and modifications to pressure vessels used for commercial diving operations must be made in accordance with the requirements of section VIII, division 1 or division 2 of the ASME Code, ASME PVHO–1, part 54 of this chapter, or 49 CFR 173.34, as applicable.

(d) All repairs and modifications to pressure piping used for commercial diving operations must be made in accordance with the requirements of the ANSI Code or part 56 of this chapter, as applicable.

§ 197.310 Air compressor system.

A compressor used to supply breathing air to a diver must have—

(a) A volume tank that is—

(1) Built and stamped in accordance with section VIII, division 1 of the ASME Code with—

(i) A check valve on the inlet side;

(ii) A pressure gage;

(iii) A relief valve; and

(iv) A drain valve; and

(2) Tested after every repair, modification, or alteration to the pressure boundaries as required by § 197.462;

(b) Intakes that are located away from areas containing exhaust fumes of internal combustion engines or other hazardous contaminants;

(c) An efficient filtration system; and

(d) Slow-opening shut-off valves when the maximum allowable working pressure of the system exceeds 500 psig.

§ 197.312 Breathing supply hoses.

(a) Each breathing supply hose must—

(1) Have a maximum working pressure that is equal to or exceeds—

(i) The maximum working pressure of the section of the breathing supply system in which used; and

(ii) The pressure equivalent of the maximum depth of the dive relative to the supply source plus 100 psig;

(2) Have a bursting pressure of four times its maximum working pressure;

(3) Have connectors that—

(i) Are made of corrosion-resistant material;

(ii) Are resistant to accidental disengagement; and

(iii) Have a maximum working pressure that is at least equal to the maximum working pressure of the hose to which they are attached; and

(4) Resist kinking by—

(i) Being made of kink-resistant materials; or

(ii) Having exterior support.

(b) Each umbilical must—

(1) Meet the requirements of paragraph (a) of this section; and

(2) Be marked from the diver or open bell end in 10-foot intervals to 100 feet and in 50-foot intervals thereafter.

§ 197.314 First aid and treatment equipment.

(a) Each dive location must have—

(1) A medical kit approved by a physician that consists of—

(i) Basic first aid supplies; and

(ii) Any additional supplies necessary to treat minor trauma and illnesses resulting from hyperbaric exposure;

(2) A copy of an American Red Cross Standard First Aid handbook;

(3) A bag-type manual resuscitator with transparent mask and tubing; and

(4) A capability to remove an injured diver from the water.

(b) Each diving installation must have a two-way communications system to obtain emergency assistance except when the vessel or facility ship-to-shore, two-way communications system is readily available.

(c) Each dive location supporting mixed-gas dives, dives deeper than 130 fsw, or dives outside the no-decompression limits must meet the requirements of paragraph (a) of this section and have—

(1) A decompression chamber;

(2) Decompression and treatment tables;

(3) A supply of breathing gases sufficient to treat for decompression sickness;

(4) The medical kit required by paragraph (a)(1) of this section that is—

(i) Capable of being carried into the decompression chamber; and

(ii) Suitable for use under hyperbaric conditions; and

(5) A capability to assist an injured diver into the decompression chamber.

§ 197.318 Gages and timekeeping devices.

(a) A gage indicating diver depth must be at each dive location for surface-supplied dives.

(b) A timekeeping device must be at each dive location.

§ 197.320 Diving ladder and stage.

(a) Each diving ladder must—

(1) Be capable of supporting the weight of at least two divers;

(2) Extend 3 feet below the water surface;

(3) Be firmly in place;

(4) Be available at the dive location for a diver to enter or exit the water unless a diving stage or bell is provided; and

(5) Be—(i) Made of corrosion-resistant material; or

(ii) Protected against and maintained free from injurious corrosion.

(b) Each diving stage must—

(1) Be capable of supporting the weight of at least two divers;

(2) Have an open-grating platform;

(3) Be available for a diver to enter or exit the water from the dive location and for in-water decompression if the diver is—

(i) Wearing a heavy-weight diving outfit; or

(ii) Diving outside the no-decompression limits, except when a bell is provided; and

(4) Be—(i) Made of corrosion-resistant material; or

(ii) Protected against and maintained free from injurious corrosion.

§ 197.322 Surface-supplied helmets and masks.

(a) Each surface-supplied helmet or mask must have—

(1) A nonreturn valve at the attachment point between helmet or mask and umbilical that closes readily and positively;

(2) An exhaust valve; and

(3) A two-way voice communication system between the diver and the dive location or bell.

(b) Each surface-supplied air helmet or mask must—

(1) Ventilate at least 4.5 ACFM at any depth at which it is operated; or

(2) Be able to maintain the diver's inspired carbon dioxide partial pressure below 0.02 ATA when the diver is producing carbon dioxide at the rate of 1.6 standard liters per minute.

§ 197.324 Diver's safety harness.

Each safety harness used in surface-supplied diving must have—

(a) A positive buckling device; and

(b) An attachment point for the umbilical life line that—

(1) Distributes the pulling force of the umbilical over the diver's body; and

(2) Prevents strain on the mask or helmet.

§ 197.326 Oxygen safety.

(a) Equipment used with oxygen or oxygen mixtures greater than 40 percent by volume must be designed for such use.

(b) Oxygen systems with pressures greater than 125 psig must have slow-opening shut-off valves except pressure boundary shut-off valves may be ball valves.

§ 197.328 PVHO—General.

(a) Each PVHO, contracted for or purchased after February 1, 1979, must be built and stamped in accordance with ASME PVHO–1.

(b) Each PVHO, contracted for or constructed before February 1, 1979, and not Coast Guard approved, must be submitted to the Coast Guard for approval prior to February 1, 1984.

(c) To be approved under paragraph (b), a PVHO must be—

(1) Constructed in accordance with part 54 of this chapter; or—

(2) Be built in accordance with section VIII, division 1 or division 2 of the ASME Code; and—

(i) Have the plans approved in accordance with § 54.01–18 of this chapter;

(ii) Pass the radiographic and other survey tests of welded joints required by section VIII, division 1 or division 2, as appropriate, of the ASME Code; and

(iii) Pass—(A) The hydrostatic test described in § 54.10–10 of this chapter; or

(B) The pneumatic test described in § 54.10–15 of this chapter and such additional tests as the Officer-in-Charge, Marine Inspection (OCMI) may require.

(d) Each PVHO must—

(1) Have a shut-off valve located within 1 foot of the pressure boundary on all piping penetrating the pressure boundary;

(2) Have a check valve located within 1 foot of the pressure boundary on all piping exclusively carrying fluids into the PVHO;

(3) Have the pressure relief device required by ASME PVHO–1;

(4) Have a built-in breathing system with at least one mask per occupant stored inside each separately pressurized compartment;

(5) Have a two-way voice communications system allowing communications between an occupant in one pressurized compartment of the PVHO and—

(i) The diving supervisor at the dive location;

(ii) Any divers being supported from the same PVHO; and

(iii) Occupants of other separately pressurized compartments of the same PVHO;

(6) If designed to mechanically couple to another PVHO, have a two-way communications system allowing communications between occupants of each PVHO when mechanically coupled;

(7) Have a pressure gage in the interior of each compartment that is—

(i) Designed for human occupancy; and

(ii) Capable of having the compartment pressure controlled from inside the PVHO;

(8) Have viewports that allow observation of occupants from the outside;

(9) Have viewports that meet the requirements of ASME PVHO–1 except those PVHO's approved under paragraph (b) of this section which have nonacrylic viewports;

(10) Have means of illumination sufficient to allow an occupant to—

(i) Read gages; and

(ii) Operate the installed systems within each compartment;

(11) Be designed and equipped to minimize sources of combustible materials and ignition;

(12) Have a protective device on the inlet side of PVHO exhaust lines;

(13) Have a means of extinguishing a fire in the interior;

(14) Have a means of maintaining the oxygen content of the interior atmosphere below 25 percent surface equivalent by volume when pressurized with air as the breathing mixture;

(15) Have a means of maintaining the interior atmosphere below 2 percent surface equivalent carbon dioxide by volume;

(16) Have a means of overriding and controlling from the exterior all interior breathing and pressure supply controls;

(17) Have a speech unscrambler when used with mixed-gas;

(18) Have interior electrical systems that are designed for the environment in which they will operate to minimize the risk of fire, electrical shock to personnel, and galvanic action of the PVHO; and

(19) Be tested after every repair, modification, or alteration to the pressure boundaries as required by § 197.462.

§ 197.330 PVHO—Closed bells.

(a) Except as provided in paragraph (b) of this section, each closed bell must meet the requirements of § 197.328 and—

(1) Have underwater breathing apparatus for each occupant stored inside each separately pressurized compartment;

(2) Have an umbilical;

(3) Have lifting equipment attached to the closed bell capable of returning the occupied closed bell when fully flooded to the dive location;

(4) Be capable of recompressing on the surface to the maximum design diving depth;

(5) Be constructed and equipped as required by § 197.332;

(6) Have an emergency locating device designed to assist personnel on the surface in acquiring and maintaining contact with the submerged PVHO if the umbilical to the surface is severed;

(7) Have a capability to remove an injured diver from the water; and

(8) Have a life support capability for the intact closed bell and its occupants for—

(i) Twelve hours after an accident severing the umbilical to the surface when the umbilical to the surface is

the only installed means of retrieving the closed bell; or

(ii) A period of time, at least equal to 1 hour plus twice the time required to retrieve the bell from its designed operating depth and attach an auxiliary lifesupport system, after an accident severing the umbilical to the surface when the umbilical is one of the two independent installed means of retrieving the closed bell, each meeting the requirements of paragraph (a)(3) of this section.

(b) A closed bell that does not meet the requirements of paragraphs (a)(3), (a)(4), and (a)(5) of this section, must be capable of attachment to another PVHO that—

(1) Allows the transfer of personnel and diver's equipment under pressure from the closed bell to the PVHO;

(2) Meets the requirements of paragraph (a)(3) of this section;

(3) Is capable of attachment to a decompression chamber meeting the requirements of paragraphs (a)(4) and (a)(5) of this section; and

(4) Allows the transfer of personnel and diver's equipment under pressure from the PVHO to the decompression chamber.

§ 197.332 PVHO—Decompression chambers.

Each decompression chamber must—

(a) Meet the requirements of § 197.328;

(b) Have internal dimensions sufficient to accommodate a diver lying in a horizontal position and another person tending the diver;

(c) Have a capability for ingress and egress of personnel and equipment while the occupants are under pressure;

(d) Have a means of operating all installed man-way locking devices, except disabled shipping dogs, from both sides of a closed hatch;

(e) Have interior illumination sufficient to allow visual observation, diagnosis, and medical treatment of an occupant.

(f) Have one bunk for each two occupants;

(g) Have a capability that allows bunks to be seen over their entire lengths from the exterior;

(h) Have a minimum pressure capability of—

(1) 6 ATA, when used for diving to 300 fsw; or

(2) The maximum depth of the dive, when used for diving operations deeper than 300 fsw, unless a closed bell meeting the requirements of § 197.330(a) (3), (4), and (5) is used;

(i) Have a minimum pressurization rate of 2 ATA per minute to 60 fsw and at least 1 ATA per minute thereafter;

(j) Have a decompression rate of 1 ATA per minute to 33 fsw;

(k) Have an external pressure gage for each pressurized compartment;

(l) Have a capability to supply breathing mixtures at the maximum rate required by each occupant doing heavy work; and

(m) Have a sound-powered headset or telephone as a backup to the communications system required by § 197.328(c) (5) and (6), except when that communications system is a sound-powered system.

§ 197.334 Open diving bells.

Each open diving bell must—

(a) Have an upper section that provides an envelope capable of maintaining a bubble of breathing mixture available to a diver standing on the lower section of the platform with his body through the open bottom and his head in the bubble;

(b) Have lifting equipment capable of returning the occupied open bell to the dive location;

(c) Have an umbilical; and

(d) Be—(1) Made of corrosion-resisting material; or

(2) Protected against and maintained free from injurious corrosion.

§ 197.336 Pressure piping.

Piping systems that are not an integral part of the vessel or facility, carrying fluids under pressures exceeding 15 psig must—

(a) Meet the ANSI Code;

(b) Have the point of connection to the integral piping system of the vessel or facility clearly marked; and

(c) Be tested after every repair, modification, or alteration to the pressure boundaries as set forth in § 197.462.

§ 197.338 Compressed gas cylinders.

Each compressed gas cylinder must—

(a) Be stored in a ventilated area;

(b) Be protected from excessive heat;
(c) Be prevented from falling;
(d) Be tested after any repair, modification, or alteration to the pressure boundaries as set forth in § 197.462; and
(e) Meet the requirements of—
(1) Part 54 of this chapter; or
(2) 49 CFR 173.34 and 49 CFR part 178, subpart C.

§ 197.340 Breathing gas supply.

(a) A primary breathing gas supply for surface-supplied diving must be sufficient to support the following for the duration of the planned dive:
(1) The diver.
(2) The standby diver.
(3) The decompression chamber, when required by § 197.432(e)(2) or by § 197.434(a) for the duration of the dive and for one hour after completion of the planned dive.
(4) A decompression chamber when provided but not required by this subpart.
(5) A closed bell when provided or required by § 197.434(d).
(6) An open bell when provided or required by § 197.432(e)(4) or by § 197.434(c).
(b) A secondary breathing gas supply for surface-supplied diving must be sufficient to support the following:
(1) The diver while returning to the surface.
(2) The diver during decompression.
(3) The standby diver.
(4) The decompression chamber when required by § 197.432(e)(2) or by § 197.434(a) for the duration of the dive and one hour after the completion of the planned dive.
(5) The closed bell while returning the diver to the surface.
(6) The open bell while returning the diver to the surface.
(c) A diver-carried reserve breathing gas supply for surface-supplied diving must be sufficient to allow the diver to—
(1) Reach the surface.
(2) Reach another source of breathing gas; or
(3) Be reached by a standby diver equipped with another source of breathing gas for the diver.
(d) A primary breathing gas supply for SCUBA diving must be sufficient to support the diver for the duration of the planned dive through his return to the dive location or planned pick-up point.
(e) A diver-carried reserve breathing gas supply for SCUBA diving must be sufficient to allow the diver to return to the dive location or planned pick-up point from the greatest depth of the planned dive.
(f) Oxygen used for breathing mixtures must—
(1) Meet the requirements of Federal Specification BB-0–925a; and
(2) Be type 1 (gaseous) grade A or B.
(g) Nitrogen used for breathing mixtures must—
(1) Meet the requirements of Federal Specification BB-N–411c;
(2) Be type 1 (gaseous);
(3) Be class 1 (oil free); and
(4) Be grade A, B, or C.
(h) Helium used for breathing mixtures must be grades A, B, or C produced by the Federal Government, or equivalent.
(i) Compressed air used for breathing mixtures must—
(1) Be 20 to 22 percent oxygen by volume;
(2) Have no objectionable odor; and
(3) Have no more than—
(i) 1,000 parts per million of carbon dioxide;
(ii) 20 parts per million carbon monoxide;
(iii) 5 milligrams per cubic meter of solid and liquid particulates including oil; and
(iv) 25 parts per million of hydrocarbons (includes methane and all other hydrocarbons expressed as methane).

§ 197.342 Buoyancy-changing devices.

(a) A dry suit or other buoyancy-changing device not directly connected to the exhaust valve of the helmet or mask must have an independent exhaust valve.
(b) When used for SCUBA diving, a buoyancy-changing device must have an inflation source separate from the breathing gas supply.

§ 197.344 Inflatable floatation devices.

An inflatable floatation device for SCUBA diving must—
(a) Be capable of maintaining the diver at the surface in a faceup position;

(b) Have a manually activated inflation device;

(c) Have an oral inflation device;

(d) Have an over-pressure relief device; and

(e) Have a manually operated exhaust valve.

§ 197.346 Diver's equipment.

(a) Each diver using SCUBA must have—

(1) Self-contained underwater breathing equipment including—

(i) A primary breathing gas supply with a cylinder pressure gage readable by the diver during the dive; and

(ii) A diver-carried reserve breathing gas supply provided by—

(A) A manual reserve (J valve); or

(B) An independent reserve cylinder connected and ready for use;

(2) A face mask;

(3) An inflatable floatation device;

(4) A weight belt capable of quick release;

(5) A knife;

(6) Swim fins or shoes;

(7) A diving wristwatch; and

(8) A depth gage.

