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§ 154.1740 Vinyl chloride: Inhibiting and inerting.

When a vessel is carrying vinyl chloride, the master shall ensure that:

(a) Section 154.1818 is met; or

(b) Section 154.1710 is met, and the oxygen content of inert gas is less than 0.1% by volume.

§ 154.1745 Vinyl chloride: Transferring operations.

A vessel carrying vinyl chloride must meet the requirements of § 151.50–34(g) through (k) of this chapter.

[CGD 95–012, 60 FR 48051, Sept. 18, 1995]

§ 154.1750 Butadiene or vinyl chloride: Refrigeration system.

A refrigeration system for butadiene or vinyl chloride must not use vapor compression unless it:

(a) Avoids any stagnation points where uninhibited liquid can accumulate; or

(b) Has inhibited liquid from the cargo tank added to the vapor upstream of the condenser.

§ 154.1755 Nitrogen.

Except for deck tanks and their piping systems, cargo containment systems and piping systems carrying nitrogen must be specially approved by the Commandant (G–MSO).

[CGD 74–289, 44 FR 26009, May 3, 1979, as amended by CGD 82–063b, 48 FR 4782, Feb. 3, 1983]

§ 154.1760 Liquid ammonia.

The master shall ensure that no person sprays liquid ammonia into a cargo tank containing more than 8% oxygen by volume.

Subpart E—Operations

§ 154.1800 Special operating requirements under Part 35 of this chapter.

Each vessel must meet the requirements of Part 35 of this chapter except § 35.30–20.

§ 154.1801 Certificates, letters, and endorsements: U.S. flag vessels.

No person may operate a U.S. flag vessel unless the vessel has a Certificate of Inspection, issued under Subchapter D of this chapter, which is endorsed with the name of the cargo that it is allowed to carry.

§ 154.1802 Certificates, letters and endorsements: Foreign flag vessels.

(a) No person may operate on the navigable waters of the United States a foreign flag vessel, whose flag administration issues IMO Certificates, unless the vessel has:

(1) An IMO Certificate issued by the flag administration that is endorsed with the name of the cargo that it is allowed to carry, and, except when entering United States waters to be examined as required by § 154.150, a Certificate of Compliance[1] issued by the Coast Guard endorsed under this part with the name of the cargo that it is allowed to carry; or

(2) Special approval under § 154.30.

(b) No person may operate on the navigable waters of the United States a foreign flag vessel, whose flag administration does not issue IMO Certificates, unless the vessel has:

(1) Except when entering United States waters to be examined as required by § 154.150, a Certificate of Compliance[1] issued by the Coast Guard endorsed under this part with the name of the cargo it is allowed to carry; or

(2) Special approval under § 154.30.

(c) No person may operate on the navigable waters of the United States a foreign flag vessel unless the vessel has onboard the following plans and information which except for the certificates under paragraph (c)(1) of this section, are in English:

(1) The vessel's Cargo Ship Safety Construction Certificate and Cargo Ship Safety Equipment Certificate issued under the International Convention for Safety of Life at Sea, 1974.

(2) A description and schematic plan of the arrangement for inerting cargo tanks, hold spaces, and interbarrier spaces.

(3) A description of the cargo tank gauging equipment.

[1] Until the Certificate of Compliance form is developed, the Letter of Compliance with a Subchapter O endorsement for the carriage of liquefied gases will serve the purpose of the endorsed Certificate of Compliance.

(4) A description and instruction manual for the calibration of the cargo leak detector equipment.

(5) A schematic plan that shows the locations of leak detectors and sampling points.

(6) If the vessel carries methane, a description of the systems for cargo temperature and pressure control. (See §§154.703 through 154.709).

[CGD 74–289, 44 FR 26009, May 3, 1979, as amended by CGD 81–052, 50 FR 8735, Mar. 5, 1985; CGD 77–069, 52 FR 31631, Aug. 21, 1987; CGD 90–008, 55 FR 30663, July 26, 1990]

§154.1803 Expiration of Certificates of Compliance.

(a) A Certificate of Compliance expires after a period not to exceed twenty-four months from the date of the examination under §154.150.

(b) If a vessel's IMO Certificate of Fitness expires or otherwise becomes invalid, its Certificate of Compliance becomes invalid for the carriage of cargoes listed in Table 4 of this part or authorized by special approval under §154.12. To maintain the validity of the Certificate of Compliance, the vessel's owner must submit a copy of any revised or reissued IMO Certificate to Commanding Officer, Marine Safety Center.

