NFPA® 306

Standard for the Control of Gas Hazards on Vessels

2014 Edition

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Standard for the

Control of Gas Hazards on Vessels

2014 Edition

This edition of NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, was prepared by the Technical Committee on Gas Hazards. It was issued by the Standards Council on May 28, 2013, with an effective date of June 17, 2013, and supersedes all previous editions.

This edition of NFPA 306 was approved as an American National Standard on June 17, 2013.

Origin and Development of NFPA 306

The original standard on this subject was developed by the NFPA Committee on Marine Fire Hazards in 1922 in cooperation with the NFPA Committee on Flammable Liquids. It was adopted by the Association and published as Appendix A of the "Regulations Governing Marine Fire Hazards." Further editions with minor changes were published in 1923, 1926, and 1930. In 1947, a completely revised standard was prepared by a joint committee of the American Bureau of Shipping and the National Fire Protection Association. A revised edition was developed by the NFPA Sectional Committee on Gas Hazards, approved by the Committee on Marine Fire Protection, adopted in 1962, and amended in 1963, 1969, 1971, 1972, 1975, 1980, and 1984.

In 1988, a complete revision was prepared by the Committee. It added a new safety designation, a safe condition for vessels in lay-up, and a section on military unique vessels. Chapters 2, 3, and 4 were restructured to present the sequence for obtaining a Marine Chemist Certificate.

The 1993 edition contained amendments to the 1988 edition.

The 1997 edition, which marked the 75th year for these requirements, incorporated a new standard safety designation that reflected a common approach to an industry practice. That new designation was also supported by other changes to the document, including expanded inspection of vessel piping systems.

The 2001 edition incorporated a revised standard safety designation, and several changes that reflect safe, commonly used industry practices. Several new definitions were also included. For the first time in this document, the well-established relationship between the Marine Chemist and the competent person (as defined by U.S. Department of Labor, Occupational Safety and Health Administration regulations), and the frequency of retesting confined spaces, was provided.

The 2003 edition was completed on an expedited schedule to further revise requirements in the standard that must complement those shipyard safety requirements defined by OSHA. The Committee clarified the standard and the Marine Chemist role by further defining the atmospheric hazards associated with safe entry and hot work as the standard's primary focus. The standard also clarified the intent for defining "permissible concentrations," by stating that the most conservative value for the various exposure limits should always be used.

The 2009 edition included changes to several definitions within the standard. The term *vessel* was expanded to apply to special purpose floating structures such as offshore drilling, production, and/or storage vessels. Definitions for *contract employer*, *host employer*, and *multi-employer workplace* were added to the standard. The Committee amended the definition of *adjacent spaces* to include areas affected by hot work and also clarified requirements for testing and inspecting spaces adjacent to hot work operations. The Committee also made several revisions to the requirements for obtaining a Marine Chemist Certificate and maintaining the conditions on the Certificate.

For the 2014 edition, the Technical Committee on Gas Hazards has reorganized the requirements to reflect the actual work process that is involved when a marine vessel goes from normal operating status to the point where a Marine Chemist's Certificate is obtained and repair work can begin. Over the years, Marine Chemists have become recognized experts in fire prevention during vessel repairs, which has led to repair contractors calling upon them to provide services or consultation for areas and spaces on a vessel where the chemist is not necessarily required by either OSHA or U.S. Coast Guard regulations. Those consultations can include tests and inspections in accommodation areas, storage spaces, and auxiliary equipment rooms. New provisions have been added that address this evolution of the NFPA Certificated Marine Chemist's role in ship repair. In addition, the Technical Committee has established a maximum acceptable concentration of combustible or flammable gas of less than 10 percent of the lower explosive limit (LEL) in all spaces adjacent to hot work, and incorporated information from an OSHA compliance directive for cargo, passenger, and miscellaneous vessels explaining that a Marine Chemist's Certificate is necessary any time hot work is closer than 7.6 m (25 ft) to an adjacent tank that contains a liquid with a flashpoint at or below 65.6°C (150°F). The 2014 edition also provides new explanatory material in Annex A about how frequently a space must be checked by the shipyard's competent person after a certificate has been posted. This guidance stresses the importance of maintaining safe conditions within confined spaces and provides minimum re-inspection and testing criteria to achieve this objective.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the prevention of fire and explosion of flammable vapors in compartments or in spaces on board vessels and within shipyards and on the conditions that must exist in those compartments or spaces in order that workers can safely enter them and perform work.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard applies to vessels that carry or burn as fuel, flammable or combustible liquids. It also applies to vessels that carry or have carried flammable compressed gases, flammable cryogenic liquids, chemicals in bulk, or other products capable of creating a hazardous condition.