(b) Each diver using a heavyweight diving outfit must—

(1) Have a helmet group consisting of helmet, breastplate, and associated valves and connections;

(2) Have a diving dress group consisting of a basic dress that encloses the body (except for head and hands) in a tough, waterproof cover, gloves, shoes, weight assembly, and knife;

(3) Have a hose group consisting of the breathing gas hose and fittings, the control valve, the lifeline, communications cable, and a pneumofathometer; and

(4) Be provided with a helmet cushion and weighted shoes.

(c) Each surface-supplied dive operation using a heavyweight diving outfit must have an extra breathing gas hose with attaching tools available to the standby diver.

(d) Each diver using a lightweight diving outfit must have—

(1) A safety harness;

(2) A weight assembly capable of quick release;

(3) A mask group consisting of a lightweight mask and associated valves and connections;

(4) A diving dress group consisting of wet or dry diving dress, gloves, shoes or fins, and knife; and

(5) A hose group consisting of the breathing gas hose and fittings, the control valve, the lifeline, communications cable, and a pneumofathometer (if the breaking strength of the communications cable is at least equal to that required for the lifeline, the communications cable can serve as the lifeline).

(e) Each surface-supplied air dive operation within the no-decompression limits and to depths of 130 fsw or less must have a primary breathing gas supply at the dive location.

(f) Each surface-supplied dive operation outside the no-compression limits, deeper than 130 fsw, or using mixed-gas as a breathing mixture must have at the dive location—

(1) A primary breathing gas supply; and

(2) A secondary breathing gas supply.

(g) Each diver diving outside the no-decompression limits, deeper than 130 fsw, or using mixed-gas must have a diver-carried reserve breathing gas supply except when using a heavyweight diving outfit or when diving in a physically confining area.

OPERATIONS

§ 197.400 Applicability.

Diving operations may only be conducted from a vessel or facility subject to the subpart if the regulations in this subpart are met.

§ 197.402 Responsibilities of the person-in-charge.

(a) The person-in-charge shall—

(1) Be fully cognizant of the provisions of this subpart;

(2) Prior to permitting any commercial diving operation to commence, have—

(i) The designation of the diving supervisor for each diving operation as required by § 197.210;

(ii) A report on—

(A) The nature and planned times of the planned diving operation; and

(B) The planned involvement of the vessel or facility, its equipment, and its personnel in the diving operation.

(b) Prior to permitting any commercial diving operation involving liveboating to commence, the person-in-charge shall insure that—

(1) A means of rapid communications with the diving supervisor while the diver is entering, in, or leaving the water is established; and

(2) A boat and crew for diver pickup in the event of an emergency is provided.

(c) The person-in-charge shall insure that a boat and crew for SCUBA diver pickup is provided when SCUBA divers are not line-tended from the dive location.

(d) The person-in-charge shall coordinate the activities on and of the vessel or facility with the diving supervisor.

(e) The person-in-charge shall insure that the vessel or facility equipment and personnel are kept clear of the dive location except after coordinating with the diving supervisor.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by USCG–2014–0688, 79 FR 58289, Sept. 29, 2014]

§ 197.404 Responsibilities of the diving supervisor.

(a) The diving supervisor shall—

(1) Be fully cognizant of the provisions of this subpart;

(2) Be fully cognizant of the provisions of the operations manual required by § 197.420;

(3) Insure that diving operations conducted from a vessel or facility subject to this subpart meet the regulations in this subpart;

(4) Prior to the commencement of any commercial diving operation, provide the report required by § 197.402 to the person-in-charge;

(5) Coordinate with the person-in-charge any changes that are made to the report required by § 197.402; and

(6) Promptly notify the person-in-charge of any diving related casualty, accident, or injury.

(b) The diving supervisor is in charge of the planning and execution of the diving operation including the responsibility for the safety and health of the dive team.

§ 197.410 Dive procedures.

(a) The diving supervisor shall insure that—

(1) Before commencing diving operations, dive team members are briefed on—

(i) The tasks to be undertaken;

(ii) Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and

(iii) Any modifications to the operations manual or procedures including safety procedures necessitated by the specific diving operation;

(2) The breathing gas supply systems, masks, helmets, thermal protection, when provided, and bell lifting equipment, when a bell is provided or required, are inspected prior to each diving operation;

(3) Each diver is instructed to report any physical problems or physiological effects including aches, pains, current illnesses, or symptoms of decompression sickness prior to each dive;

(4) A depth, bottom time profile, including any breathing mixture changes, is maintained at the dive location for each diver during the dive, except that SCUBA divers shall maintain their own profiles;

(5) A two-way voice communication system is used between—

(i) Each surface-supplied diver and a dive team member at the dive location or bell (when provided); and

(ii) The bell (when provided) and the dive location;

(6) A two-way communication system is available at the dive location to obtain emergency assistance;

(7) After the completion of each dive—

(i) The physical condition of the diver is checked by—

(A) Visual observation; and

(B) Questioning the diver about his physical well-being;

(ii) The diver is instructed to report any physical problems or adverse physiological effects including aches, pains, current illnesses, or symptoms of decompression sickness or gas embolism;

(iii) The diver is advised of the location of an operational decompression chamber; and

(iv) The diver is alerted to the potential hazards of flying after diving;

(8) For any dive outside the no-decompression limits, deeper than 130 fsw, or using mixed-gas as a breathing mixture—

(i) A depth, time, decompression profile including breathing mixture changes is maintained for each diver at the dive location;

(ii) The diver is instructed to remain awake and in the vicinity of the dive location decompression chamber for at least one hour after the completion of a dive, decompression, or treatment; and

(iii) A dive team member, other than the diver, is trained and available to operate the decompression chamber; and

(9) When decompression sickness or gas embolism is suspected or symptoms are evident, a report is completed containing—

(i) The investigation for each incident including—

(A) The dive and decompression profiles;

(B) The composition, depth, and time of breathing mixture changes;

(C) A description of the symptoms including depth and time of onset; and

(D) A description and results of the treatment;

(ii) The evaluation for each incident based on—

(A) The investigation;

(B) Consideration of the past performance of the decompression table used; and

(C) Individual susceptibility; and

(iii) The corrective action taken, if necessary, to reduce the probability of recurrence.

(b) The diving supervisor shall ensure that the working interval of a dive is terminated when he so directs or when—

(1) A diver requests termination;

(2) A diver fails to respond correctly to communications or signals from a dive team member;

(3) Communications are lost and cannot be quickly reestablished between—

(i) The diver and a dive team member at the dive location; or

(ii) The person-in-charge and the diving supervisor during liveboating operations; or

(4) A diver begins to use his diver-carried reserve breathing gas supply.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by USCG–2014–0688, 79 FR 58289, Sept. 29, 2014]

§ 197.420 Operations manual.

(a) The diving supervisor shall—

(1) Provide an operations manual to the person-in-charge prior to commencement of any diving operation; and

(2) Make an operations manual available at the dive location to all members of the dive team.

(b) The operations manual must be modified in writing when adaptation is required because of—

(1) The configuration or operation of the vessel or facility; or

(2) The specific diving operation as planned.

(c) The operations manual must provide for the safety and health of the divers.

(d) The operations manual must contain the following:

(1) Safety procedures and checklists for each diving mode used.

(2) Assignments and responsibilities of each dive team member for each diving mode used.

(3) Equipment procedures and checklists for each diving mode used.

(4) Emergency procedures for—

(i) Fire;

(ii) Equipment failure;

(iii) Adverse environmental conditions including, but not limited to, weather and sea state;

(iv) Medical illness; and

(v) Treatment of injury.

(5) Procedures dealing with the use of—

(i) Hand-held power tools;

(ii) Welding and burning equipment; and

(iii) Explosives.

SPECIFIC DIVING MODE PROCEDURES

§ 197.430 SCUBA diving.

The diving supervisor shall insure that—

(a) SCUBA diving is not conducted—

(1) Outside the no-decompression limits;

(2) At depths greater than 130 fsw;

(3) Against currents greater than one (1) knot unless line-tended; and

(4) If a diver cannot directly ascend to the surface unless line-tended;

(b) The SCUBA diver has the equipment required by § 197.346(a);

(c) A standby diver is available while a diver is in the water;

(d) A diver is line-tended from the surface or accompanied by another diver in the water in continuous visual contact during the diving operation;

(e) When a diver is in a physically confining space, another diver is stationed at the underwater point of entry and is line-tending the diver; and

(f) A boat is available for diver pick-up when the divers are not line-tended from the dive location.

§ 197.432 Surface-supplied air diving.

The diving supervisor shall insure that—

(a) Surface-supplied air diving is conducted at depths less than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;

(b) Each diving operation has a primary breathing gas supply;

(c) Each diver is continuously tended while in the water;

(d) When a diver is in a physically confining space, another diver is stationed at the underwater point of entry and is line-tending the diver;

(e) For dives deeper than 130 fsw or outside the no-decompression limits—

(1) Each diving operation has a secondary breathing gas supply;

(2) A decompression chamber is ready for use at the dive location;

(3) A diving stage is used except when a bell is provided;

(4) A bell is used for dives with an in-water decompression time greater than 120 minutes, except when the diver is using a heavy-weight diving outfit or is diving in a physically confining space;

(5) A separate dive team member tends each diver in the water;

(6) A standby diver is available while a diver is in the water; and

(7) Each diver has a diver-carried reserve breathing gas supply except when using a heavy-weight diving outfit or when diving in a physically confining space; and

(f) The surface-supplied air diver has the equipment required by § 197.346 (b) or (d).

§ 197.434 Surface-supplied mixed-gas diving.

The diving supervisor shall insure that—

(a) When mixed-gas diving is conducted, a decompression chamber or a closed bell meeting the requirements of § 197.332 is ready for use at the dive location;

(b) A diving stage is used except when a bell is provided;

(c) A bell is used for dives deeper than 220 fsw or when the dive involves in-water decompression times greater than 120 minutes, except when the diver is using a heavy-weight diving outfit or is diving in a physically confining space;

(d) A closed bell is used for dives at depths greater than 300 fsw, except when diving is conducted in a physically confining space;

(e) A separate dive team member tends each diver in the water;

(f) A standby diver is available during all nonsaturation dives;

(g) When saturation diving is conducted—

(1) A standby diver is available when the closed bell leaves the dive location until the divers are in saturation; and

(2) A member of the dive team at the dive location is a diver able to assist in the recovery of the closed bell or its occupants, if required;

(h) When closed bell operations are conducted, a diver is available in the closed bell to assist a diver in the water;

(i) When a diver is in a physically confining space, another diver is stationed at the underwater point of entry and is line-tending the diver;

(j) Each diving operation has a primary and secondary breathing gas supply meeting the requirements of § 197.340; and

(k) The surface-supplied mixed-gas diver has the equipment required by § 197.346 (b) or (d).

§ 197.436 Liveboating.

(a) During liveboating operations, the person-in-charge shall insure that—

(1) Diving is not conducted in seas that impede station-keeping ability of the vessel;

(2) Liveboating operations are not conducted—

(i) From 1 hour after sunset to 1 hour before sunrise; or

(ii) During periods of restricted visibility;

(3) The propellers of the vessel are stopped before the diver enters or exits the water; and

(4) A boat is ready to be launched with crew in the event of an emergency.

(b) As used in paragraph (a)(2)(ii) of this section, *restricted visibility* means any condition in which vessel navigational visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes.

(c) During liveboating operations, the diving supervisor shall insure that—

(1) Diving is not conducted at depths greater than 220 fsw;

(2) Diving is not conducted in seas that impede diver mobility or work function;

(3) A means is used to prevent the diver's hose from entangling in the propellers of the vessel;

(4) Each diver carries a reserve breathing gas supply;

(5) A standby diver is available while a diver is in the water;

(6) Diving is not conducted with in-water decompression times greater than 120 minutes; and

(7) The person-in-charge is notified before a diver enters or exits the water.

PERIODIC TESTS AND INSPECTIONS OF DIVING EQUIPMENT

§ 197.450 Breathing gas tests.

The diving supervisor shall insure that—

(a) The output of each air compressor is tested and meets the requirements of § 197.340 for quality and quantity by means of samples taken at the connection point to the distribution system—

(1) Every 6 months; and

(2) After every repair or modification.

(b) Purchased supplies of breathing mixtures supplied to a diver are checked before being placed on line for—

(1) Certification that the supply meets the requirements of § 197.340; and

(2) Noxious or offensive odor and oxygen percentage;

(c) Each breathing supply system is checked, prior to commencement of diving operations, at the umbilical or underwater breathing apparatus connection point for the diver, for noxious or offensive odor and presence of oil mist; and

(d) Each breathing supply system, supplying mixed-gas to a diver, is checked, prior to commencement of diving operations, at the umbilical or underwater breathing apparatus connection point for the diver, for percentage of oxygen.

§ 197.452 Oxygen cleaning.

The diving supervisor shall ensure that equipment used with oxygen or oxygen mixtures greater than 40 percent by volume is cleaned of flammable materials—

(a) Before being placed into service; and

(b) After any repair, alteration, modification, or suspected contamination.

§ 197.454 First aid and treatment equipment.

The diving supervisor shall ensure that medical kits are checked monthly to insure that all required supplies are present.

§ 197.456 Breathing supply hoses.

(a) The diving supervisor shall insure that—

(1) Each breathing supply hose is pressure tested prior to being placed into initial service and every 24 months thereafter to 1.5 times its maximum working pressure;

(2) Each breathing supply hose assembly, prior to being placed into initial service and after any repair, modification, or alteration, is tensile tested by—

(i) Subjecting each hose-to-fitting connection to a 200 pound axial load; and

(ii) Passing a visual examination for evidence of separation, slippage, or other damage to the assembly;

(3) Each breathing supply hose is periodically checked for—

(i) Damage which is likely to affect pressure integrity; and

(ii) Contamination which is likely to affect the purity of the breathing mixture delivered to the diver; and

(4) The open ends of each breathing supply hose are taped, capped, or plugged when not in use.

(b) To meet the requirements of paragraph (a)(3) of this section, each breathing supply hose must be—

(1) Carefully inspected before being shipped to the dive location;

(2) Visually checked during daily operation; and

(3) Checked for noxious or offensive odor before each diving operation.

§ 197.458 Gages and timekeeping devices.

The diving supervisor shall insure that—

(a) Each depth gage and timekeeping device is tested or calibrated against a master reference gage or time-keeping device every 6 months;

(b) A depth gage is tested when a discrepancy exists in a depth gage reading greater than 2 percent of full scale between any two gages of similar range and calibration;

(c) A timekeeping device is tested when a discrepancy exists in a timekeeping device reading greater than one-quarter of a minute in a 4-hour period between any two timekeeping devices; and

(d) Each depth gage and timekeeping device is inspected before diving operations are begun.

§ 197.460 Diving equipment.

The diving supervisor shall insure that the diving equipment designated for use in a dive under § 197.346 is inspected before each dive.

§ 197.462 Pressure vessels and pressure piping.

(a) The diving supervisor shall ensure that each pressure vessel, including each volume tank, cylinder and PVHO, and each pressure piping system is examined and tested as required by this section and after any repair, modification or alteration to determine that they are in satisfactory condition and fit for the service intended.

(b) Pressure vessels and pressure piping shall be examined annually for mechanical damage or deterioration. Any defect that may impair the safety of the pressure vessel or piping shall be repaired and pressure tested to the satisfaction of the Officer in Charge, Marine Inspection.

(c) The following tests shall be conducted at least every three years:

(1) All piping permanently installed on a PVHO shall be pressure tested.

(2) PVHOs subject to internal pressure shall be leak tested at the maximum allowable working pressure using the breathing mixture normally used in service.

(3) Equivalent nondestructive testing may be conducted in lieu of pressure testing. Proposals to use nondestructive testing in lieu of pressure testing shall be submitted to the Officer in Charge, Marine Inspection.

(d) Unless otherwise noted, pressure tests conducted in accordance with this section shall be either hydrostatic tests or pneumatic tests.

(1) When a hydrostatic test is conducted on a pressure vessel, the test pressure shall be no less than 1.25 times the maximum allowable working pressure.

(2) When a pneumatic test is conducted on a pressure vessel, the test pressure shall be the maximum allowable working pressure stamped on the nameplate.

(3) When a pneumatic test is conducted on piping, the test pressure shall be no less than 90 percent of the setting of the relief device.

(4) Pressure tests shall be conducted only after suitable precautions are taken to protect personnel and equipment.

(5) When pressure tests are conducted on pressure vessels or pressure piping, the test pressure shall be maintained for a period of time sufficient to allow examination of all joints, connections and high stress areas.

[CGD 95–028, 62 FR 51220, Sept. 30, 1997]

RECORDS

§ 197.480 Logbooks.