[CGD 81–052, 50 FR 8735, Mar. 5, 1985; CGD 95–072, 60 FR 50466, Sept. 29, 1995; 60 FR 54106, Oct. 19, 1995]

§154.1804 Document posted in wheelhouse.

No person may operate a U.S. flag vessel unless the documents under §154.1801 are under glass in a conspicuous place in the wheelhouse.

§154.1806 Regulations on board.

No person may operate a U.S. flag vessel unless a copy of this part and a copy of Part 35 of this chapter are on board.

§154.1808 Limitations in the endorsement.

No person may operate a vessel unless that person complies with all limitations in the endorsement on the vessel's Certificate of Inspection or Certificate of Compliance.

[CGD 81–052, 50 FR 8735, Mar. 5, 1985]

§154.1809 Loading and stability manual.

(a) No person may operate a vessel unless that vessel has on board a loading and stability manual.

(b) The loading and stability manual must contain:

(1) Information that enables the master to load and ballast the vessel while keeping structural stresses within design limits; and

(2) The information required by §170.110 of this chapter.

[CGD 74–289, 44 FR 26009, May 3, 1979, as amended by CGD 79–023, 49 FR 51010, Nov. 4, 1983]

§154.1810 Cargo manual.

(a) No person may operate a foreign flag vessel, whose flag administration does not issue IMO Certificates, on the navigable waters of the United States, or a U.S. flag vessel, unless the vessel has on board a cargo manual containing the following information:

(1) A description of each cargo carried, its handling hazards as a liquid or as a gas including frostbite or asphyxiation, its safety equipment and necessary first aid measures required by this part.

(2) A description of the dangers of asphyxiation from the inerting gases used on the vessel.

(3) The measures that mitigate embrittlement of steel structure in way of cargo leakage.

(4) The use of the firefighting systems on the vessel.

(5) The features of the cargo containment system that affect its operation and maintenance, including pressure and temperature ranges and relief valve settings.

(6) Pressures, temperatures, and liquid levels for all operations.

(7) General information derived from the first loading of the vessel.

(8) Alarm settings.

(9) Descriptions of the components of the cargo system, including the following:

(i) Liquid cargo system.

(ii) Liquid recirculating or condensate return system.

(iii) Cargo tank cool-down system.

(iv) Cargo tank warm-up or vaporization system.

(v) Gas main system.

(vi) Cargo tank or compressor relief system and blocked liquid or gas relief system.

(vii) Inerting system.

(viii) Boil-off gas compressor or reliquefaction system.

(ix) Gas detection systems.

(x) Alarm or safety indication systems.

(xi) Cargo jettisoning system.

(xii) The system for using boil-off gas as fuel.

(10) A description of cargo loading and discharge operations, including simultaneous handling of multigrades of cargo and ballast.

(11) A description of cargo operations during the voyage.

(12) A description of cargo tank cooldown and warm-up operations including purging with inert gas and air.

(13) A description of hull and cargo tank temperature monitoring systems.

(14) A description of gas detection systems and alarm or safety systems.

(15) A description of the following conditions and their symptoms, including emergency measures and corrective actions:

(i) Cargo or ballast valve malfunction.

(ii) Low cargo tank gas pressure.

(iii) High fill level shutdown.

(iv) Gas compressor shutdown.

(v) Hull cold spots.

(vi) Cargo piping leaks.

(vii) Primary or secondary barrier failure.

(viii) Hold boundary structural failure.

(ix) Fire in vent mast head.

(x) Reliquefaction plant failure.

(xi) Vaporizer malfunction or failure.

(xii) Piping or cargo valve freeze-up.

(16) Any other matters relating to operation of the cargo systems.

(17) The operational means to maintain the vessel in a condition of positive stability in accordance with the loading and stability manual under § 154.1809 through all conditions of:

(i) Loading and deballasting; and

(ii) Unloading and ballasting.

(b) The master shall ensure that the cargo manual is kept up-to-date.

§ 154.1812 Operational information for terminal personnel.

The master shall ensure that terminal personnel are told the operational information required by § 154.1810(a)(17).

§ 154.1814 Cargo information cards.