1.1.2 This standard describes the conditions required before a space can be entered or work can be started, continued, or started and continued on any vessel under construction, alteration, or repair, or on any vessel awaiting shipbreaking.

1.1.3 This standard applies to cold work, application or removal of protective coatings, and work involving riveting, welding, burning, or similar fire-producing operations.

1.1.4 This standard applies to vessels while in the United States, its territories and possessions, both within and outside of yards for ship construction, ship alteration, ship repair, or shipbreaking.

1.1.5 This standard applies specifically to those spaces on vessels that are subject to concentrations of combustible, flammable, and toxic liquids, vapors, gases, and chemicals as herein described. This standard is also applicable to those spaces on vessels that might not contain sufficient oxygen to permit safe entry.

1.1.5.1 When requested, the Marine Chemist shall apply this standard to other spaces to ensure and promote safe working conditions.

1.1.6 This standard applies to land-side confined spaces, whether stationary or mobile; underground and aboveground storage tanks; other hollow structures throughout a shipyard such as tank trucks, railroad tank cars, power plant fuel tanks, storage tanks, dip and laundry tanks, vaults, tunnels; or other spaces that could contain dangerous atmospheres located within the boundaries of a shipyard or ship repair facility.

1.1.7 This standard applies to Marine Chemists performing activities related to inspection and certification procedures described in this standard and consulting services connected therewith on board any vessel.

1.1.8* This standard does not apply to physical hazards of tanks and confined or enclosed spaces on a vessel or vessel sections, or in the shipyard. For the purposes of this standard, physical hazards do not include fire and explosion hazards.

1.2 Purpose. The purpose of this standard is to provide minimum requirements and conditions for use in determining that a space or area on a vessel, or in a shipyard or ship repair facility, is safe for entry or work.

1.3* Emergency Exception. Nothing in this standard shall be construed as prohibiting the Marine Chemist from allowing the immediate drydocking or emergency repair of a vessel whose safety is imperiled or that presents the potential of a serious release, discharge, or disbursement into the environment of combustible, flammable, or toxic liquids, vapors, gases, or solid chemicals (the vessel is sinking or is seriously damaged), making it impracticable to clean and to gas free in advance. This emergency exception shall be subject to the approval of any authority having jurisdiction.

1.4* Governmental Regulations. Attention of owners, repairers, and Marine Chemists is directed to the rules and regulations for tank vessels in 46 CFR 35, "Operations," and other rules and regulations for vessel inspection of the United States Coast Guard and the Occupational Safety and Health Administration standards (OSHA) of the United States Department of Labor, in 29 CFR 1915, which prescribe an inspection prior to making repairs involving hot work and prior to entering spaces where oxygen deficiency can exist. Those standards provide, under the conditions stated therein, for inspection by a Marine Chemist certificated by the National Fire Protection Association or, alternatively, for inspection by certain other persons.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up,* 2011 edition.

"Rules for the Certification and Recertification of Marine Chemists," as amended 2013.

2.3 Other Publications.

2.3.1 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1915.7.

Title 29, Code of Federal Regulations, Part 1915.15.

Title 46, Code of Federal Regulations, Chapter I, Part 35, "Operations," Subpart 35.01.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.2 Shall. Indicates a mandatory requirement.

3.2.3 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents*.

3.3 General Definitions.

3.3.1 Adjacent Spaces. Those spaces in all directions from subject space, including all points of contact, corners, diagonals, decks, tank tops, and bulkheads. Pipelines are not adjacent spaces and are not considered safe for hot work unless noted on the Marine Chemist's Certificate.

3.3.2 Certificate. See 3.3.14, Marine Chemist's Certificate.

3.3.3 Chemical. Any compound, mixture, or solution in the form of a solid, liquid, or gas that might be hazardous by virtue of its properties other than or in addition to flammability or by virtue of the properties of compounds that might be evolved from hot work or cold work.