(a) The person-in-charge of a vessel or facility, that is required by 46 U.S.C. 11301 to have an official logbook, shall maintain the logbook on form CG–706.

(b) The person-in-charge of a vessel or facility not required by 46 U.S.C.

11301 to have an official logbook, shall maintain, on board, a logbook for making the entries required by this subpart.

(c) The diving supervisor conducting commercial diving operations from a vessel or facility subject to this subpart shall maintain a logbook for making the entries required by this subpart.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by CGD 95–028, 62 FR 51220, Sept. 30, 1997]

§ 197.482 Logbook entries.

(a) The person-in-charge shall insure that the following information is recorded in the logbook for each commercial diving operation:

(1) Date, time, and location at the start and completion of dive operations.

(2) Approximate underwater and surface conditions (weather, visibility, temperatures, and currents).

(3) Name of the diving supervisor.

(4) General nature of work performed.

(b) The diving supervisor shall insure that the following information is recorded in the logbook for each commercial diving operation:

(1) Date, time, and location at the start and completion of each dive operation.

(2) Approximate underwater and surface conditions (weather, visibility, temperatures, and currents).

(3) Names of dive team members including diving supervisor.

(4) General nature of work performed.

(5) Repetitive dive designation or elapsed time since last hyperbaric exposure if less than 24 hours for each diver.

(6) Diving modes used.

(7) Maximum depth and bottom time for each diver.

(8) Name of person-in-charge.

(9) For each dive outside the no-decompression limits, deeper than 130 fsw, or using mixed-gas, the breathing gases and decompression table designations used.

(10) When decompression sickness or gas embolism is suspected or symptoms are evident—

(i) The name of the diver; and

(ii) A description and results of treatment.

(11) For each fatality or any diving related injury or illness that results in incapacitation of more than 72 hours or requires any dive team member to be hospitalized for more than 24 hours—

(i) The date;

(ii) Time;

(iii) Circumstances; and

(iv) Extent of any injury or illness.

(c) The diving supervisor shall insure that the following is recorded in the logbook for each diving operation deviating from the requirements of this subpart:

(1) A description of the circumstances leading to the situation.

(2) The deviations made.

(3) The corrective action taken, if appropriate, to reduce the possibility of recurrence.

(d) The diving supervisor shall insure that a record of the following is maintained:

(1) The date and results of each check of the medical kits.

(2) The date and results of each test of the air compressor.

(3) The date and results of each check of breathing mixtures.

(4) The date and results of each check of each breathing supply system.

(5) The date, equipment cleaned, general cleaning procedure, and names of persons cleaning the diving equipment for oxygen service.

(6) The date and results of each test of the breathing supply hoses and system.

(7) The date and results of each inspection of the breathing gas supply system.

(8) The date and results of each test of depth gages and timekeeping devices.

(9) The date and results of each test and inspection of each PVHO.

(10) The date and results of each inspection of the diving equipment.

(11) The date and results of each test and inspection of pressure piping.

(12) The date and results of each test and inspection of volume tanks and cylinders.

(e) The diving supervisor shall insure that a notation concerning the location of the information required under paragraph (d) is made in the logbook.

NOTE: 46 U.S.C. 11301 requires that certain entries be made in an official logbook in addition to the entries required by this section; and 46 U.S.C. 11302 prescribes the manner of making those entries.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by USCG–1999–6216, 64 FR 53229, Oct. 1, 1999]

§ 197.484 Notice of casualty.

(a) In addition to the requirements of subpart 4.05 of this chapter and 33 CFR 146.30, the person-in-charge shall notify the Officer-in-Charge, Marine Inspection, as soon as possible after a diving casualty occurs, if the casualty involves any of the following:

(1) Loss of life.

(2) Diving-related injury to any person causing incapacitation for more than 72 hours.

(3) Diving-related injury to any person requiring hospitalization for more than 24 hours.

(b) The notice required by this section must contain the following:

(1) Name and official number (if applicable) of the vessel or facility.

(2) Name of the owner or agent of the vessel or facility.

(3) Name of the person-in-charge.

(4) Name of the diving supervisor.

(5) Description of the casualty including presumed cause.

(6) Nature and extent of the injury to persons.

(c) The notice required by this section is not required if the written report required by § 197.486 is submitted within 5 days of the casualty.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by CGD 95–072, 60 FR 50469, Sept. 29, 1995]

§ 197.486 Written report of casualty.

The person-in-charge of a vessel or facility for which a notice of casualty was made under § 197.484 shall submit a report to the Officer-in-Charge, Marine Inspection, as soon as possible after the casualty occurs, as follows:

(a) On Form CG–2692, when the diving installation is on a vessel.

(b) Using a written report, in narrative form, when the diving installation is on a facility. The written report must contain the information required by § 197.484.

(c) The report required by this section must be accompanied by a copy of the report required by § 197.410(a)(9) when decompression sickness is involved.

(d) The report required by this section must include information relating to alcohol or drug involvement as required by § 4.05–12 of this chapter.

(The reporting requirement in paragraph (a) was approved by OMB under control number 1625–0001)

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by CGD 82–023, 47 FR 35748, Aug. 16, 1982; 48 FR 43328, Sept. 23, 1983; CGD 84–099, 52 FR 47536, Dec. 14, 1987; USCG–2006–25697, 71 FR 55747, Sept. 25, 2006]

§ 197.488 Retention of records after casualty.

(a) The owner, agent, or person-in-charge of a vessel or facility for which a report of casualty is made under § 197.484 shall retain all records onboard that are maintained on the vessel or facility and those records required by this subpart for 6 months after the report of a casualty is made or until advised by the Officer-in-Charge, Marine Inspection, that records need not be retained onboard.

(b) The records required by paragraph (a) of this section to be retained on board include, but are not limited to, the following:

(1) All logbooks required by § 197.480.

(2) All reports required by § 197.402(a)(2)(ii), § 197.404(a)(4), § 197.410(a)(9).

(c) The owner, agent, person-in-charge, or diving supervisor shall, upon request, make the records described in this section available for examination by any Coast Guard official authorized to investigate the casualty.

Subpart C—Benzene

SOURCE: CGD 88–040, 56 FR 52135, Oct. 17, 1991, unless otherwise noted.

§ 197.501 Applicability.

(a) Except for vessels satisfying paragraph (b) of this section, this subpart applies to all Coast Guard inspected vessels, including tank ships and barges, that are carrying benzene or benzene containing liquids in bulk as cargo.

(b) This subpart does not apply to vessels that are carrying only liquid cargoes containing less than 0.5% benzene by volume.

(c) This subpart does not apply to vessels of foreign registry.

[CGD 88–040, 56 FR 52135, Oct. 17, 1991; 56 FR 65006, Dec. 13, 1991]

§ 197.505 Definitions.

As used in this subpart—

Action level means an airborne concentration of benzene of 0.5 parts of benzene per million parts of air calculated as an eight hour time-weighted average, generated from vessels regulated by this subpart.

Authorized person means a person specifically authorized by the person in charge of the vessel to enter a regulated area.

Benzene means liquefied or gaseous benzene (C_6 H_6; Chemical Abstracts Service Registry No. 71–43–2) and includes benzene contained in liquid mixtures and the benzene vapors released by these mixtures. The term does not include trace amounts of unreacted benzene contained in solid materials.

Breathing zone means the area within one foot of a person's mouth and nose.

Employee means an individual who is on board a vessel by reason of that individual's employment and who is employed directly by the owner, charterer, managing operator, or agent of that vessel.

Employer means the owner, charterer, managing operator, or agent of a vessel.

Emergency means an occurrence, such as an equipment failure, a container rupture, or a control equipment failure, which results or may result in an unexpected release of benzene.

Operations involving benzene means any operation that could subject a worker to benzene exposures above the PEL, including cargo transfer operations involving connecting or disconnecting liquid or vapor hoses; cargo tank gauging and sampling; and cargo tank gas freeing, venting, and cleaning.

Performance standard means the standard in § 197.520.

Person in charge means—

(1) For a self propelled vessel, the master or licensed operator of the vessel; and

(2) For an unmanned barge,

(i) The licensed operator of the vessel for barge tows;

(ii) Where there is no licensed operator, the tankerman who signs the declaration of inspection for a cargo transfer for an operation involving benzene; or

(iii) Where there is no licensed operator or tankerman, the individual in charge of the vessel when it is moored at a fleet, terminal, or other place.

Permissible exposure limits or *PELs* mean the exposure limits specified in § 197.515.

Personal exposure means the concentration of airborne benzene to which a person would be exposed if that person were not using a properly fitted respirator in compliance with § 197.550 and the personal protective clothing and equipment in compliance with § 197.555.

Regulated area means an area designated in compliance with § 197.535.

Short-term exposure limit or *STEL* means an airborne concentration of five parts of benzene per million parts of air (five ppm), as averaged over any 15 minute period.

Time-weighted average exposure limit or *TWA* means an airborne concentration of one part of benzene per million parts of air (one ppm), as averaged over an eight-hour period. This eight hour period covers the time, up to eight hours, that the employee works in any 24 hour period. If the exposure period is less than eight hours within the 24 hour period, the difference between eight hours and the time of exposure (that is, the unexposed time) is averaged into the TWA. If the exposure period exceeds eight hours in any 24 hour period, sum the products of each exposure level multiplied by the time at that exposure level. The TWA is the value of that sum divided by eight hours.

Vapor control or recovery system means a system of piping and equipment used to collect vapors by transporting the vapors from a tank being loaded to a tank being unloaded or by collecting the vapors and containing them, recovering them, dispersing them in a location remote from personnel, or destroying them.

§ 197.510 Incorporation by reference.

(a) Certain materials are incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 522(a) and 1 CFR part 51. To enforce any edition other than the one listed in paragraph (b) of this section, notice of the change must be published in the FEDERAL REGISTER and the material made available to the public. All approved material is on file at Coast Guard Headquarters. Contact Commandant (CG–OES), Attn: Office of Operating and Environmental Standards, U.S. Coast Guard Stop 7509, 2703 Martin Luther King Jr. Avenue SE., Washington, DC 20593–7509. You may also contact the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. All approved material is available from the sources indicated in paragraph (b) of this section.

(b) The material approved for incorporation by reference in this subpart and the sections affected are as follows:

American National Standards Institute (ANSI)

11 West 42nd Street, New York, NY 10036

ANSI Z 88.2—1980—Practices for Respiratory Protection .....§ 197.550

[CGD 88–040, 56 FR 52135, Oct. 17, 1991, as amended by CGD 95–072, 60 FR 50469, Sept. 29, 1995; CGD 96–041, 61 FR 50735, Sept. 27, 1996; 61 FR 52497, Oct. 7, 1996; 69 FR 18803, Apr. 9, 2004; USCG–2009–0702, 74 FR 49241, Sept. 25, 2009; USCG–2012–0832, 77 FR 59789, Oct. 1, 2012; USCG–2013–0671, 78 FR 60165, Sept. 30, 2013]

§ 197.515 Permissible exposure limits (PELs).

The permissible exposure limits (PELs) for personal exposure are as follows:

(a) The time-weighted average exposure limit (TWA).

(b) The short-term exposure limit (STEL). Exposures at the STEL must not be repeated more than four times a day. There must be at least 60 minutes between successive exposures at the STEL.

§ 197.520 Performance standard.

No person may be subjected to a personal exposure in excess of the permissible exposure limits unless respiratory protection is used.

§ 197.525 Responsibility of the person in charge.

Unless otherwise specified, the person in charge shall ensure that the performance standard and other requirements of this subpart are complied with on that person's vessel.

§ 197.530 Persons other than employees.

(a) Before a nonemployee (other than Federal, state, and local government personnel) engages in a benzene operation on a vessel in which the person is likely to be exposed to benzene in excess of the PELs, that person must certify that—

(1) That person has had, within the previous 12 months, at least one medical examination in compliance with § 197.560 or 29 CFR 1910.1028;

(2) The physician who performed or who supervised the latest medical examination in compliance with paragraph (a)(1) of this section did not recommend that that person be excluded from areas where personal exposure may exceed the action level;

(3) All respirators and personal protective clothing and equipment that will be used by that person while on the vessel meet the requirements of § 197.550(b) and § 197.555(c) or of 29 CFR 1910.1028; and

(4) All respirators that will be used by that person while on the vessel have been fitted and fit tested in accordance with § 197.550 (c) and (d) or with 29 CFR 1910.1028.

NOTE: The employer need not furnish the required respirators and personal protective clothing and equipment to nonemployees.

(b) The certification required by paragraph (a) of this section must be in writing, list the items in paragraphs (a)(1) through (a)(4) of this section, reference 46 CFR 197.530, state the date of the certification, and be signed by the person making the certification. A sample certification form is contained in appendix F of this subpart.

(c) Before the nonemployee making the certification engages in a benzene operation on a vessel, that person or a representative of the entity which employs that person must show a copy of the certification to the person in charge of the vessel and the person in charge must examine the certification to ensure compliance with the requirements of this section.

§ 197.535 Regulated areas.

(a) Based on the employer's evaluation of the environmental monitoring, whenever the airborne concentration of benzene within an area exceeds or reasonably can be expected to exceed the permissible exposure limits, the person in charge shall mark the area as a regulated area.

(b) The person in charge shall restrict access to regulated areas to authorized persons wearing an appropriate respirator in compliance with § 197.550 and the personal protective clothing and equipment in compliance with § 197.555. The person in charge shall not allow any person to enter a regulated area without another individual in the vicinity to perform rescue or call for help. The second individual must maintain communication with the one entering the regulated area or keep that individual in sight. Also, the second individual must be located at the point of access during confined space entry.

(c) The boundaries of regulated areas must be indicated by barricades, other devices, or by painted areas on the vessel. A sign bearing the following legend in letters at least three inches high (except for the words ''DANGER—BENZENE'', which must be printed in letters at least 50 percent larger than the other words) must be posted at each access to the regulated areas:

DANGER—BENZENE

REGULATED AREA

CANCER CAUSING AGENT

FLAMMABLE—NO SMOKING

AUTHORIZED PERSONNEL ONLY

RESPIRATOR REQUIRED

§ 197.540 Determination of personal exposure.

(a) *General.* (1) The employer shall ensure that one or more persons in each type of operation conducted on the vessel which involves the handling of or potential exposure to benzene are monitored. The monitoring must be conducted so as to determine the representative personal exposure of all persons engaged in each particular operation involving benzene. Monitoring one vessel of a class is sufficient for all vessels of that class provided the procedures, equipment, work practices, cargo, and control equipment are substantially the same.

(2) For long duration operations, such as cargo loading or tank entry, the persons monitored must be monitored to determine the representative TWA for all persons engaged in the operation. The monitoring must be based on breathing zone air samples taken for the duration of the operation or for eight hours, whichever is less.

(3) For short duration operations, such as tank gauging or hose connection and disconnection, the persons monitored must be monitored to determine the representative short term exposure level for all persons engaged in the operation. The monitoring must be based on 15 minute breathing zone air samples. Brief period measuring devices may be used to determine whether monitoring for the short term exposure level is needed.

(4) If cargoes with different benzene concentrations are being carried on the vessel, an operation involving the lower concentration cargoes need not be monitored if the same type of operation involving the highest concentration cargo is monitored and found to be below the action level.

(5) Initial monitoring must be conducted during weather conditions typical in the geographic area and during

the time of day the operation is normally conducted. If the benzene level is above half the action level for the operation, additional monitoring must be conducted under those weather conditions that will maximize benzene exposure, such as low wind, stable air, and high temperature.

(6) The monitoring method used must be accurate to a confidence level of 95 percent to within plus or minus 25 percent for airborne concentrations of benzene equal to or greater than 0.5 ppm.

(b) *Initial exposure monitoring.* When benzene is first loaded as a cargo on board a vessel, an initial monitoring of each type of operation must be conducted to determine accurately the representative personal exposure of persons involved in the operation.

(c) *Periodic exposure monitoring.* The monitoring must be repeated each July or August if benzene containing cargoes are carried during those months; monitoring must be conducted under those weather conditions that will maximize benzene exposure, such as low wind, stable air, and high temperature. If benzene containing cargoes are not carried during those months, monitoring must be conducted at the time of carriage nearest those months; monitoring must be conducted under those weather conditions that will maximize benzene exposure, such as low wind, stable air, and high temperature.

(d) *Additional exposure monitoring.* (1) Monitoring in compliance with paragraphs (b) and (c) of this section must be repeated for the operation when there has been a change in the procedure, equipment, or work practices of the operation which may increase personal exposure or whenever the employer or person in charge has any reason to suspect that personal exposure has increased.