(a) No person may operate a vessel unless a cargo information card for each cargo being transported is carried either in the wheelhouse, in the ship's office, or in another location easily accessible to the person in charge of the watch.

(b) When a vessel is moored at a terminal, the master shall ensure that a set of information cards is in the possession of the terminal's person in charge of cargo transfer operations.

(c) Each card must be at least 17 cm × 24 cm (6¾ in. × 9½ in.), have printing on one side only, and must contain the following information about the cargo:

(1) Name as listed in Table 4.

(2) Appearance.

(3) Odor.

(4) Safe handling procedures, including special handling instructions, and handling hazards.

(5) Procedures to follow in the event of spills, leaks, or uncontrolled cargo release.

(6) Procedures to be followed if a person is exposed to the cargo.

(7) Firefighting procedures and materials.

§ 154.1816 Cargo location plan.

The master shall ensure that:

(a) A cargo location plan is prepared that gives:

(1) The location and number of each cargo tank; and

(2) The name of the cargo in each tank;

(b) One cargo location plan is kept with the sets of cargo information cards required under § 154.1814; and

(c) The cargo names in the cargo location plan do not differ from the names of the cargoes listed in Table 4.

§ 154.1818 Certification of inhibition.

(a) Except as provided in § 154.1740(b), no person may operate a vessel carrying butadiene or vinyl chloride without

carrying in the wheelhouse written certification from the shipper that the product is inhibited.

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

(1) The name and concentration of the inhibitor.

(2) The date the inhibitor was added.

(3) The expected duration of the inhibitor's effectiveness.

(4) Any temperature limitations qualifying the inhibitor's effective lifetime.

(5) The action to be taken if the time of the voyage exceeds the inhibitor's lifetime.

§154.1820 Shipping document.

No person may operate a vessel without carrying a shipping document in the wheelhouse that lists for each cargo on board:

(a) The cargo tank in which the cargo is stowed;

(b) The name of the shipper;

(c) The location of the loading terminal;

(d) The cargo name as listed in Table 4; and

(e) The approximate quantity of the cargo.

§154.1822 Shipping document: Copy for transfer terminal.

While a vessel is moored at a transfer terminal, the master shall ensure that at least one copy of the shipping document is given to the terminal's person in charge of cargo transfer.

§154.1824 Obstruction of pumproom ladderways.

The master shall ensure that each cargo pumproom access is unobstructed.

§154.1826 Opening of cargo tanks and cargo sampling.

(a) The master shall ensure that each cargo tank opening is fully closed at all times.

(b) The master may authorize the opening of a cargo tank:

(1) During tank cleaning; and

(2) To sample a cargo that Table 4 allows to be carried in a containment system having a restricted gauging system if:

(i) The cargo tank is not being filled during sampling;

(ii) The vent system has relieved any pressure in the tank; and

(iii) The person sampling the cargo wears protective clothing.

(c) The master shall ensure that cargoes requiring closed gauging as listed in Table 4 are sampled only through the controlled sampling arrangement of the cargo tank.

§154.1828 Spaces containing cargo vapor: Entry.

(a) No person may enter a cargo handling space without the permission of the master or without following a safety procedure established by the master.

(b) Before allowing anyone to enter a cargo handling space, the master shall ensure that:

(1) The space is free of toxic vapors and has an oxygen concentration of at least 19.5 percent oxygen by volume; or

(2) Those entering the space wear protective equipment with breathing apparatus and an officer closely supervises the entire operation in the space.

§154.1830 Warning sign.

(a) The master shall ensure that a vessel transferring cargo, while fast to a dock or while at anchor in port, displays a warning sign:

(1) At the gangway facing the shore so that the sign may be seen from the shore; and

(2) Facing outboard towards the water so that the sign may be seen from the water.

(b) Except as provided in paragraph (e) of this section, each warning sign must have the following words:

(1) Warning.

(2) Dangerous Cargo.

(3) No Visitors.

(4) No Smoking.

(5) No Open Lights.

(c) Each letter in the words on the sign must:

(1) Be block style;

(2) Be black on a white background;

(3) Be 7.6 cm (3 in.) high;

(4) Be 5.1 cm (2 in.) wide, except for ''M'' and ''W'' which must be 7.6 cm (3 in.) wide, and the letter ''I'' which may be 1.3 cm (½ in.) wide; and

(5) Have 1.3 cm (½ in.) stroke width.