3.3.4 Coiled Vessels. See 3.3.20.2.

3.3.5* Combustible Material. Material made of or surfaced with wood, compressed paper, plant fibers, plastics, liquids, or other material that will ignite and burn, whether flameproofed or not, or whether plastered or unplastered.

3.3.6* Competent Person. A person who is designated in writing by their employer in accordance with 29 CFR 1915.7.

3.3.7 Contract Employer. An employer, such as a welder, burner, grinder, painter, or other subcontractor, who performs work under contract to the host employer or to another employer under contract to the host employer at the host employer's work site.

3.3.8 Facility. A shoreside location such as a shipyard, cleaning plant, naval base, dock, pier complex, and so forth, that is under the ownership or control of the same party and has the same continuous shoreline under their ownership or operation.

3.3.9 Flammable Compressed Gas. Any flammable gas that has been compressed, liquefied, or compressed and liquefied for the purpose of transportation and has a Reid vapor pressure exceeding 2.76×10^5 Pa (40 psia).

3.3.10 Hollow Structures. Rudders, rudder stocks, skegs, castings, masts and booms, rails, lapped plates, and other attachments to a vessel that enclose a void space.

3.3.11 Host Employer. An employer who is in charge of coordinating work or who hires other employers to perform work at a multi-employer workplace.

3.3.12 Liquids.

3.3.12.1* *Combustible Liquid.* Any liquid that has a closed-cup flash point at or above 37.8°C (100°F).

3.3.12.2 *Cryogenic Liquid.* See 3.5.3.

3.3.12.3* *Flammable Liquid.* A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068 mm Hg (40 psia) at 37.8°C (100°F).

3.3.13* Marine Chemist. The holder of a valid Certificate issued by the National Fire Protection Association in accordance with the "Rules for the Certification and Recertification of Marine Chemists," establishing the person's qualifications to determine whether construction, alteration, repair, or shipbreaking of vessels can be undertaken with safety.

3.3.14 Marine Chemist's Certificate (Certificate). A document issued by a Marine Chemist, on a form authorized by the National Fire Protection Association, stating the conditions that the Marine Chemist found at the time of inspection. *(See Annex C for an example.)*

3.3.15 Multi-Employer Workplace. A workplace where there is a host employer and at least one contract employer.

3.3.16* Requester. A company or entity that requests the survey by the Marine Chemist and is listed at the top of the Marine Chemist Certificate in the space, *Survey Requested by.*

3.3.17* Secured. Closed in a manner to prevent opening or operation.

3.3.18 Shipbreaking. The breaking down of a vessel's structure for the purpose of scrapping the vessel.

3.3.19 Toxic. A property of any chemical that has the capacity to produce injury to workers, which is dependent on concentration, rate, and method and site of absorption.

3.3.20* Vessel. Every description of watercraft or other artificial contrivance used or capable of being used as a means of transportation on water including special purpose floating structures not primarily designed for or used as a means of transportation on water.

3.3.20.1 ***Barge.*** Any vessel not equipped with a means of self-propulsion.

3.3.20.2 ***Coiled Vessel.*** Tank vessels using a closed system or heating coils that use thermal oil as the heating medium.

3.3.20.3 ***Ship.*** Any vessel propelled by power or sail.

3.3.20.4 ***Tank Vessel.*** Any vessel especially constructed or converted to carry liquid bulk cargo in tanks.

3.3.21 Visual Inspection. The physical survey of the space or compartment and surroundings in order to identify potential atmospheric and fire hazards.

3.4 Repair Classifications.

3.4.1 Cold Work. Any construction, alteration, repair, or ship-breaking that does not involve heat-, fire-, or spark-producing operations.

3.4.2* Hot Work. Any activity involving any of the following: riveting, welding, burning, the use of powder-actuated tools or similar fire-producing operations; any operation that raises the temperature of the work piece equal to or greater than 204°C (400°F); or grinding, drilling, abrasive blasting, or similar operations in the presence of or against the accumulations of readily combustible materials or flammable or combustible liquids or vapors when the atmosphere exceeds 10 percent of the LEL.

3.5 Flammable Cryogenic Liquid Carriers.

3.5.1* Cargo Area. That part of the ship that contains the cargo containment system, cargo pump room, and compressor room and that includes the deck areas over both the full beam and the length of the ship located above the aforementioned.