(2) Whenever emergencies occur that may increase personal exposure, operations affected by the emergency must be monitored using area or personal sampling after the spill is cleaned up or the leak, rupture, or other breakdown is repaired to determine when personal exposure has returned to the level that existed before the emergency. There must be monitoring equipment aboard each ship.

(3) For those cases in which the benzene exposure can vary significantly over the year, the personnel exposure reduction plan can reflect this variation in time if both initial and periodic exposure monitoring are conducted at those times. There must be sufficient monitoring to quantitatively justify differences in the exposure reduction program over the course of the year. The exposure monitoring must be conducted under those weather conditions that will maximize benzene exposure, such as low wind, stable air, and high temperature.

(4) The Coast Guard may require additional monitoring upon reasonable belief that the PEL's are being exceeded.

(e) *Notification of exposure monitoring results.* (1) Within 60 working days after the receipt of the results of monitoring in compliance with this section, each person involved in the operation monitored must be given written notice of the results, either by separate letter or by notice posted in a location accessible to all persons involved.

(2) If the results indicate that the PELs were exceeded, the written notice required by paragraph (e)(1) of this section must state, or refer to a document available to the persons involved which states, the corrective action to be taken to reduce the personal exposure to or below the PELs.

[CGD 88–040, 56 FR 52135, Oct. 17, 1991; 56 FR 65006, Dec. 13, 1991; CGD 95–028, 62 FR 51221, Sept. 30, 1997]

§ 197.545 Program to reduce personal exposure.

(a) When personal exposure for an operation is over the applicable PEL as determined in compliance with § 197.540, the employer shall develop and implement, within 60 working days of the date of that determination, a written program detailing the corrective actions that will be taken to reduce personal exposure to or below the PEL's. The written program must include a timeframe for implementing the corrective actions to be taken.

(b) Corrective actions in compliance with paragraph (a) of this section may include, but are not limited to, one or more of the following:

(1) Engineering controls (e.g. vapor control or recovery systems, closed loading systems, or controlled venting systems);

(2) Revised work practices; or

(3) Respirators in compliance with § 197.550 and personal protective clothing and equipment in compliance with § 197.555.

(c) Whenever the exposure monitoring data show a significant increase in personnel exposure, the program must be revised to reflect the new data.

(d) Each person involved in the operation must be notified that a written program detailing corrective actions is available upon request.

(e) A copy of the written program must be furnished upon request to the Coast Guard.

§ 197.550 Respiratory protection.

(a) *General*. When the use of respirators in compliance with this section and the personal protective clothing and equipment in compliance with § 197.555 is chosen as the method or one of the methods in compliance with § 197.545 to be used in meeting the performance standard, the respirators used must be selected and fitted according to this section.

(b) *Respirator selection*. (1) The respirator must be approved by the Mine Safety and Health Administration (MSHA) in compliance with 30 CFR part 11. When filter elements are used, they must include MSHA approval for organic vapors or benzene.

(2) The employer shall provide affected employees with the appropriate respirators without charge and ensure that the respirators are used properly. Any employee determined by the testing physician as being unable to wear negative pressure respirators, who continues to be subject to exposure over the PEL, must be given the option of wearing a respirator with less breathing resistance, such as a powered air-purifying respirator or a supplied air respirator.

(3) Electrically powered respiratory protective equipment must meet the electrical engineering requirements in subchapter J of this chapter and the electrical equipment requirements in part 151, table 151.05, and part 153, table 1, of this chapter.

(4) The type of respirator provided must be a type specified in table 197.550(b) of this section that is appropriate for the exposure.

TABLE 197.550(b)—RESPIRATORY PROTECTION FOR BENZENE

Airborne concentration of benzene or condition of use	Respirator type
Up to 10 times the TWA	(1) Half-mask air-purifying respirator with organic vapor cartridges.
Up to 50 times the TWA	(1) Full facepiece respirator with organic vapor cartridges. (2) Full facepiece gas mask with chin style canister. [1]
Up to 100 times the TWA	(1) Full facepiece powered air purifying respirator with organic vapor canister. [1]
Up to 1,000 times the TWA	(1) Supplied air respirator with full facepiece in positive-pressure mode.
More than 1,000 times the TWA or unknown concentration.	(1) Self-contained breathing apparatus with full facepiece in positive pressure mode. (2) Full facepiece positive-pressure supplied-air respirator with auxiliary self-contained air supply.
Escape	(1) Any organic vapor gas mask. (2) Any self-contained breathing apparatus with full facepiece
Fire fighting	(1) Full facepiece self-contained breathing apparatus in positive pressure mode.

[1] Canisters for non-powered air purifying respirators must have a minimum service life of four hours when tested at 150 ppm benzene, at a flow rate of 64 liters/minute at 25 °C and 85% relative humidity. Canisters for powered air-purifying respirators must have a flow rate of 115 liters/minute (for tight fitting respirators) or 170 liters/minute (for loose fitting respirators).

(c) *Respirator fit testing*. (1) Before the person is permitted to use a respirator selected and fitted in compliance with this section, the person must undergo an Initial Fit Test (IFT) and either a Qualitative Fit Test (QLFT) or a Quantitative Fit Test (QNFT), in compliance with Appendix E of this subpart, using the respirator fitted. If a negative pressure respirator is used, the QLFT or QNFT must be repeated at least once a year thereafter.

(2) The objective of the tests is to identify for the person a respirator which minimizes the chance of leakage.

(3) The person conducting the tests required by paragraph (c)(1) of this section must understand the purpose of these tests and how to perform them.

(4) The person conducting the tests required by paragraph (c)(1) of this section must certify the results by signing the test report.

(d) *Respirator fitting.* (1) Employees who are being fitted for respirators must be trained in the methods for properly fitting a respirator and informed of the factors which may affect a proper fit, such as beards, sideburns, dentures, eyeglasses, and goggles, and that an unobstructed sealing surface is critical in fitting a respirator. (See appendix E of this subpart).

(2) For employees requiring eye glasses, corrective lenses should be fitted to the respirator faceplate. As a temporary measure, glasses with short temple bars may be taped to the wearer's head. Contact lenses other than soft lenses or gas permeable lenses must not be worn with respirators.

(e) *Respirator use.* Persons wearing a respirator in a regulated area must be permitted to leave the regulated area to wash their face and respirator facepiece, as necessary, in order to prevent skin irritation associated with respirator use or, if an air-purifying respirator is used, to change the filter elements whenever the person wearing the respirator detects a change in breathing resistance or a chemical vapor breakthrough.

(f) *Respirator inspection.* Respirators must be inspected in accordance with ANSI Z88.2—1980, section 8.

(g) *Respirator maintenance.* (1) Respirators must be maintained in accordance with ANSI Z88.2—1980, section 8.

(2) During respirator cleaning, the rubber or elastomer parts of the respirator must be stretched and manipulated with a massaging action to keep the parts pliable and flexible and to keep the parts from taking a set during storage.

(3) The air purifying element of air-purifying respirators must be replaced when the employee detects breakthrough or after a period not to exceed eight hours, whichever comes first. The element must also be replaced at the start of each shift. An air purifying element with an end of useful life indicator approved by MSHA or NIOSH for benzene may be used until the indicator indicates end of useful life even if this exceeds eight hours.

(h) *Respirator storage.* Respirators must be stored in accordance with ANSI Z88.2—1980, section 8.

[CGD 76–009, 43 FR 53683, Nov. 16, 1978, as amended by USCG–2014–0688, 79 FR 58289, Sept. 29, 2014]

§ 197.555 Personal protective clothing and equipment.

(a) When the use of respirators in compliance with § 197.550 and the personal protective clothing and equipment in compliance with this section is chosen as the method or one of the methods required by § 197.545 to be used in meeting the performance standard, the clothing and equipment must meet the requirements of this section.

(b) The employer shall provide employees with the necessary personal protective clothing and equipment without charge and shall ensure that the clothing and equipment are worn or used properly.

(c) Employees must be provided with coveralls or a large apron, boots, gloves, and, if necessary, tight-fitting eye goggles to limit dermal exposure to, and prevent eye contact with, liquid benzene.

§ 197.560 Medical surveillance.

(a) *General.* (1) The employer must provide, and the employees must submit to, the medical surveillance examinations for employees, as required by this section.

(2) All medical surveillance procedures in compliance with this section, other than the pulmonary function test of paragraph (b)(5)(v) of this section and all laboratory tests, must be performed by, or under the supervision of, a licensed physician.

(3) The pulmonary function test of paragraph (b)(5)(v) of this section must be administered by a licensed physician or by a person who has completed a training course in spirometry sponsored by a governmental, academic, or professional institution.

(4) All laboratory tests must be conducted by a laboratory accredited by an accrediting organization acceptable to the Commandant.

(b) *Initial medical examination.* (1) Within March 14, 1992 the employer shall make available to the employees

listed in paragraph (b)(2)(i) of this section an initial medical examination. Within six months all initial medical examinations must be completed, including those for the employees listed in paragraph (b)(2)(ii), and each employee notified of the results of that employee's examination.

(2) The initial medical examination must be made available to the following employees before they are permitted to enter or continue working in a workplace in which they will be or may be exposed to benzene:

(i) Employees who were exposed to more than 10 ppm of benzene as an eight-hour TWA on at least 30 calendar days during the year before January 15, 1992 and who were employed by their present employer during each of the 30 days.

(ii) Employees, other than employees defined in paragraph (b)(2)(i) of this section, who may reasonably be expected to be exposed to benzene at or above the action level on at least 30 calendar days, or at a level above a PEL on at least 10 calendar days, during the coming year.

(3) Exposure to benzene, as referred to in paragraph (b)(2) of this section, means any exposure to benzene, whether or not at the time of the exposure, the employee was or will be wearing an appropriate respirator in compliance with § 197.550 and the personal protective clothing and equipment in compliance with § 197.555.

(4) An initial medical examination is not required if the employer or employee has adequate records showing that the employee has had, within one year, an examination meeting the requirements of paragraph (b)(5) of this section.

(5) The initial medical examination must include at least the following elements:

(i) A detailed occupational history which includes a history of past work exposure to benzene or any other hematological toxin, a family history of blood dyscrasias including hematological neoplasms, a history of blood dyscrasias including genetic hemoglobin abnormalities, bleeding abnormalities, and abnormal functions of formed blood elements, a history of renal or liver dysfunction, a history of medicinal drugs routinely taken, a history of previous exposure to ionizing radiation, and a history of exposure to marrow toxins outside of the employee's current work situation. The employee must provide to the examining physician as complete an occupational history as possible for the period prior to the current employment.

(ii) A complete physical examination.

(iii) A complete blood count, including a leukocyte count, with differential, quantitative thrombocyte count, hematocrit, hemoglobin, erythrocyte count. and erythrocyte indices (MCV, MCH, MCHC). The results of these tests must be reviewed by the examining physician.

(iv) As determined necessary by the examining physician, additional tests based on alterations to the components of the blood or other signs which may be related to benzene exposure.

(v) For employees required to wear respirators for at least 30 days a year, a pulmonary function test.

(c) *Periodic medical examinations.* (1) The employer shall ensure that no one performs a benzene operation exceeding the level criteria of paragraph (b)(2) of this section without having undergone an initial medical examination and periodic medical examinations yearly thereafter. Also, those who in the previous year have performed benzene operations exceeding the level criteria of paragraph (b)(2) of this section shall undergo a periodic medical examination even if they will not perform benzene operations in the current year. Periodic examinations must include, at least, the following elements:

(i) A brief history regarding new exposure to potential marrow toxins, changes in medicinal drug use, and the appearance of physical signs relating to blood disorders.

(ii) A complete blood count, including a leukocyte count with differential, quantitative thrombocyte count, hematocrit, hemoglobin, erythrocyte count, and erythrocyte indices (MCV, MCH, MCHC). The results of these tests must be reviewed by the examining physician.

(iii) As determined necessary by the examining physician, additional tests based on alterations to the components

of the blood or other signs which may be related to benzene exposure.

(2) If the employee develops signs and symptoms commonly associated with toxic exposure to benzene, the employee must be provided with an additional medical examination which includes those elements considered appropriate by the examining physician.

(3) For employees required to use respirators for at least 30 days a year, a pulmonary function test must be performed, and specific evaluation of the cardiopulmonary system must be made, at least every three years.

(d) *Additional examinations and referrals.* (1) If the results of the complete blood count laboratory test required for the initial or periodic medical examination indicate that any of the following abnormal conditions exist, the blood count must be retaken within four weeks:

(i) The hemoglobin or the hematocrit falls below the normal limit (outside the 95% confidence interval (C.I.)), as determined by the laboratory, or the hemoglobin or hematocrit shows a persistent downward trend from the employee's pre-exposure norms, if these findings cannot be explained by other medical reasons.

(ii) The thrombocyte count varies more than 20 percent below the employee's most recent values or falls outside the normal limit (95% C.I.), as determined by the laboratory.

(iii) The leukocyte count is below 4,000 per cubic millimeter or there is an abnormal differential count.

(2) If the abnormal conditions persist, the employee must be referred by the examining physician to a hematologist or an internist for further evaluation, unless the physician has good reason to believe that the referral is unnecessary. (See appendix C of this subpart for examples of conditions in which referrals may be unnecessary.)

(3) The hematologist or internist must be provided with the information provided to the physician in compliance with paragraph (f) of this section and with the medical record in compliance with § 197.570(b).

(4) If the hematologist or internist determines that additional tests are needed, the employer shall ensure that these additional tests are provided. These test must be completed in thirty days, whether or not the employee continues to perform benzene operations.

(e) *Emergency medical examinations.* (1) Whenever an employee is exposed to benzene resulting from an emergency, a sample of that employee's urine must be taken at the end of the employee's shift and a urinary phenol test must be performed on the sample within 72 hours. Where due to unavoidable circumstances the sample cannot be tested by a laboratory within 72 hours of exposure, the sample shall be frozen until it can be delivered to the laboratory. The specific gravity of the urine must be corrected to 1.024. Since certain foods and medications can result in elevated phenol levels, the employee must provide the physician with a dietary and medication history.

(2) If the result of the urinary phenol test is below 75 mg phenol/l of urine, no further testing is required.

(3) If the result of the urinary phenol test is equal to or greater than 75 mg phenol/l of urine, the employee's complete blood count including an erythrocyte count, a leukocyte count with differential, and a thrombocyte count must be taken at monthly intervals for a duration of three months following the emergency.

(4) If any of the conditions specified in paragraph (d)(1) of this section exists, the additional examinations and referrals specified in paragraph (d) of this section must be performed and the employee must be provided with periodic medical examinations, if any are recommended by the examining physician.

(f) *Information provided to the physician.* The following information must be provided to the examining physician:

(1) A copy of this subpart and its appendices.

(2) A description of the affected employee's duties as they relate to the employee's exposure.

(3) The employee's actual or representative exposure level.

(4) A description of the respirator and personal protective clothing and equipment used or to be used, if any.

(5) Records of all previous employment-related medical examinations of

the affected employee which were conducted while in the employ of the current employer and which have not been provided to the examining physician.

(g) *Physician's written opinion.* (1) The employer shall ensure that, within 45 days of each examination required by this section, the employer and the employee must be provided with a copy of the examining physician's written opinion of the examination.

(2) The written opinion must contain at least the following information:

(i) The occupationally pertinent results of the medical examination and tests.

(ii) All medical conditions, if any, of the employee which the examining physician believes would subject the employee to a greater than normal risk of material impairment of health if the employee is exposed again to benzene.

(iii) The examining physician's recommended limitations, if any, upon the employee's future exposure to benzene or use of respirators or other personal protective clothing or equipment.

(iv) A statement that the employee has been informed by the physician of the results of the medical examination and of all medical conditions of the employee resulting from benzene exposure which require further explanation or treatment.

(3) The physician's written opinion must not reveal specific records, findings, or diagnoses that have no bearing on the employee's ability to work in a benzene-exposed workplace, ability to use a respirator, or ability to use personal protective clothing or equipment.

(h) *Removal from exposure.* (1) From the time an employee is referred to a hematologist or internist in compliance with paragraph (d)(2) of this section, the employee must not be permitted to enter areas where personal exposure may exceed the action level until the physician determines in compliance with paragraph (h)(2) of this section that the employee again may enter those areas.