(d) The spacing between letters must be:

(1) 1.3 cm (½ in.) between letters of the same word on the sign;

(2) 5.1 cm (2 in.) between words;

(3) 5.1 cm (2 in.) between lines; and

(4) 5.1 cm (2 in.) at the borders of the sign.

(e) The words ''No Smoking'' and ''No Open Lights'' may be omitted when the cargoes on board a vessel are not flammable.

(f) When a vessel carries or transfers vinyl chloride, the warning sign under paragraph (b) of this section must also have the words ''Cancer Suspect Agent.''

§ 154.1831 Persons in charge of transferring liquid cargo in bulk or preparing cargo tanks.

(a) The owner and operator of the vessel, and his or her agent, and each of them, shall ensure that—

(1) Enough ''Tankerman-PICs'' or restricted ''Tankerman-PICs'', and ''Tankerman-Assistants'', authorized for the classification of cargo carried, are on duty to safely conduct a transfer of liquid cargo in bulk or a cool-down, warm-up, gas-free, or air-out of each cargo tank;

(2) Each transfer of liquid cargo in bulk, and each cool-down, warm-up, gas-free, or air-out of a cargo tank, is supervised by a person designated as a person in charge of the transfer that possesses the qualifications required by 33 CFR 155.710;

(3) On each foreign tankship, the person in charge of either a transfer of liquid cargo in bulk or a cool-down, warm-up, gas-free, or air-out of a cargo tank possesses the qualifications required by 33 CFR 155.710;

(4) When cargo regulated under this part is being transferred, the person in charge of the transfer has received special training in the particular hazards associated with the cargo and in all special procedures for its handling; and

(5) On each foreign vessel, the person in charge understands his or her responsibilities as described in this subchapter.

(b) Upon request by the Officer in Charge, Marine Inspection, in whose zone the transfer will take place, the owner and operator of the vessel, and his or her agent, and each of them, shall provide documentary evidence that the person in charge has received the training specified by paragraph (a)(4) of this section and is capable of competently performing the procedures necessary for the cargo.

[CGD 79–116, 60 FR 17158, Apr. 4, 1995]

§ 154.1834 Cargo transfer piping.

The person in charge of cargo transfer shall ensure that cargo is transferred to or from a cargo tank only through the cargo piping system.

§ 154.1836 Vapor venting as a means of cargo tank pressure and temperature control.

When the vessel is on the navigable waters of the United States, the master shall ensure that the cargo pressure and temperature control system under §§ 154.701 through 154.709 is operating and that venting of cargo is unnecessary to maintain cargo temperature and pressure control, except under emergency conditions.

§ 154.1838 Discharge by gas pressurization.

The person in charge of cargo transfer may not authorize cargo discharge by gas pressurization unless:

(a) The tank to be offloaded is an independent tank type B or C;

(b) The pressurizing medium is the cargo vapor or a nonflammable, nontoxic gas that is inert with the cargo; and

(c) The pressurizing line has:

(1) A pressure reducing valve that has a setting that is 90 percent or less of the tank's relief valve setting; and

(2) A manual control valve between the pressure reducing valve and the tank.

§ 154.1840 Protective clothing.

The person in charge of cargo transfer shall ensure that each person involved in a cargo transfer operation, except those assigned to gas-safe cargo control rooms, wears protective clothing.

§ 154.1842 Cargo system: Controls and alarms.

The master shall ensure that the cargo emergency shut-down system

and the alarms under §154.1325 are tested and working before cargo is transferred.

§154.1844 Cargo tanks: Filling limits.

(a) Unless a higher limit is specified on the certificate the master shall ensure that a cargo tank is not loaded:

(1) More than 98 percent liquid full; or

(2) In excess of the volume determined under the following formula:

$$V_L = (0.98\,V)\left(\frac{d_r}{d_L}\right)$$

where:

V_L=maximum volume to which the tank may be loaded;
V=volume of the tank;
d_r=density at the reference temperature specified in paragraph (b) of this section; and
d_L=density of the cargo at the loading temperature and pressure.

(b) The reference temperature to be used in paragraph (a)(2) of this section is the temperature corresponding to the vapor pressure of the cargo at the set pressure of the pressure relief valves.

§154.1846 Relief valves: Changing set pressure.