3.5.2* Cargo Containment System. The arrangement for containment of cargo including, where applicable, a primary and secondary barrier, associated insulation, and any intervening spaces and adjacent structures if necessary for the support of these elements.

3.5.3 Cryogenic Fluid. A fluid with a boiling point lower than –130°F (–90°C) at an absolute pressure of 14.7 psi (101.3 kPa). [**55,** 2013]

3.5.4 Hold Space. The space enclosed by the ship's structure in which a cargo containment system is situated.

3.5.5 Interbarrier Space. That space between a primary and secondary barrier, whether or not completely or partially occupied by insulation or other material.

3.5.6 Primary Barrier. The inner element designed to contain the cargo when the cargo containment system includes two boundaries.

3.5.7 Secondary Barrier. The liquid-resisting outer element of a cargo containment system designed to afford temporary containment of any envisaged leakage of liquid cargo through the primary barrier and to prevent the lowering of the temperature of the ship's structure to an unsafe level.

Chapter 4 Vessels Required to Have Marine Chemist's Certificate

4.1 Tank Vessels. Tank vessels shall be permitted to be repaired in accordance with the provisions of Chapter 5. A Certificate to this effect shall be required. Repairs or alterations involving hot work shall not be undertaken unless specifically authorized by the Certificate.

Exception No. 1: Tank vessels shall be permitted to enter a repair yard — while afloat or in dry dock — for examination, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 2: Tank vessels shall be permitted to enter a repair yard — while afloat or in dry dock — for scraping, washing down, and painting, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 3: Tank vessels shall be permitted to enter a repair yard — while afloat or in dry dock — for cold work to be performed outside of the vessel on the propeller, tailshaft, or rudder, or for hot work to be performed off the vessel, such as on the anchors or chains, provided that all bulk cargo compartments and cofferdams are kept closed.

Exception No. 4: Tank vessels shall be permitted to enter a repair yard — while afloat or in dry dock — for work within boiler and machinery spaces and other locations provided that, where hot work is to be undertaken, a Certificate shall be required. This Certificate shall set forth each specific location for which hot work is approved. All bulk cargo compartments, cofferdams, and other areas where the flammable content of the atmosphere is above 10 percent of the LEL shall be kept closed and secured. The securing of the compartments, cofferdams, and other areas shall be noted on the Certificate.

4.2 Vessels Other Than Tank Vessels. On any vessels that have carried flammable or combustible liquid in bulk as fuel or cargo, or that have carried cargoes that can produce hazardous atmospheres (including, but not limited to, those caused by decomposition or reaction with oxygen from the atmosphere), no repairs involving hot work shall be made in or on the external boundaries (shell, tank top, or deck) of cargo tanks, fuel tanks, oil pipelines, heating coils or hollow structures, and machinery spaces, unless such compartments and pipelines, as deemed necessary by the Marine Chemist, have been inerted or cleaned to meet the appropriate designation requirements of 7.1.4, 7.1.6, or 7.1.8, and for spaces that will be entered, the requirements of 7.1.1. Repairs and alterations shall not be undertaken until a Certificate is obtained.

4.3 Military Unique Vessels (i.e., U.S. Navy, Coast Guard, Army).

4.3.1 Oilers and tank barges shall be treated as tank vessels in accordance with Section 4.1.

4.3.2 All ammunition shall be removed from any space requiring hot work. Adjacent spaces containing ammunition shall be treated in accordance with the Marine Chemist's requirements. Adjacent spaces containing flammable or combustible liquids shall be treated in accordance with the Marine Chemist's requirements and acknowledged on the Certificate.

4.3.3 Adjacent tanks used for radiation shielding on nuclear-powered vessels shall be treated in accordance with the Marine Chemist's requirements.

4.3.4 All tanks, confined spaces, and machinery compartments in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of either 7.1.1 or 7.1.3. For repair or alteration involving hot work, these spaces shall meet the requirements of 7.1.4, 7.1.6, or 5.1.3, and adjacent compartments shall be cleaned to meet the requirements of 7.1.4, 7.1.6, or 5.1.3, or shall be permitted to be inerted to meet the requirements of 7.1.8. The adjacent spaces shall be permitted to be secured in accordance with the Marine Chemist's requirements and acknowledged on the Certificate.