(2) After examination by and consultation with the hematologist or internist, the examining physician decides whether or not to permit the employee to enter areas where personal exposure may exceed the action level. The employee must provide the employer with a written copy of the physician's decision signed by the physician. If the decision recommends that the employee not be permitted to enter those areas, the decision must include the examining physician's opinion as to when the employee may be permitted to reenter those areas and the requirements for future medical examinations to review the decision.

(3) Within six months of the date a decision in compliance with paragraph (h)(2) of this section not to permit reentry is made, the employee must be provided with a follow-up examination and a decision of the examining physician (based on the follow-up examination and consultation with a hematologist or internist) as to whether reentry should be permitted and, if so, when, or whether it should be permanently prohibited.

[CGD 88–040, 56 FR 52135, Oct. 17, 1991; 56 FR 65006, Dec. 13, 1991, as amended by USCG–2014–0688, 79 FR 58289, Sept. 29, 2014]

§ 197.565 Notifying personnel of benzene hazards.

(a) *Material safety data sheet.* A material safety data sheet (MSDS) addressing benzene must be made available to all persons involved in the benzene operation. The MSDS must describe the physical and chemical characteristics, physical and health hazards, permissible exposure limits, precautions for safe handling and use, control measures such as personal protection equipment, and first aid procedures for benzene. A copy of appendices A and B of this subpart or a MSDS on benzene meeting the requirements of 29 CFR 1910.1200(g) is sufficient.

(b) *Training.* (1) All employees must be provided with training at the time of their initial assignment to a work area where benzene is present and, if exposures are above the action level, at least once a year thereafter. Employees transferring to a new work area must be provided with training specific to that new work area.

(2) The training must provide information on—

(i) Which operations on the vessel involve or may involve exposure to benzene;

(ii) The methods and observations that may be used to detect the presence or release of benzene;

(iii) The physical and health hazards associated with exposure to benzene;

(iv) The measures that may be taken and the equipment that may be used to protect persons from the hazards of benzene exposure;

(v) The proper selection, fitting, fit testing, and use of personal protective equipment in emergency situations;

(vi) The meaning of a regulated area and the means specified in § 197.535(c) to indicate a regulated area;

(vii) The contents of this subpart and of appendices A through E of this subpart and on where copies of this material are available; and

(viii) The medical surveillance program specified in § 197.560.

§ 197.570 Recordkeeping.

(a) *Record of personal exposure monitoring.* (1) The employer shall maintain an accurate record of all monitoring conducted in compliances with § 197.540 for three years.

(2) The record must include—

(i) The dates, number, duration, and results of each sample taken, and a description of the procedure used to determine representative personal exposures;

(ii) A description of the sampling and analytical methods used;

(iii) A description of the type of respirator and personal protective clothing and equipment worn, if any; and

(iv) The name, social security number, and job classification of each person monitored and of all other persons whose exposure the monitoring is intended to represent; and

(v) The exposure levels to which monitored persons were subjected, even if this level is below the PEL.

(b) *Medical record.* (1) The employer shall maintain an accurate medical record for each employee subjected to medical surveillance specified in § 197.560 for three years after the employee's employment is terminated.

(2) The record must include—

(i) The name and social security number of the employee;

(ii) The physician's written opinion on the initial, periodic, and special examinations of the employee, including the results of medical examinations and tests and all opinions and recommendations;

(iii) A list of medical complaints, if any, by the employee related to exposure to benzene;

(iv) A copy of the information provided to the physician required in § 197.560(f)(2) through (f)(5); and

(v) A copy of the employee's medical and work history related to exposure to benzene or other hematologic toxin.

(c) *Availability of records.* (1) All records required to be maintained by this section must be made available upon request to the Coast Guard.

(2) Records of personal exposure monitoring in compliance with (a) of this section must be provided upon request to persons involved in the operation.

(3) A copy of each item entered into the medical record in compliance with paragraph (b) of this section for a particular employee must be given to that employee at the time the item is entered into the medical record.

(4) Medical records required by paragraph (b) of this section must be provided to persons upon the written request of the subject employee.

(d) *Transfer of records.* (1) If the employer ceases to do business and there is no successor to receive and retain the records for the prescribed period, the employer shall make the best effort to transfer all records required in paragraphs (a) and (b) of this section relating to the affected employees to those employees for their disposition. Before transferring medical records to former employees, the employer shall determine whether any forwarding address provided by the employee is still valid and whether the employee desires the records. If a current or former employee refuses to accept the records or does not respond to notification of their availability, the records shall be destroyed.

(2) If the employer ceases to engage in operations involving benzene, the employer shall retain the records for inspection unless the employee requests them as provided in § 197.570(c).

(e) *Confidentiality of records.* Except as specifically required by this Subpart, the employer shall keep confidential all records required to be maintained by this Subpart.

§ 197.575 Observation of monitoring.

(a) Persons involved in benzene operations or their representatives must be provided with an opportunity to observe all monitoring in compliance with § 197.540. Coast Guard officials may also observe all monitoring in compliance with § 197.540.

(b) When observation of monitoring requires entry into regulated areas, the observers shall use respirator and personal protective clothing and equipment approved in compliance with this subpart and comply with § 197.530.

§ 197.580 Appendices.

(a) Appendices A through D and F of this subpart contain technical information on benzene and its effects and provide guidance for medical surveillance, monitoring, and measuring. The appendices are informational and advisory and do not create mandatory requirements.

(b) Appendix E of this subpart contains tests and procedures for fitting respirators. As required by § 197.550(d)(1), compliance with appendix E of this subpart is mandatory.

APPENDIX A TO SUBPART C OF PART 197—SAMPLE SUBSTANCE SAFETY DATA SHEET, BENZENE

I. Substance Identification

(a) *Substance:* Benzene.

(b) *Performance standard exposure limits:*

(1) Airborne: The maximum time-weighted average (TWA) exposure limit is one part of benzene vapor per million parts of air (one ppm) for an eight-hour workday and the maximum short-term exposure limit (STEL) is five ppm for any 15-minute period.

(2) Dermal: Eye contact must be prevented and skin contact with liquid benzene must be limited.

(c) *Appearance and odor:* Benzene is a clear, colorless liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

II. Health Hazard Data

(a) *Ways in which benzene affects your health.* Benzene can affect your health if you inhale it or if it comes in contact with your skin or eyes. Benzene is also harmful if you swallow it.

(b) *Effects of overexposure.* (1) Short-term (acute) overexposure: If you are overexposed to high concentrations of benzene, well above the levels where its odor is first recognizable, you may feel breathless, irritable, euphoric, or giddy and you may experience irritation in your eyes, nose, and respiratory tract. You may develop a headache, feel dizzy, nauseated, or intoxicated. Severe exposures may lead to convulsions and loss of consciousness.

(2) Long-term (chronic) exposure: Repeated or prolonged exposure to benzene, even at relatively low concentrations, may result in various blood disorders ranging from anemia to leukemia, an irreversible, fatal disease. Many blood disorders associated with benzene exposure may occur without symptoms.

III. Protective Clothing and Equipment

(a) *Respirators.* Respirators are required for those operations in which engineering controls or work practice controls are not feasible for reducing exposure to the permissible level or are not chosen as the method of complying with the performance standard. If respirators are worn, they must have joint Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) seal of approval. Cartridges or canisters must be replaced before the end of their service life, or the end of the shift, whichever occurs first. If you experience difficulty breathing while wearing a respirator, you may request a positive pressure respirator from your employer. You must be thoroughly trained to use the assigned respirator, and the training will be provided by your employer.

(b) *Protective clothing.* You must wear appropriate protective clothing (such as boots, gloves, sleeves, and aprons) over any parts of your body that could be exposed to liquid benzene.

(c) *Eye and face protection.* You must wear splash-proof safety goggles if it is possible that benzene may get into your eyes. In addition, you must wear a face shield if your face could be splashed with benzene liquid.

IV. Emergency and First Aid Procedures

(a) *Eye and face exposure.* If benzene is splashed in your eyes, wash it out immediately with large amounts of water. If irritation persists or vision appears to be affected, see a doctor as soon as possible.

(b) *Skin exposure.* If benzene is spilled on your clothing or skin, remove the contaminated clothing and wash the exposed skin with large amounts of water and soap immediately. Wash contaminated clothing before you wear it again.

(c) *Breathing.* If you or any other person breathes in large amounts of benzene, get the exposed person to fresh air at once. Apply artificial respiration if breathing has stopped. Call for medical assistance or a doctor as soon as possible. Never enter any vessel or confined space where the benzene concentration might be high without proper safety equipment and with at least one other

person present who will stay outside. A life line should be used.

(d) *Swallowing.* If benzene has been swallowed and the subject is conscious, do not induce vomiting. Call for medical assistance or a doctor immediately.

V. Medical Requirements

If you will be exposed to benzene at a concentration at or above 0.5 ppm as an eight-hour time-weighted average or have been exposed at or above 10 ppm in the past while employed by your current employer, your employer may be required by 46 CFR 197.560 to provide a medical examination and history and laboratory tests. These tests must be provided without cost to you. In addition, if you are accidentally exposed to benzene (either by ingestion, inhalation, or skin/eye contact) under emergency conditions known or suspected to constitute a toxic exposure to benzene, your employer is required to make special laboratory tests available to you.

VI. Observation of Monitoring

The employer is required to conduct monitoring that is representative of your exposure to benzene, and you or your designated representative are entitled to observe the monitoring procedure. You are entitled to observe the steps taken in the measurement procedure and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you or your representative must wear the protective clothing and equipment (See 46 CFR 197.575.)

VII. Access to Records

You or your representative may see the records of monitoring of your exposure to benzene upon written request to your employer. Your medical examination records may be furnished to you, your physician, or a representative designated by you. (See 46 CFR 197.570(c).)

VIII. Precautions for Safe Use, Handling, and Storage

Benzene liquid is highly flammable. Benzene vapor may form explosive mixtures in air. All sources of ignition must be controlled. Use non-sparking tools when opening or closing benzene containers. Fire extinguishers, where required, must be readily available. Know where they are located and how to operate them. Smoking is prohibited in areas where benzene is used or stored.

APPENDIX B TO SUBPART C OF PART 197—SUBSTANCE TECHNICAL GUIDELINES, BENZENE

I. Physical and Chemical Data

(a) *Substance identification.* (1) Synonyms: Benzol, benzole, coal naphtha, cyclohexatriene, phene, phenyl hydride, pyrobenzol. (Benzin, petroleum benzin, and benzine do not contain benzene).

(2) Formula: C_6 H_6 (CAS Registry Number: 71–43–2).

(b) *Physical data.* (1) Boiling point (760 mm Hg): 80.1 °C (176 °F).

(2) Specific gravity (water = 1): 0.879.

(3) Vapor density (air = 1): 2.7.

(4) Melting point: 5.5 °C (42 °F).

(5) Vapor pressure at 20 °C (68 °F): 75 mm Hg.

(6) Solubility in water: .06%.

(7) Evaporation rate (ether = 1): 2.8.

(8) Appearance and odor: Clear, colorless liquid with a distinctive sweet odor.

II. Fire, Explosion, and Reactivity Hazard Data

(a) *Fire.* (1) Flash point (closed cup): −11 °C (12 °F).

(2) Autoignition temperature: 580 °C (1076 °F).

(3) Flammable limits in air, % by volume: Lower: 1.3%, Upper: 7.5%.

(4) Extinguishing media: Carbon dioxide, dry chemical, or foam.

(5) Special fire fighting procedures: Do not use a solid stream of water, because it will scatter and spread the fire. Fine water spray may be used to keep fire-exposed containers cool.

(6) Unusual fire and explosion hazards: Benzene is a flammable liquid. Its vapors can form explosive mixtures. All ignition sources must be controlled when benzene is used, handled, or stored. Areas where liquid or vapor may be released are considered hazardous locations. Benzene vapors are heavier than air. Thus, benzene vapors may travel along the deck and ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

(7) Benzene is classified as a flammable liquid for the purpose of conforming to the requirements of 49 CFR 172.101 concerning the designation of materials as hazardous materials. Locations where benzene may be present in quantities sufficient to produce explosive or ignitable mixtures are considered Class I Group D locations for the purposes of conforming to the requirements of 46 CFR parts 30 through 40, 151, and 153 when determining the requirements for electrical equipment as specified in Subchapter J (Electrical engineering).

(b) *Reactivity.* (1) Conditions contributing to instability: Heat.

(2) Incompatibility: Heat and oxidizing materials.

(3) Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide).

III. Spill and Leak Procedures

(a) *Steps to be taken if the material is released or spilled.* As much benzene as possible should be absorbed with suitable materials, such as dry sand or earth. That remaining must be flushed with large amounts of water. Do not flush benzene into a confined space, such as a sewer, because of explosion danger. Remove all ignition sources. Ventilate enclosed places.

(b) *Waste disposal method.* Disposal methods must conform to state and local regulations. If allowed, benzene may be disposed of (a) by absorbing it in dry sand or earth and disposing in a sanitary landfill, (b), if in small quantities, by removing it to a safe location away from buildings or other combustible sources or by pouring onto dry sand or earth and cautiously igniting it, and (c), if in large quantities, by atomizing it in a suitable combustion chamber.

APPENDIX C TO SUBPART C OF PART 197—MEDICAL SURVEILLANCE GUIDELINES FOR BENZENE

I. Route of Entry

Inhalation; skin absorption.

II. Toxicology

Benzene is primarily an inhalation hazard. Systemic absorption may cause depression of the hematopoietic system, pancytopenia, aplastic anemia, and leukemia. Inhalation of high concentrations may affect the functioning of the central nervous system. Aspiration of small amounts of liquid benzene immediately causes pulmonary edema and hemorrhage of pulmonary tissue. There is some absorption through the skin. Absorption may be more rapid in the case of abraded skin or if it is present in a mixture or as a contaminant in solvents which are readily absorbed. The defatting action of benzene may produce primary irritation due to repeated or prolonged contact with the skin. High concentrations are irritating to the eyes and the mucous membranes of the nose and respiratory tract.

III. Signs and Symptoms

Direct skin contact with benzene may cause erythema. Repeated or prolonged contact may result in drying, scaling dermatitis or development of secondary skin infections. In addition, benzene is absorbed through the skin. Local effects of benzene vapor or liquid on the eye are slight. Only at very high concentrations is there any smarting sensation in the eye. Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation, or giddiness, followed by a period of depression, drowsiness, or fatigue. A sensation of tightness in the chest accompanied by breathlessness may occur and ultimately the victim may lose consciousness. Tremors, convulsions, and death may follow from respiratory paralysis or circulatory collapse in a few minutes to several hours following severe exposures.

The detrimental effect on the blood-forming system of prolonged exposure to small quantities of benzene vapor is of extreme importance. The hematopoietic system is the chief target for benzene's toxic effects which are manifested by alterations in the levels of formed elements in the peripheral blood. These effects may occur at concentrations of benzene which may not cause irritation of mucous membranes or any unpleasant sensory effects. Early signs and symptoms of benzene morbidity are varied. Often, they are not readily noticed and are non-specific. Complaints of headache, dizziness, and loss of appetite may precede or follow clinical signs. Rapid pulse and low blood pressure, in addition to a physical appearance of anemia, may accompany a complaint of shortness of breath and excessive tiredness. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots (small bruises) may occur as the condition progresses. Clinical evidence of leukopenia, anemia, and thrombocytopenia, singly or in combination, may be among the first signs.

Bone marrow may appear normal, aplastic, or hyperplastic and may not, in all situations, correlate with peripheral blood forming tissues. Because of variations in the susceptibility to benzene morbidity, there is no ''typical'' blood picture. The onset of effects of prolonged benzene exposure may be delayed for many months or years after the actual exposure has ceased. Identification or correlation with benzene exposure must be sought out in the occupational history.

IV. Treatment of Acute Toxic Effects

Remove from exposure immediately. Make sure you are adequately protected and do not risk being overcome by fumes. Give oxygen or artificial resuscitation, if indicated. Flush eyes, wash skin if contaminated, and remove all contaminated clothing. Symptoms of intoxication may persist following severe exposures. Recovery from mild exposures is usually rapid and complete.

V. Surveillance and Preventive Considerations

(a) *General.* The principal effects of benzene exposure addressed in 46 CFR part 197, subpart C, appendix A, are pathological changes in the hematopoietic system, reflected by changes in the peripheral blood and manifested clinically as pancytopenia, aplastic anemia, or leukemia. Consequently, the

medical surveillance program specified in 46 CFR 197.560 is designed to observe, on a regular basis, blood indices for early signs of these effects. Although early signs of leukemia are not usually available, emerging diagnostic technology and innovative regimes are making consistent surveillance for leukemia, as well as other hematopoietic effects, more and more beneficial.