The master shall:

(a) Supervise the changing of the set pressure of relief valves under §154.802(b);

(b) Enter the change of set pressure in the vessel's log; and

(c) Ensure that a sign showing the set pressure is posted:

(1) In the cargo control room or station; and

(2) At each relief valve.

§154.1848 Inerting.

(a) The master shall ensure that:

(1) Hold and interbarrier spaces on a vessel with full secondary barriers are inerted so that the oxygen concentration is 8 percent or less by volume when flammable cargoes are carried;

(2) Hold and interbarrier spaces contain only dry air or inert gas on:

(i) A vessel with partial secondary barriers;

(ii) A vessel with full secondary barriers when non-flammable cargoes are carried; and

(iii) A vessel with refrigerated independent tanks type C;

(3) When cargo tanks containing flammable vapor are to be gas freed, the flammable vapors are purged from the tank by inert gas before air is admitted; and

(4) When gas free cargo tanks are to be filled with a flammable cargo, air is purged from the tank by inert gas until the oxygen concentration in the tank is 8 percent or less by volume before cargo liquid or vapor is introduced.

(b) Inert gas must be supplied from the shore or from the vessel's inert gas system.

§154.1850 Entering cargo handling spaces.

(a) The master shall ensure that the ventilation system under §154.1200 is in operation for 30 minutes before a person enters one of the following:

(1) Spaces containing cargo pumps, compressors, and compressor motors.

(2) Gas-dangerous cargo control spaces.

(3) Other spaces containing cargo handling equipment.

(b) The master shall ensure that a warning sign listing the requirement for use of the ventilation system, is posted outside of each space under paragraph (a) of this section.

(c) The master shall ensure that no sources of ignition are put in a cargo handling space on a vessel carrying flammable cargo unless the space is gas free.

§154.1852 Air breathing equipment.

(a) The master shall ensure that a licensed officer inspects the compressed air breathing equipment at least once each month.

(b) The master shall enter in the vessel's log a record of the inspection required under paragraph (a) of this section that includes:

(1) The date of the inspection; and

(2) The condition of the equipment at the time of the inspection.

§154.1854 Methane (LNG) as fuel.

(a) If methane (LNG) vapors are used as fuel in the main propulsion system

of a vessel, the master shall ensure that the fuel oil fired pilot under § 154.705(c) is used when the vessel is on the navigable waters of the United States.

(b) When the methane (LNG) fuel supply is shut down due to loss of ventilation or detection of gas, the master shall ensure that the methane (LNG) fuel supply is not used until the leak or other cause of the shutdown is found and corrected.

(c) The master shall ensure that the required procedure under paragraph (b) of this section is posted in the main machinery space.

(d) The master shall ensure that the oxygen concentration in the annular space of the fuel line under § 154.706(a)(1) is 8% or less by volume before methane (LNG) vapors are admitted to the fuel line.

§ 154.1858 Cargo hose.

The person in charge of cargo transfer shall ensure that cargo hose used for cargo transfer service meets §§ 154.552 through 154.562.

§ 154.1860 Integral tanks: Cargo colder than −10° C (14°F).

The master shall ensure that an integral tank does not carry a cargo colder than −10°C (14°F) unless that carriage is specially approved by the Commandant (G–MSO).

[CGD 74–289, 44 FR 26009, May 3, 1979, as amended by CGD 82–063b, 48 FR 4782, Feb. 3, 1983]

§ 154.1862 Posting of speed reduction.

If a speed reduction is specially approved by the Commandant under § 154.409, the master shall ensure that the speed reduction is posted in the wheelhouse.

§ 154.1864 Vessel speed within speed reduction.

The master shall ensure that the speed of the vessel is not greater than the posted speed reduction.

§ 154.1866 Cargo hose connection: Transferring cargo.

No person may transfer cargo through a cargo hose connection unless the connection has the remotely controlled quick closing shut off valve required under § 154.538.

§ 154.1868 Portable blowers in personnel access openings.

The master shall ensure that a portable blower in a personnel access opening does not reduce the area of the opening so that it does not meet § 154.340.

§ 154.1870 Bow and stern loading.

(a) When the bow or stern loading piping is not in use, the master shall lock closed the shut-off valves under § 154.355(a)(4) or remove the spool piece under § 154.355(a)(4).

(b) The person in charge of cargo transfer shall ensure that after the bow or stern loading piping is used it is purged of cargo vapors with inert gas.