Initial and periodic medical examinations must be provided as required in 46 CFR 197.560. There are special provisions for medical tests in the event of hematologic abnormalities or emergencies.

The blood values which require referral to a hematologist or internist are noted in 46 CFR 197.560(d) (i), (ii), and (iii). That section specifies that, if blood abnormalities persist, the employee must be referred unless the physician has good reason to believe that the referral is unnecessary. Examples of conditions that might make a referral unnecessary despite abnormal blood limits are iron or folate deficiency, menorrhagia, or blood loss due to some unrelated medical abnormality.

Symptoms and signs of benzene toxicity can be non-specific. Only a detailed history and appropriate investigative procedures will enable a physician to rule out or confirm conditions that place the employee at increased risk. To assist the examining physician with regard to which laboratory tests are necessary and when to refer an employee to the specialist, the following guidelines have been established.

(b) *Hematology Guidelines.* A minimum battery of tests is to be performed by strictly standardized methods.

(1) Red cell, white cell, platelet counts, white blood cell differential, hematocrit, and red cell indices must be performed by an accredited laboratory. The normal ranges for the red cell and white cell counts are influenced by altitude, race, and sex and, therefore, should be determined by an accredited laboratory in the specific area where the tests are performed.

Either a decline from an absolute normal or from an individual's base line to a subnormal value or a rise to a supra-normal value are indicative of potential toxicity, particularly if all blood parameters decline. The normal total white blood count is approximately 7,200/mm^3 plus or minus 3,000. For cigarette smokers, the white count may be higher and the upper range may be 2,000 cells higher than normal for the laboratory. In addition, infection, allergies, and some drugs may raise the white cell count. The normal platelet count is approximately 250,000 with a range of 140,000 to 400,000. Counts outside this range should be regarded as possible evidence of benzene toxicity.

Certain abnormalities found through routine screening are of greater significance in the benzene-exposed worker and require prompt consultation with a specialist, namely:

(i) Thrombocytopenia.

(ii) A trend of decreasing white cell, red cell, or platelet indices in an individual over time is more worrisome than an isolated abnormal finding at one test time. The importance of a trend highlights the need to compare an individual's test results to baseline, to previous periodic tests, or to both.

(iii) A constellation or pattern of abnormalities in the different blood indices is of more significance than a single abnormality. A low white count not associated with any abnormalities in other cell indices may be a normal statistical variation. Whereas, if the low white count is accompanied by decreases in the platelet and/or red cell indices, such a pattern is more likely to be associated with benzene toxicity and merits thorough investigation.

Anemia, leukopenia, macrocytosis, or an abnormal differential white blood cell count should alert the physician to investigate further and to refer the patient if repeat tests confirm the abnormalities. If routine screening detects an abnormality, the follow-up tests which may be helpful in establishing the etiology of the abnormality are the peripheral blood smear and the reticulocyte count.

The extreme range of normal for reticulocytes is 0.4 to 2.5 percent of the red cells. The usual range is 0.5 to 1.2 percent of the red cells. A decline in reticulocytes to levels of less than 0.4 percent is to be regarded as possible evidence of benzene toxicity requiring accelerated surveillance (unless another specific cause is found). An increase in reticulocyte levels to above 2.5 percent also may be consistent with, but not characteristic of, benzene toxicity.

(2) A careful examination of the peripheral blood smear is an important diagnostic test. As with the reticulocyte count, the smear should be with fresh uncoagulated blood obtained from a needle tip following venipuncture or from a drop of earlobe blood (capillary blood). If necessary, the smear may, under certain limited conditions, be made from a blood sample anticoagulated with EDTA (but never with oxalate or heparin). When the smear is to be prepared from a specimen of venous blood which has been collected by a commercial Vacutainer® type tube containing neutral EDTA, the smear should be made as soon as possible after the venesection. A delay of up to 12 hours is permissible between the drawing of the blood specimen into EDTA and the preparation of the smear if the blood is stored at refrigerator (not freezing) temperature.

(3) The minimum mandatory observations to be made from the smear are as follows:

(i) The differential white blood cell count.

(ii) Description of abnormalities in the appearance of red cells.

(iii) Description of any abnormalities in the platelets.

(iv) A careful search must be made of every blood smear for immature white cells such as band forms (in more than normal proportion, *i.e.*, over ten percent of the total differential count), any number of metamyelocytes, myelocytes, or myeloblasts. Any nucleate or multinucleated red blood cells should be reported. Large ''giant'' platelets or fragments of megakaryocytes must be recognized.

An increase in the proportion of band forms among the neutrophilic granulocytes is an abnormality deserving special mention. Such an increase may represent a change which should be considered as an early warning of benzene toxicity in the absence of other causative factors (most commonly infection). Likewise, the appearance of metamyelocytes, in the absence of another probable cause, is to be considered a possible indication of benzene-induced toxicity.

An upward trend in the number of basophils, which normally do not exceed about 2.0 percent of the total white cells, is to be regarded as possible evidence of benzene toxicity. A rise in the eosinophil count is less specific but may indicate toxicity if the rise is above 6.0 percent of the total white count.

The normal range of monocytes is from 2.0 to 8.0 percent of the total white count with an average of about 5.0 percent. About 20 percent of individuals reported to have mild but persisting abnormalities caused by exposure to benzene show a persistent monocytosis. The findings of a monocyte count which persists at more than ten to 12 percent of the normal white cell count (when the total count is normal) or persistence of an absolute monocyte count in excess of $800/mm^3$ should be regarded as a possible sign of benzene-induced toxicity.

A less frequent but more serious indication of benzene toxicity is the finding in the peripheral blood of the so-called ''pseudo'' (or acquired) Pelger-Huet anomaly. In this anomaly, many, or sometimes the majority, of the neutrophilic granulocytes possess two round nuclear segments, or, less often, one or three round segments, rather than three normally elongated segments. When this anomaly is not hereditary, it is often, but not invariably, predictive of subsequent leukemia. However, only about two percent of patients who ultimately develop acute myelogenous leukemia show the acquired Pelger-Huet anomaly. Other tests that can be administered to investigate blood abnormalities are discussed below. However, these tests should be undertaken by the hematologist.

An uncommon sign, which cannot be detected from the smear but can be elicited by a ''sucrose water test'' of peripheral blood, is transient paroxysmal nocturnal hemoglobinuria (PNH). This sign may first occur insidiously during a period of established aplastic anemia and may be followed within one to a few years by the appearance of rapidly fatal, acute myelogenous leukemia. Clinical detection of PNH, which occurs in only one or two percent of those destined to have acute myelogenous leukemia, may be difficult. If the ''sucrose water test'' is positive, the somewhat more definitive Ham test, also known as the acid-serum hemolysis test, may provide confirmation.

(v) Individuals documented to have developed acute myelogenous leukemia years after initial exposure to benzene may have progressed through a preliminary phase of hematologic abnormality. In some instances, pancytopenia (*i.e.*, a lowering in the counts of all circulating blood cells of bone marrow origin, but not to the extent implied by the term ''aplastic anemia'') preceded leukemia for many years. Depression of a single blood cell type or platelets may represent a harbinger of aplasia or leukemia. The finding of two or more cytopenias or pancytopenia in a benzene-exposed individual must be regarded as highly suspicious of more advanced, although still reversible, toxicity. Pancytopenia coupled with the appearance of immature cells (myelocytes, myeloblasts, erythroblasts, etc.) with abnormal cells (pseudo Pelger-Huet anomaly, atypical nuclear heterochromatin, etc.) or of unexplained elevations of white blood cells must be regarded as evidence of benzene overexposure, unless proved otherwise. Many severely aplastic patients manifested the ominous finding of five to ten percent myeloblasts in the marrow, occasional myeloblasts and myelocytes in the blood, and 20 to 30 percent monocytes. It is evident that isolated cytopenias, pancytopenias, and even aplastic anemias induced by benzene may be reversible and complete recovery has been reported on cessation of exposure. However, because any of these abnormalities is serious, the employee must immediately be removed from any possible exposure to benzene vapor. Certain tests may substantiate the employee's prospects for progression or regression. One such test would be an examination of the bone marrow, but the decision to perform a bone marrow aspiration or needle biopsy must be made by the hematologist.

The findings of basophilic stippling in circulating red blood cells (usually found in one to five percent of red cells following marrow injury) and detection in the bone marrow of what are termed ''ringed sideroblasts'' must be taken seriously, as they have been noted in recent years to be premonitory signs of subsequent leukemia.

Recently peroxidase-staining of circulating or marrow neutrophil granulocytes, employing benzidine dihydrochloride, have revealed the disappearance of, or diminution in, peroxidase in a sizable proportion of the granulocytes. This has been reported as an

early sign of leukemia. However, relatively few patients have been studied to date. Granulocyte granules are normally strongly peroxidase positive. A steady decline in leukocyte alkaline phosphatase has also been reported as suggestive of early acute leukemia. Exposure to benzene may cause an early rise in serum iron, often but not always associated with a fall in the reticulocyte count. Thus, serial measurements of serum iron levels may provide a means of determining whether or not there is a trend representing sustained suppression of erythropoiesis.

Measurement of serum iron and determination of peroxidase and of alkaline phosphatase activity in peripheral granulocytes can be performed in most pathology laboratories. Peroxidase and alkaline phosphatase staining are usually undertaken when the index of suspicion for leukemia is high.

APPENDIX D TO SUBPART C OF PART 197—SAMPLING AND ANALYTICAL METHODS FOR BENZENE MONITORING—MEASUREMENT PROCEDURES

Measurements taken for the purpose of determining employee exposure to benzene are best taken so that the representative average eight-hour exposure may be determined from a single eight-hour sample or two four-hour samples. Short-time interval samples (or grab samples) may also be used to determine average exposure level if a minimum of five measurements are taken in a random manner over the eight-hour work shift. In random sampling, any portion of the work shift has the same chance of being sampled as any other. The arithmetic average of all random samples taken on one work shift is an estimate of an employee's average level of exposure for that work shift. Air samples should be taken in the employee's breathing zone (*i.e.*, air that would most nearly represent that inhaled by the employee). Sampling and analysis must be performed with procedures meeting the requirements of 46 CFR part 197, subpart C.

There are a number of methods available for monitoring employee exposures to benzene. The sampling and analysis may be performed by collection of the benzene vapor on charcoal adsorption tubes, with subsequent chemical analysis by gas chromatography. Sampling and analysis also may be performed by portable direct reading instruments, real-time continuous monitoring systems, passive dosimeters, or other suitable methods. The employer is required to select a monitoring method which meets the accuracy and precision requirements of 46 CFR 197.540(a)(6) for the weather conditions expected. Section 197.540(a)(6) requires that monitoring must have an accuracy, to a 95 percent confidence level, of not less than plus or minus 25 percent for concentrations of benzene greater than or equal to 0.5 ppm.

In developing the following analytical procedures, the OSHA Laboratory modified NIOSH Method S311 and evaluated it at a benzene air concentration of one ppm. A procedure for determining the benzene concentration in bulk material samples was also evaluated. This work, as reported in OSHA Laboratory Method No. 12, includes the following two analytical procedures:

I. OSHA Method 12 for Air Samples

Analyte: Benzene.

Matrix: Air.

Procedure: Adsorption on charcoal, desorption with carbon disulfide, analysis by gas chromatograph.

Detection limit: 0.04 ppm.

Recommended air volume and sampling rate: 10 liter at 0.2 liter/min.

1. Principle of the method

1.1. A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2. The charcoal in the tube is transferred to a small, stoppered vial and the analyte is desorbed with carbon disulfide.

1.3. An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4. The area of the resulting peak is determined and compared with areas obtained from standards.

2. Advantages and disadvantages of the method

2.1. The sampling device is small, portable, and involves no liquids. Interferences are minimal and most of those which do occur can be eliminated by altering chromatographic conditions. The samples are analyzed by means of a quick, instrumental method.

2.2. The amount of sample which can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

3. Apparatus

3.1. A calibrated personal sampling pump having a flow that can be determined within ±five percent at the recommended flow rate.

3.2. Charcoal tubes: Glass with both ends flame sealed, seven cm long with a six mm O.D. and a four mm I.D., containing two sections of 20/40 mesh activated charcoal separated by a two mm portion of urethane foam. The activated charcoal is prepared from coconut shells and is fired at 600 °C before packing. The adsorbing section contains 100 mg of charcoal and the back-up section 50

mg. A three mm portion of urethane foam is placed between the outlet end of the tube and the back-up section. A plug of silanized glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than one inch of mercury at a flow rate of one liter per minute.

3.3. Gas chromatograph equipped with a flame ionization detector.

3.4. Column (10 ft. × ⅛ in. stainless steel) packed with 80/100 Supelcoport coated with 20 percent SP 2100 and 0.1 percent CW 1500.

3.5. An electronic integrator or some other suitable method for measuring peak area.

3.6. Two-milliliter sample vials with Teflon-lined caps.

3.7. Microliter syringes: ten microliter (ten µl) syringe, and other convenient sizes for making standards. One µl syringe for sample injections.

3.8. Pipets: 1.0 ml delivery pipets.

3.9. Volumetric flasks: convenient sizes for making standard solutions.

4. Reagents

4.1. Chromatographic quality carbon disulfide (CS_2). Most commercially available carbon disulfide contains a trace of benzene which must be removed. It can be removed with the following procedure. Heat, under reflux for two to three hours, 500 ml of carbon disulfide, ten ml concentrated sulfuric acid, and five drops of concentrated nitric acid. The benzene is converted to nitrobenzene. The carbon disulfide layer is removed, dried with anhydrous sodium sulfate, and distilled. The recovered carbon disulfide should be benzene free. (It has recently been determined that benzene can also be removed by passing the carbon disulfide through a 13x molecular sieve).

4.2. Benzene, reagent grade.

4.3. p-Cymene, reagent grade, (internal standard).

4.4. Desorbing reagent. The desorbing reagent is prepared by adding 0.05 ml of p-cymene per milliliter of carbon disulfide. (The internal standard offers a convenient means correcting analytical response for slight inconsistencies in the size of sample injections. If the external standard technique is preferred, the internal standard can be eliminated.)

4.5. Purified GC grade helium, hydrogen, and air.

5. Procedure

5.1. Cleaning of equipment. All glassware used for the laboratory analysis should be properly cleaned and free of organics which could interfere in the analysis.

5.2. Calibration of personal pumps. Each pump must be calibrated with a representative charcoal tube in the line.

5.3. Collection and shipping of samples.

5.3.1. Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (two mm).

5.3.2. The smaller section of the charcoal is used as the backup and should be placed nearest the sampling pump.

5.3.3. The charcoal tube should be placed in a vertical position during sampling to minimize channeling through the charcoal.

5.3.4. Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

5.3.5. A sample size of 10 liters is recommended. Sample at a flow rate of approximately 0.2 liters per minute. The flow rate should be known with an accuracy of at least ±five percent.

5.3.6. The charcoal tubes should be capped with the supplied plastic caps immediately after sampling.

5.3.7. Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.8. Take necessary shipping and packing precautions to minimize breakage of samples.

5.4. Analysis of samples.

5.4.1. Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a two ml vial. The separating section of foam is removed and discarded and the second section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2. Desorption of samples. Before analysis, 1.0 ml of desorbing solution is pipetted into each sample container. The desorbing solution consists of 0.05 µl internal standard per milliliter of carbon disulfide. The sample vials are capped as soon as the solvent is added. Desorption should be done for 30 minutes with occasional shaking.

5.4.3. GC conditions. Typical operating conditions for the gas chromatograph are as follows:

1. 30 ml/min (60 psig) helium carrier gas flow.
2. 30 ml/min (40 psig) hydrogen gas flow to detector.
3. 240 ml/min (40 psig) air flow to detector.
4. 150 °C injector temperature.
5. 250 °C detector temperature.
6. 100 °C column temperature.

5.4.4. Injection size. One µl.

5.4.5. Measurement of area. The peak areas are measured by an electronic integrator or some other suitable form of area measurement.

5.4.6. An internal standard procedure is used. The integrator is calibrated to report results in ppm for a 10 liter air sample after correction for desorption efficiency.

5.5. Determination of desorption efficiency.

5.5.1. Importance of determination. The desorption efficiency of a particular compound may vary from one laboratory to another and from one lot of chemical to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2. Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X (X represents target concentration) based on a 10 liter air sample, are injected into several tubes at each level. Dilutions of benzene with carbon disulfide are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration, they are analyzed following the same procedure as the samples. Desorption efficiency is determined by dividing the amount of benzene found by amount spiked on the tube.

6. Calibration and standards

A series of standards varying in concentration over the range of interest is prepared and analyzed under the same GC conditions that will be used on the samples. A calibration curve is prepared by plotting concentration (µg/ml) versus peak area.

7. Calculations

Benzene air concentration can be calculated from the following equation:

$mg/m^3 = (A)(B)/(C)(D)$

Where:

A=µg/ml benzene, obtained from the calibration curve; B = desorption volume (one ml); C = liters of air sampled; and D = desorption efficiency.

The concentration in mg/m^3 can be converted to ppm (at 25° and 760 mm) with following equation:

$ppm = (mg/m^3)(24.46)/(78.11)$.

Where:

24.46 = molar volume of an ideal gas 25 °C and 760 mm; and 78.11 = molecular weight of benzene.

8. Backup data

8.1 Detection limit—Air Samples. The detection limit for the analytical procedure is 1.28 ng with a coefficient of variation of 0.023 at this level. This would be equivalent to an air concentration of 0.04 ppm for a 10 liter air sample. This amount provided a chromatographic peak that could be identifiable in the presence of possible interferences. The detection limit data were obtained by making one µl injections of a 1.283 µg/ml standard.

Injection	Area count	
1	655.4	
2	617.5	
3	662.0	X = 640.2
4	641.1	SD = 14.9
5	636.4	CV = 0.023
6	629.2	

8.2 Pooled coefficient of variation—Air Samples. The pooled coefficient of variation for the analytical procedure was determined by one µl replicate injections of analytical standards. The standards were 16.04, 32.08, and 64.16 µg/ml, which are equivalent to 0.5, 1.0, and 2.0 ppm for a 10 liter air sample respectively.

8.3 Storage data—Air Samples. Samples were generated at 1.03 ppm benzene at 80% relative humidity, 22 °C, and 643 mm. All samples were taken for 50 minutes at 0.2 liters/min. Six samples were analyzed immediately and the rest of the samples were divided into two groups by fifteen samples each. One group was stored at refrigerated temperature of −25 °C and the other group was stored at ambient temperature (approximately 23 °C). These samples were analyzed over a period of fifteen days. The results are tabulated below.

Injection	Area counts		
	0.5 ppm	1.0 ppm	2.0 ppm
1	3996.5	8130.2	16481
2	4059.4	8235.6	16493
3	4052.0	8307.9	16535
4	4027.2	8263.2	16609
5	4046.8	8291.1	16552
6	4137.9	8288.8	16618
X=	4053.3	8254.0	16548.3
SD=	47.2	62.5	57.1
CV=	0.0116	0.0076	0.0034
CV = 0.008.			

PERCENT RECOVERY

Day analyzed	Refrigerated			Ambient		
0	97.4	98.7	98.9	97.4	98.7	98.9
0	97.1	100.6	100.9	97.1	100.6	100.9
2	95.8	96.4	95.4	95.4	96.6	96.9
5	93.9	93.7	92.4	92.4	94.3	94.1
9	93.6	95.5	94.6	95.2	95.6	96.6

PERCENT RECOVERY—Continued

Day analyzed	Refrigerated			Ambient		
13	94.3	95.3	93.7	91.0	95.0	94.6
15	96.8	95.8	94.2	92.9	96.3	95.9

8.4 Desorption data. Samples were prepared by injecting liquid benzene onto the A section of charcoal tubes. Samples were prepared that would be equivalent to 0.5, 1.0, and 2.0 ppm for a 10 liter air sample.

PERCENT RECOVERY

Sample	0.5 ppm	1.0 ppm	2.0 ppm
1	99.4	98.8	99.5
2	99.5	98.7	99.7
3	99.2	98.6	99.8
4	99.4	99.1	100.0
5	99.2	99.0	99.7
6	99.8	99.1	99.9
X=	99.4	98.9	99.8
SD=	0.22	0.21	0.18
C V=	0.0022	0.0021	0.0018
X = 99.4.			

8.5 Carbon disulfide. Carbon disulfide from a number of sources was analyzed for benzene contamination. The results are given in the following table. The benzene contaminant can be removed with the procedures given in section I.4.1.

Sample	µg Benzene/ml	ppm equivalent (for 10 liter air sample)
ALDRICH Lot 83017	4.20	0.13
BAKER Lot 720364	1.01	0.03
BAKER Lot 822351	1.01	0.03
Malinkrodt Lot WEMP	1.74	0.05
Malinkrodt Lot WDSJ	5.65	0.18
Malinkrodt Lot WHGA	2.90	0.09
Treated CS_2		

II. OSHA Laboratory Method No. 12 for Bulk Samples

Analyte: Benzene.

Matrix: Bulk Samples.

Procedure: Bulk samples are analyzed directly by high performance liquid chromatography (HPLC).

Detection limits: 0.01% by volume.

1. Principle of the method

1.1. An aliquot of the bulk sample to be analyzed is injected into a liquid chromatograph.

1.2. The peak area for benzene is determined and compared to areas obtained from standards.

2. Advantages and disadvantages of the method

2.1. The analytical procedure is quick, sensitive, and reproducible.

2.2. Reanalysis of samples is possible.

2.3. Interferences can be circumvented by proper selection of HPLC parameters.

2.4. Samples must be free of any particulates that may clog the capillary tubing in the liquid chromatograph. This may require distilling the sample or clarifying with a clarification kit.

3. Apparatus

3.1. Liquid chromatograph equipped with a UV detector.

3.2. HPLC Column that will separate benzene from other components in the bulk sample being analyzed. The column used for validation studies was a Waters uBondapack C18, 30 cm × 3.9 mm.

3.3. A clarification kit to remove any particulates in the bulk if necessary.

3.4. A micro-distillation apparatus to distill any samples if necessary.

3.5. An electronic integrator or some other suitable method of measuring peak areas.

3.6. Microliter syringes—ten µl syringe and other convenient sizes for making standards. 10 µl syringe for sample injections.

3.7. Volumetric flasks, five ml and other convenient sizes for preparing standards and making dilutions.

4. Reagents

4.1. Benzene, reagent grade.

4.2. HPLC grade water, methyl alcohol, and isopropyl alcohol.

5. Collection and shipment of samples

5.1. Samples should be transported in glass containers with Teflon-lined caps.

5.2. Samples should not be put in the same container used for air samples

6. Analysis of samples

6.1. Sample preparation. If necessary, the samples are distilled or clarified. Samples are analyzed undiluted. If the benzene concentration is out of the working range, suitable dilutions are made with isopropyl alcohol.

6.2. HPLC conditions. The typical operating conditions for the high performance liquid chromatograph are:

6.2.1. Mobile phase—Methyl alcohol/water, 50/50.

6.2.2. Analytical wavelength—254 nm.

6.2.3. Injection size—10 µl.

6.3. Measurement of peak area and calibration. Peak areas are measured by an integrator or other suitable means. The integrator is calibrated to report results in % benzene by volume.

7. Calculations

Because the integrator is programmed to report results in % benzene by volume in an undiluted sample, the following equation is used: % Benzene by Volume = A × B.

Where: A = % by volume on report. B = Dilution Factor. (B = one for undiluted sample).

8. Backup data

8.1. Detection limit—Bulk Samples. The detection limit for the analytical procedure for bulk samples is 0.88 µg, with a coefficient of variation of 0.019 at this level. This amount provided a chromatographic peak that could be identifiable in the presence of possible interferences. The detection limit date were obtained by making ten µl injections of a 0.10% by volume standard.

Injection	Area Count	
1	45386	
2	44214	
3	43822	X = 44040.1
4	44062	SD = 852.5
6	42724	CV = 0.019

8.2. Pooled coefficient of variation—Bulk Samples. The pooled coefficient of variation for the analytical procedure was determined by 50 µl replicate injections of analytical standards. The standards were 0.01, 0.02, 0.04, 0.10, 1.0, and 2.0% benzene by volume.

AREA COUNT (PERCENT)

Injection #	0.01	0.02	0.04	0.10	1.0	2.0
1	45386	84737	166097	448497	4395380	9339150
2	44241	84300	170832	441299	4590800	9484900
3	43822	83835	164160	443719	4593200	9557580
4	44062	84381	164445	444842	4642350	9677060
5	44006	83012	168398	442564	4646430	9766240
6	42724	81957	173002	443975	4646260	
X=	44040.1	83703.6	167872	444149	4585767	9564986
SD=	852.5	1042.2	3589.8	2459.1	96839.3	166233
CV=	0.0194	0.0125	0.0213	0.0055	0.0211	0.0174
CV = 0.017.						

APPENDIX E TO SUBPART C OF PART 197—RESPIRATOR FIT TESTS

PROCEDURES

This appendix contains the procedures for properly fitting a respirator to employees who may be exposed to benzene and includes the Initial Fit Tests (IFT), the Qualitative Fit Tests (QLFT), and the Quantitative Fit Test (QNFT).

Note that respirators (negative pressure or positive pressure) must not be worn when conditions prevent a tight seal between the faceplate and the skin or the proper functioning of the inhalation or exhalation valves. In order for a respirator to protect the wearer, the facepiece must make a proper seal against the wearer's face. Several factors can negatively affect the respirator to face seal and reduce the level of protection afforded by the respirator. Among these are facial shape, temple pieces of eyeglasses, facial abnormalities (e.g., scars and indentations) absence of dentures, hair style or length of hair, specific skin conditions, and facial hair. Therefore, nothing can come between or otherwise interfere with the sealing surface of the respirator and the face or interfere with the function of the inhalation or exhalation valves.

I. Initial Fit Tests (IFT)

(a) The test subject must be allowed to select the most comfortable respirator from a selection of respirators of various sizes. The selection must include at least three sizes of elastomeric facepieces for the type of respirator that is to be tested (*i.e.*, three sizes of half mask or three sizes of full facepiece).

(b) Before the selection process, the test subject must be shown how to put on a respirator, how it should be positioned on the face, how to set strap tension, and how to determine a comfortable fit. A mirror must be available to assist the subject in evaluating the fit and positioning the respirator. This instruction is only a preliminary review and must not constitute the subject's formal training on respirator use.

(c) The test subject must be informed that he or she is being asked to select the respirator which provides the most comfortable fit. Each respirator represents a different size and shape and, if fitted and used properly, should provide adequate protection.

(d) The test subject must be instructed to hold each facepiece up to the face and eliminate those facepieces which obviously do not give a comfortable fit.

(e) The more comfortable facepieces must be noted and the most comfortable mask donned and worn at least five minutes to assess comfort. Assistance in assessing comfort may be given by discussing the points in section I(f) of this appendix. If the test subject is not familiar with using a particular respirator, the test subject must be directed to don the mask several times and to adjust the straps each time to become adept at setting proper tension on the straps.

(f) Assessment of comfort must include reviewing the following points with the test subject and allowing the test subject adequate time to determine the comfort of the respirator:

(1) Position of the mask on the nose.

(2) Room for eye protection.

(3) Room to talk.

(4) Position of mask on face and cheeks.

(g) The following criteria must be used to help determine the adequacy of the respirator fit:

(1) Chin properly placed.

(2) Adequate strap tension, not overly tightened.

(3) Fit across nose bridge.

(4) Respirator of proper size to span distance from nose to chin.

(5) Tendency of respirator to slip.

(6) Self-observation in mirror to evaluate fit and respirator position.

(h) The following negative and positive pressure fit tests must be conducted. Before conducting a negative or positive pressure fit test, the subject must be told to seat the mask on the face by moving the head from side-to-side and up and down slowly while taking in a few slow deep breaths Another facepiece must be selected and retested if the test subject fails the fit check tests.

(1) *Positive pressure fit test.* The exhalation valve must be closed off and the subject must exhale gently onto the facepiece. The face fit is considered satisfactory if a slight positive pressure can be built up inside the facepiece without any evidence of outward leakage of air at the seal. For most respirators this method of leak testing requires the wearer to first remove the exhalation valve cover before closing off the exhalation valve and then carefully replacing it after the test.

(2) *Negative pressure fit test.* The inlet opening of the canister or cartridge(s) must be closed off by covering with the palm of the hand(s) or by replacing the filter seal(s). The subject must inhale gently so that the facepiece collapses slightly and hold his or her breath for ten seconds. If the facepiece remains in its slightly collapsed condition and no inward leakage of air is detected, the tightness of the respirator is considered satisfactory.

(i) The test must not be conducted if the subject has any hair growth between the skin and the facepiece sealing surface, such as stubble beard growth, beard, or long sideburns which cross the respirator sealing surface. Any type of apparel, such as a skull cap or the temple bars of eye glasses, which projects under the facepiece or otherwise interferes with a satisfactory fit must be altered or removed.

(j) If the test subject exhibits difficulty in breathing during the tests, the subject must be referred to a physician trained in respiratory disease or pulmonary medicine to determine whether the test subject can wear a respirator while performing his or her duties.

(k) The test subject must be given the opportunity to wear the successfully fitted respirator for a period of two weeks. If at any time during this period the respirator becomes uncomfortable, the test subject must be given the opportunity to select a different facepiece and to be retested.

(l) Exercise regimen. Before beginning the fit test, the test subject must be given a description of the fit test and of the test subject's responsibilities during the test procedure. The description of the process must include a description of the test exercises that the subject must perform. The respirator to be tested must be worn for at least five minutes before the start of the fit test.

(m) Test Exercises. The test subject must perform the following exercises in the test environment:

(1) Normal breathing. In a normal standing position, without talking, the subject must breathe normally.

(2) Deep breathing. In a normal standing position, the subject must breathe slowly and deeply, taking caution so as to not hyperventilate.

(3) Turning head side to side. Standing in place, the subject must slowly turn his or her head from side to side between the extreme positions on each side. The subject must hold his or her head at each extreme momentarily and inhale.

(4) Moving head up and down. Standing in place, the subject must slowly move his or her head up and down. The subject must be instructed to inhale in the up position (*i.e.*, when looking toward the ceiling).

(5) Talking. The subject must talk slowly and loudly enough so as to be heard clearly by the test conductor. The subject must count backward from 100, recite a memorized poem or song, or read the following passage:

RAINBOW PASSAGE

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the

shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

(6) Grimace. The test subject must grimace by smiling or frowning.

(7) Bending over. The test subject must bend at the waist as if to touch the toes or, for test environments such as shroud type QNFT units which prohibit bending at the waist, the subject must jog in place.

(8) Normal breathing. Same as exercise 1.

Each test exercise must be performed for one minute, except for the grimace exercise which must be performed for 15 seconds. The test subject must be questioned by the test conductor regarding the comfort of the respirator upon completion of test exercises. If it has become uncomfortable, another respirator must be tried and the subject retested.

(n) The employer shall certify that a successful fit test has been administered to the test subject. The certification must include the following information:

(1) Name of employee.

(2) Type, brand, and size of respirator.

(3) Date of test.

Where QNFT is used, the fit factor, strip chart, or other recording of the results of the test must be retained with the certification. The certification must be maintained until the next fit test is administered.

II. Qualitative Fit Tests (QLFT)

(a) *General.* (1) The employer shall designate specific individuals to administer the respirator qualitative fit test program. The employer may contract for these services.

(2) The employer shall ensure that persons administering QLFT are able to properly prepare test solutions, calibrate equipment, perform tests, recognize invalid tests, and determine whether the test equipment is in proper working order.

(3) The employer shall ensure that QLFT equipment is kept clean and maintained so as to operate at the parameters for which it was designed.

(b) *Isoamyl acetate tests.* (1) Odor threshold screening test. The odor threshold screening test, performed without wearing a respirator, is intended to determine if the test subject can detect the odor of isoamyl acetate.

(i) Three one-liter glass jars with metal lids must be used.

(ii) Odor free water (e.g. distilled or spring water) at approximately 25 degrees C must be used for the solutions.

(iii) An isoamyl acetate (IAA) (also known at isopentyl acetate) stock solution must be prepared by adding one cc of pure IAA to 800 cc of odor free water in a one liter jar and by shaking the jar for 30 seconds. A new solution must be prepared at least weekly.

(iv) The screening test must be conducted in a room separate from the room used for actual fit testing. The two rooms must be well ventilated but not connected to the same recirculating ventilation system.

(v) An odor test solution must be prepared in a second one-liter jar by placing 0.4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. The solution must be shaken for 30 seconds and allowed to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution must be used for only one day.

(vi) A test blank must be prepared in a third one-liter jar by adding 500 cc of odor free water.

(vii) The odor test jar and the test blank jar must be labeled ''1'' and ''2'' for identification. The labels must be placed on the jar lids so that the labels can be periodically peeled off dried, and switched to maintain the integrity of the test.