(c) The person in charge of cargo transfer shall ensure that entrances, forced or natural ventilation intakes, exhausts, and other openings to any deck house alongside the bow or stern loading piping are closed when this piping is in use.

(d) The person in charge of cargo transfer shall ensure that bow or stern loading piping installed in the area of the accommodation, service, or control space is not used for transfer of the following:

(1) Acetaldehyde.
(2) Ammonia, anhydrous.
(3) Dimethylamine.
(4) Ethylamine.
(5) Ethyl Chloride.
(6) Methyl Chloride.
(7) Vinyl Chloride.

§ 154.1872 Cargo emergency jettisoning.

(a) The master shall ensure that emergency jettisoning piping under § 154.356, except bow and stern loading and discharging piping, is only used when an emergency exists.

(b) Emergency jettisoning piping when being used may be outside of the transverse tank location under § 154.310.

(c) The master shall ensure that cargo is not jettisoned in a U.S. port.

(d) When ethylene oxide is carried, the master shall ensure that the emergency jettisoning piping with associated pumps and fittings is on-line and ready for use for an emergency.

(e) The master shall lock closed the shut-off valves under § 154.356 when the emergency jettisoning piping is not in use.

(f) The person in charge of cargo transfer shall ensure that after the emergency jettisoning piping is used it is purged of cargo vapors with inert gas.

(g) The person in charge of cargo transfer shall ensure that entrances, forced or natural ventilation intakes, exhausts, and other openings to accommodation, service, or control spaces facing the emergency jettisoning piping area and alongside the emergency jettisoning piping are closed when this piping is in use.

TABLE 4—SUMMARY OF MINIMUM REQUIREMENTS

Cargo name[1]	Ship type	Independent tank type C required	Control of cargo tank vapor space	Vapor detection[2]	Gauging[3]	Electrical hazard class and group[4]	Special requirements
Acetaldehyde	IIG/IIPG		Inert	I & T	C	I–C	154.1410 (c), 154.1410, 154.1710, 154.1720, 154.1870.
Ammonia, anhydrous.	IIG/IIPG			T	C	I–D	154.1000, 154.1400 (c), 154.1405, 154.1410, 154.1702 (b), (c), (e), 154.1760, 154.1870.
Butadiene	IIG/IIPG		Inert	I	R	I–B	154.1702 (b), (d), (f), 154.1710, 154.1750, 154.1818.
Butane	IIG/IIPG			I	R	I–D	None.
Butylene	IIG/IIPG			I	R	I–D	None.
Dimethylamine	IIG/IIPG			I & T	C	I–C	154.1400 (c), 154.1405, 154.1410, 154.1702 (b), (c), (e), 154.1870.
Ethane	IIG			I	R	I–D	None.
Ethylamine	IIG/IIPG			I & T	C	I–C	154.1400 (c), 154.1405, 154.1410, 154.1702 (b), (c), (e), 154.1870.
Ethyl Chloride	IIG/IIPG			I & T	R	I–D	154.1870.
Ethylene	IIG			I	R	I–C	None.
Ethylene oxide	IG	Yes	Inert	I & T	C	I–B	154.660 (b) (3), 154.1400 (c), 154.1405, 154.1410, 154.1702 (b), (d), (f), 154.1705, 154.1710, 154.1720, 154.1725, 154.1730, 154.1870 (a), (b).
Methane (LNG).	IIG			I	C	I–D	154.703 through 154.709, 154.1854.
Methyl acetylene-propadiene mixture.	IIG/IIPG			I	R	I	154.1735.
Methyl bromide.	IG	Yes		I & T	C	I–D	154.660 (b) (3), 154.1345 (c) (d), 154.1400 (c), 154.1405, 154.1410, 154.1702 (a), (d), 154.1705, 154.1720, 154.1870 (a), (b).
Methyl chloride.	IIG/IIPG			I & T	C	I–D	154.1702 (a), 154.1870.
Nitrogen	IIIG			O	C		154.1755.
Propane	IIG/IIPG			I	R	I–D	None.
Propylene	IIG/IIPG			I	R	I–D	None.
Refrigerant	IIIG				R		None.