(viii) The following instruction must be typed on a card and placed on a table in front of the odor test jar and the test blank jar:

The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil.

(ix) The mixtures in the jars used in the IAA odor threshold screening must be prepared in an area separate from the test area, in order to prevent olfactory fatigue in the test subject.

(x) If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA qualitative fit test must not be performed.

(xi) If the test subject correctly identifies the jar containing the odor test solution, the test subject may proceed to respirator selection and fit testing.

(2) Isoamyl acetate fit test. (i) The fit test chamber must be a clear 55-gallon drum liner or similar device suspended inverted over a two foot diameter frame so that the top of the chamber is about six inches above the test subject's head. The inside top center of the chamber must have a small hook attached.

(ii) Each respirator used for the fitting and fit testing must be equipped with organic vapor cartridges or offer protection against

organic vapors. The cartridges or masks must be changed at least weekly.

(iii) After selecting, donning, and properly adjusting a respirator, the test subject must wear the respirator to the fit testing room. This room must be separate from the room used for odor threshold screening and respirator selection and must be well ventilated by an exhaust fan, lab hood, or other device to prevent general room contamination.

(iv) A copy of the test exercises and any prepared text from which the subject is to read must be taped to the inside of the test chamber.

(v) Upon entering the test chamber, the test subject must be given a six inch by five inch piece of paper towel or other porous, absorbent, single-ply material, folded in half and wetted with 0.75 cc of pure IAA. The test subject must hang the wet towel on the hook at the top of the chamber.

(vi) Two minutes must be allowed for the IAA test concentration to stabilize before starting the fit test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of the subject's cooperation, and the purpose for the head exercises, or to demonstrate some of the exercises.

(vii) The test subject must be instructed to perform the exercises described in section I(n) of this appendix. If at any time during the test the subject detects the banana like odor of IAA, the test is failed. The subject must be removed quickly from the test chamber and the test area to avoid olfactory fatigue.

(viii) If the test is failed, the subject must return to the selection room, remove the respirator, repeat the odor sensitivity test, select and don another respirator, return to the test chamber, and again take the IAA fit test. The process must continue until a respirator that fits well is found. If the odor sensitivity test is failed, the subject must wait at least five minutes before retesting to allow odor sensitivity to return.

(ix) When a respirator is found that passes the test, the subject must demonstrate the efficiency of the respirator by breaking the face seal and taking a breath before exiting the chamber. If the subject cannot detect the odor of IAA, the test is deemed inconclusive and must be rerun.

(x) When the test subject leaves the chamber, the subject must remove the saturated towel and return it to the person conducting the test. To keep the test area from becoming contaminated, the used towel must be kept in a self-sealing bag to avoid significant IAA concentration build-up in the test chamber for subsequent tests.

(c) *Saccharin solution aerosol test.* The saccharin solution aerosol test is an alternative qualitative test. Although it is the only validated test currently available for use with particulate disposable dust respirators not equipped with high-efficiency filters, it may also be used for testing other respirators. The entire screening and testing procedure must be explained to the test subject before the conduct of the saccharin test threshold screening test.

(1) Saccharin taste threshold screening test. The test, performed without wearing a respirator, is intended to determine whether the test subject can detect the taste of saccharin.

(i) The subject must wear an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear. If the enclosure is also used for the saccharin solution aerosol fit test in compliance with section II(c)(2) of this appendix, the enclosure must allow free movements of the head when a respirator is worn. An enclosure substantially similar to the Minnesota, Mining and Manufacturing (3M) hood assembly, parts No. FT 14 and No. FT 15 combined, is adequate.

(ii) The test enclosure must have a ¾ inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

(iii) The test subject must don the test enclosure. Throughout the threshold screening test, the test subject must breathe with mouth wide open and tongue extended.

(iv) Using a DeVilbiss Model 40 Inhalation Medication Nebulizer, the test conductor must spray the threshold check solution in accordance with II(c)(1)(v) of this appendix into the enclosure. The nebulizer must be clearly marked to distinguish it from the fit test solution nebulizer.

(v) The threshold check solution consists of 0.83 grams of sodium saccharin USP in one cc of warm water. It may be prepared by putting one cc of the fit test solution (see section II(c)(2)(iv) of this appendix) in 100 cc of distilled water.

(vi) To produce the aerosol, the nebulizer bulb must be firmly squeezed so that it collapses completely. Then, the bulb must be released and allowed to expand fully.

(vii) The bulb must be squeezed rapidly ten times and the test subject must be asked whether he or she tastes the saccharin.

(viii) If the first response is negative, the ten rapid squeezes must be repeated and the test subject is again asked whether he or she tastes the saccharin.

(ix) If the second response is negative, ten more squeezes are repeated rapidly and the test subject again asked whether the saccharin is tasted.

(x) The test conductor must take note of the number of squeezes required to solicit a taste response.

(xi) If the saccharin is not tasted after 30 squeezes, the test subject may not perform the saccharin fit test.

(xii) If a taste response is elicited, the test subject must be asked to take note of the taste for reference in the fit test.

(xiii) Correct use of the nebulizer means that approximately one cc of liquid is used at a time in the nebulizer body.

(xiv) The nebulizer must be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four-hours.

(2) Saccharin solution aerosol fit test. (i) The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

(ii) The fit test must be conducted with the same type of enclosure used for the saccharin taste threshold screening test in accordance with section II(c)(1) of this appendix.

(iii) The test subject must don the enclosure while wearing the respirator selected in the saccharin taste threshold screening test. The respirator must be properly adjusted and equipped with a particulate filter(s).

(iv) A second DeVilbiss Model 40 Inhalation Medication Nebulizer must be used to spray the fit test solution into the enclosure. This nebulizer must be clearly marked to distinguish it from the nebulizer used for the threshold check solution in accordance with section II(c)(1)(iv) of this appendix.

(v) The fit test solution must be prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

(vi) The test subject must breathe with mouth wide open and tongue extended.

(vii) The nebulizer must be inserted into the hole in the front of the enclosure and the fit test solution must be sprayed into the enclosure using the same number of squeezes required to elicit a taste response in the screening test in accordance with sections II(c)(1)(vi) through II(c)(1)(xi) of this appendix.

(viii) After generating the aerosol, the test subject must be instructed to perform the exercises in section I(n) of this appendix.

(ix) Every 30 seconds, the aerosol concentration must be replenished using one half the number of squeezes used initially.

(x) The test subject must indicate to the test conductor if, at any time during the fit test, the taste of saccharin is detected.

(xi) If the taste of saccharin is detected, the fit must be deemed unsatisfactory and a different respirator must be tried.

(d) *Irritant fume test*. The irritant fume test is an alternative qualitative fit test.

(1) The respirator to be tested must be equipped with high-efficiency particulate air (HEPA) filters.

(2) The test subject must be allowed to smell a weak concentration of the irritant smoke before the respirator is donned to become familiar with the smoke's characteristic odor.

(3) Both ends of a ventilation smoke tube containing stannic oxychloride, such as the Marine Safety Appliance part No. 5645 or equivalent, must be broken. One end of the smoke tube must be attached to a low flow air pump set to deliver 200 milliliters per minute.

(4) The test subject must be advised that the smoke may be irritating to the eyes and that the subject must keep his or her eyes closed while the test is performed.

(5) The test conductor must direct the stream of irritant smoke from the smoke tube towards the face seal area of the test subject. The test must be started with the smoke tube at least 12 inches from the facepiece, moved gradually to within one inch, and moved around the whole perimeter of the mask

(6) Each test subject who passes the smoke test without evidence of a response must be given a sensitivity check of the smoke from the same tube once the respirator has been removed. This check is necessary to determine whether the test subject reacts to the smoke. Failure to evoke a response voids the fit test.

(7) The fit test must be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.

III. Quantitative Fit Tests (ONFT)

(a) *General*. (1) The employer shall designate specific individuals to administer the respirator quantitative fit test program.

(2) The employer shall ensure that persons administering QNFT are able to properly calibrate equipment, perform tests, recognize invalid tests, calculate fit factors, and determine whether the test equipment is in proper working order.

(3) The employer shall ensure that QNFT equipment is kept clean and maintained so as to operate at the parameters for which it was designed.

(b) *Definitions*. (1) *Quantitative fit test* means a test which is performed in a test chamber and in which the normal air-purifying element of the respirator is replaced with a high-efficiency particulate air (HEPA) filter, in the case of particulate QNFT aerosols, or with a sorbent offering contaminant penetration protection equivalent to high-efficiency filters, if the QNFT test agent is a gas or vapor.

(2) *Challenge agent* means the aerosol, gas, or vapor introduced into a test chamber so that its concentration inside and outside of the respirator may be measured.

(3) *Test subject* means the person wearing the respirator for quantitative fit testing.

(4) *Normal standing position* means an erect and straight stance with arms down along the sides and eyes looking straight ahead.

(5) *Maximum peak penetration method* means the method of determining test agent penetration in the respirator as determined by strip chart recordings of the test. The highest peak penetration for a given exercise is taken to be representative of average penetration into the respirator for that exercise.

(6) *Average peak penetration method* means the method of determining test agent penetration into the respirator by using a strip chart recorder, integrator, or computer. The agent penetration is determined by an average of the peak heights on the graph, or by computer integration, for each exercise except the grimace exercise. Integrators or computers which calculate the actual test agent penetration into the respirator for each exercise also may be used in accordance with this method.

(7) *Fit factor* means the ratio of challenge agent concentration outside with respect to the inside of a respirator inlet covering (facepiece or enclosure).

(c) *Apparatus.* (1) Instrumentation. Aerosol generation, dilution, and measurement systems using corn oil or sodium chloride as test aerosols must be used for quantitative fit testing.

(2) Test chamber. The test chamber must be large enough to permit all test subjects to perform freely all required exercises without disturbing the challenge agent concentration or the measurement apparatus. The test chamber must be equipped and constructed so that the challenge agent is effectively isolated from the ambient air, yet is uniform in concentration throughout the chamber.

(3) When testing air-purifying respirators, the normal filter or cartridge element must be replaced with a high-efficiency particulate filter supplied by the same manufacturer.

(4) The sampling instrument must be selected so that a strip chart record may be made of the test showing the rise and fall of the challenge agent concentration with each inspiration and expiration at fit factors of at least 2,000. Integrators or computers which integrate the amount of test agent penetration leakage into the respirator for each exercise may be used if a record of the readings is made.

(5) The combination of substitute air-purifying elements, challenge agent, and challenge agent concentration in the test chamber must be such that the test subject is not exposed to a concentration of the challenge agent in excess of the established exposure limit for the challenge agent at any time during the testing process.

(6) The sampling port on the test specimen respirator must be placed and constructed so that no leakage occurs around the port (e.g. where the respirator is probed), so that a free air flow is allowed into the sampling line at all times, and so that there is no interference with the fit or performance of the respirator.

(7) The test chamber and test set up must permit the person administering the test to observe the test subject inside the chamber during the test.

(8) The equipment generating the challenge atmosphere must maintain a constant concentration of challenge agent inside the test chamber to within a ten percent variation for the duration of the test.

(9) The time lag (*i.e.*, the interval between an event and the recording of the event on the strip chart, computer, or integrator) must be kept to a minimum. There must be a clear association between the occurrence of an event inside the test chamber and the recording of that event.

(10) The sampling line tubing for the test chamber atmosphere and for the respirator sampling port must be of equal diameter and of the same material. The length of the two lines must be equal.

(11) The exhaust flow from the test chamber must pass through a high-efficiency filter before release.

(12) When sodium chloride aerosol is used, the relative humidity inside the test chamber must not exceed 50 percent.

(13) The limitations of instrument detection must be taken into account when determining the fit factor.

(14) Test respirators must be maintained in proper working order and inspected for deficiencies, such as cracks, missing valves, and gaskets.

(d) *Procedural requirements.* (1) When performing the initial positive or negative pressure test, the sampling line must be crimped closed in order to avoid air pressure leakage during either of these tests.

(2) In order to reduce the amount of QNFT time, an abbreviated screening isoamyl acetate test or irritant fume test may be used in order to quickly identify poor fitting respirators which passed the positive or negative pressure test. When performing a screening isoamyl acetate test, combination high-efficiency organic vapor cartridges or canisters must be used.

(3) A reasonably stable challenge agent concentration must be measured in the test chamber before testing. For canopy or shower curtain type of test units, the determination of the challenge agent stability may be established after the test subject has entered the test environment.

(4) Immediately after the subject enters the test chamber, the challenge agent concentration inside the respirator must be measured to ensure that the peak penetration does not exceed five percent for a half mask or one percent for a full facepiece respirator.

(5) A stable challenge concentration must be obtained before the actual start of testing.

(6) Respirator restraining straps must not be overtightened for testing. The straps must be adjusted by the wearer without assistance from other persons to give a fit reasonably comfortable for normal use.

(7) After obtaining a stable challenge concentration, the test subject must be instructed to perform the exercises described in section I(n) of this appendix. The test must be terminated whenever any single peak penetration exceeds five percent for half masks and one percent for full facepiece respirators. The test subject must be refitted and retested. If two of the three required tests are terminated, the fit is deemed inadequate.

(8) In order to successfully complete a QNFT, three successful fit tests must be conducted. The results of each of the three independent fit tests must exceed the minimum fit factor needed for the class of respirator (e.g., half mask respirator, full facepiece respirator).

(9) Calculation of fit factors. (i) The fit factor must be determined for the quantitative fit test by taking the ratio of the average chamber concentration to the concentration inside the respirator.

(ii) The average test chamber concentration is the arithmetic average of the test chamber concentration at the beginning and of the end of the test.

(iii) The concentration of the challenge agent inside the respirator must be determined by one of the following methods:

(A) Average peak concentration.

(B) Maximum peak concentration.

(C) Integration by calculation of the area under the individual peak for each exercise. This includes computerized integration.

(10) Interpretation of test results. The fit factor established by the quantitative fit testing must be the lowest of the three fit factor values calculated from the three required fit tests.

(11) The test subject must not be permitted to wear a half mask or a full facepiece respirator unless a minimum fit factor equivalent to at least ten times the hazardous exposure level is obtained.

(12) Filters used for quantitative fit testing must be replaced at least weekly, whenever increased breathing resistance is encountered, or whenever the test agent has altered the integrity of the filter media. When used, organic vapor cartridges and canisters must be replaced daily or whenever there is an indication of a breakthrough by a test agent.

APPENDIX F TO SUBPART C OF PART 197—SAMPLE WORKER CERTIFICATION FORM

BENZENE WORKER'S CERTIFICATION

I, _____(Name of worker), certify in accordance with 46 CFR 197.530—

(1) That I have had, within the previous twelve months, at least one medical examination in compliance with 46 CFR 197.560 or 29 CFR 1910.1028;

(2) That the physician conducting the latest medical examination in compliance with paragraph (1) of this certification did not recommend that I be excluded from areas where personal exposure may exceed the action level as defined in 46 CFR 197.505;

(3) That all respirators and personal protective clothing and equipment that I will use while on the vessel meet the requirements of 46 CFR 197.550(b) and 197.555(c) or of 29 CFR 1910.1028; and

(4) That all respirators that I will use while on the vessel have been fitted and fit tested in accordance with 46 CFR 197.550 (c) and (d) or with 29 CFR 1910.1028.

_____

(signature of worker)

_____

(printed name of worker)

_____

(date signed by worker)

APPENDIX A TO PART 197—AIR NO-DECOMPRESSION LIMITS

The following table gives the depth versus bottom time limits for single, no-decompression, air dives made within any 12-hour period. The limit is the maximum bottom time in minutes that a diver can spend at that depth without requiring decompression beyond that provided by a normal ascent rate of 60 fsw per minute. (Although bottom time is concluded when ascent begins, a slower ascent rate would increase the bottom time thereby requiring decompression.) An amount of nitrogen remains in the tissues of a diver after any air dive, regardless of whether the dive was a decompression or no-decompression dive. Whenever another dive is made within a 12-hour period, the nitrogen remaining in the blood and body tissues of the diver must be considered when calculating his decompression.

AIR NO-DECOMPRESSION LIMITS

Depth (feet):	*No-decompression limits (minutes)*
35	310
40	200
50	100
60	60
70	50
80	40
90	30
100	25
110	20
120	15

AIR NO-DECOMPRESSION LIMITS—Continued

Depth (feet):	*No-decompression limits (minutes)*
130	10

(Source: U.S. Navy Diving Manual, 1 September 1973.)

PART 198 [RESERVED]