TABLE 4—SUMMARY OF MINIMUM REQUIREMENTS—Continued

Cargo name[1]	Ship type	Independent tank type C required	Control of cargo tank vapor space	Vapor detection[2]	Gauging[3]	Electrical hazard class and group[4]	Special requirements
Sulfur dioxide	IG	Yes	Dry	T	C	.....	154.660 (b) (3), 154.1345 (c), (d), 154.1400 (c), 154.1405, 154.1410, 154.1705, 154.1715, 154.1720, 154.1870 (a), (b).
Vinyl chloride	IIG/IIPG ..	.....	.....	I & T	C	I–D	154.1405, 154.1410, 154.1702 (a) (b) (d) (f), 154.1710, 154.1740, 154.1745, 154.1750, 154.1818, 154.1830 (f), 154.1870.

[1]Refrigerant gases include non-toxic, non-flammable gases such as: dichlorodifluoromethane, dichloromonofluoromethane, dichlorotetrafluoroethane, monochlorodifluoromethane, monochlorotetrafluoroethane, and monochlorotrifluoromethane.
[2]As used in this column: ''I'' stands for flammable vapor detection; ''T'' stands for toxic vapor detection; ''O'' stands for oxygen detection; and see §§154.1345 thru 154.1360.
[3]As used in this column: ''C'' stands for closed gauging; ''R'' stands for restricted gauging; and see §154.1300.
[4]The designations used in this column are from the National Electrical Code.

[CGD 74–289, 44 FR 26009, May 3, 1979; 44 FR 59234, Oct. 15, 1979]

APPENDIX A—EQUIVALENT STRESS

I. Equivalent stress (σ_c) is calculated by the following formula or another formula specially approved by the Commandant (G–MSO) as equivalent to the following:

$$\sigma_c = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x\sigma_y + 3\tau_{xy}^2}$$

where:

σ_x=total normal stress in ''x'' direction.

σ_y=total normal stress in ''y'' direction.

τ_{xy}=total shear stress in ''xy'' plane.

II. When the static and dynamic stresses are calculated separately, the total stresses in paragraph I are calculated from the following formulae or another formulae specially approved by the Commandant (G–MSO) as equivalent to the following:

$$\sigma_x = \sigma_x(\text{static}) \pm \sqrt{\sum(\sigma_x(\text{dynamic}))^2}$$

$$\sigma_y = \sigma_y(\text{static}) \pm \sqrt{\sum(\sigma_y(\text{dynamic}))^2}$$

$$\tau_{xy} = \tau_{xy}(\text{static}) \pm \sqrt{\sum(\tau_{xy}(\text{dynamic}))^2}$$

III. Each dynamic and static stress is determined from its acceleration component and its hull strain component from hull deflection and torsion.

[CGD 74–289, 44 FR 26009, May 3, 1979, as amended by CGD 82–063b, 48 FR 4782, Feb. 3, 1983]

APPENDIX B—STRESS ANALYSES DEFINITIONS

The following are the standard definitions of stresses for the analysis of an independent tank type B:

Normal stress means the component of stress normal to the plane of reference.

Membrane stress means the component of normal stress that is uniformly distributed and equal to the average value of the stress across the thickness of the section under consideration.

Bending stress means the variable stress across the thickness of the section under consideration, after the subtraction of the membrane stress.

Shear stress means the component of the stress acting in the plane of reference.

Primary stress means the stress produced by the imposed loading that is necessary to balance the external forces and moments. (The

basic characteristic of a primary stress is that it is not self-limiting. Primary stresses that considerably exceed the yield strength result in failure or at least in gross deformations.)

Primary general membrane stress means the primary membrane stress that is so distributed in the structure that no redistribution of load occurs as a result of yielding.

Primary local membrane stress means the resulting stress from both a membrane stress, caused by pressure or other mechanical loading, and a primary or a discontinuity effect that produces excessive distortion in the transfer of loads to other portions of the structure. (The resulting stress is a primary local membrane stress although it has some characteristics of a secondary stress.) A stress region is local if:

$$S_1 \leq 0.5\sqrt{Rt};\ \text{and}$$

$$S_2 \leq 2.5\sqrt{Rt}$$

Where:

S_1=distance in the meridional direction over which the equivalent stress exceeds 1.1 f.

S_2=distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded.

R=mean radius of the vessel.

t=wall thickness of the vessel at the location where the primary general membrane stress limit is exceeded.

f=allowable primary general membrane stress.

Secondary stress means a normal stress or shear stress caused by constraints of adjacent parts or by self-constraint of a structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur.

PART 155 [RESERVED]