4.3.5 All tanks, confined spaces, and machinery compartments in which external repairs or alterations are to be undertaken shall be either cleaned to comply with the requirements of 7.1.4 or 7.1.6 or shall be inerted to comply with the requirements of 7.1.8. All adjacent compartments shall be cleaned to meet the requirements of 7.1.4, 7.1.6, or 5.1.3, or shall be permitted to be inerted to meet the requirements of 7.1.8. The adjacent spaces shall be permitted to be secured in accordance with the Marine Chemist's requirements and acknowledged on the Certificate.

4.3.6 All other types of military vessels shall be treated in accordance with Section 4.2.

4.4 Vessels in Lay-Up. A tank vessel in lay-up shall be treated in accordance with Section 4.1 and NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up.* No repairs or alterations involving hot work shall be made unless authorized by the Marine Chemist in accordance with the provisions of 7.1.10.

4.5 Vessels Carrying Flammable Compressed Gas. On any vessels that have carried flammable compressed gas in bulk, no repairs or alterations involving hot work shall be made unless the provisions of Section 4.1 have been complied with, provided individual pressure tanks (inerted in accordance with 7.1.9) are considered in a safe condition for such work not directly involving these tanks or their pipelines.

4.6 Obtaining the Marine Chemist's Certificate. It shall be the responsibility of the Certificate requester to retain the services of the Marine Chemist and to obtain copies of the Marine Chemist's Certificate in accordance with the provisions of Section 8.3.

Chapter 5 Preparing Vessels by the Vessel Owner, Operator, or Repairer, for Issuance of a Marine Chemist's Certificate Involving Hot Work

5.1* Where a Safe Condition Is to Be Obtained Entirely by Cleaning. *[See Figure B.1, part (b).]*

5.1.1 All cargo pumps, cargo lines, inert gas lines, crude oil wash lines, piped cargo fire-extinguishing lines, vapor control and recovery lines, and vent lines to the spaces involved in the scope of work shall have been flushed with water, blown with steam or air, or inerted.

5.1.2 Compartments concerned shall be cleaned so that the atmosphere in all cargo compartments and adjacent spaces, including those diagonally adjacent to the cargo compartments, is in accordance with 7.1.1, 7.1.4, or 7.1.6, or with both 7.1.1 and 7.1.6, or with both 7.1.1 and 7.1.4, as applicable.

5.1.3 Partial Cleaning for Limited Hot Work. Tanks or compartments containing combustible residues or preservative coatings shall be permitted to be partially cleaned for limited hot work as described by 5.1.3(A), (B), and (C). Areas to be cleaned shall be cleaned a sufficient distance from the hot work to prevent the spread of fire and shall be cleaned in such a manner as to prevent sparks or slag from the hot work operations from being thrown or dropped into the other portions of the space. A fire watch shall not be used in lieu of cleaning to establish a safe condition. The nature, location, and extent of the hot work shall be listed on the Marine Chemist's Certificate.

(A) Tanks or compartments that have not been washed or steamed and have residues or preservative coatings whose flash point is 82.2°C (180°F) or above, and are free of flowing residues or coatings shall be permitted to be partially cleaned for limited hot work. The area to be cleaned shall meet the requirements of 7.1.4. The flash point of the residues or preservative coatings shall be verified by the Marine Chemist prior to issuing a Certificate.

(B)* Tanks or compartments that have been washed or steamed as thoroughly as practicable and are free of flowing residues or preservative coatings shall be permitted to be partially cleaned for limited hot work. The area to be cleaned shall meet the requirements of 7.1.4. An ignitibility test shall be performed on the residues or preservative coatings prior to issuing a Certificate.

(C) When subject spaces are cleaned to meet 5.1.3(A) and 5.1.3(B), adjacent spaces shall be permitted to be cleaned to meet the requirements of 5.1.3(A) and (B), provided the residues or preservative coatings meet the requirements of 5.1.3(A).

5.1.4 The residues or preservative coatings in all compartments concerned (with the exception of tanks described in 5.1.3) shall be such that the conditions of either 7.1.1 or 7.1.4, or both 7.1.1 and 7.1.4, as applicable, shall be met.

5.2* Where a Safe Condition Is to Be Obtained by Both Cleaning and Inerting or Entirely by Inerting. *[See Figure B.1, parts (c) and (d).]*

5.2.1 The Marine Chemist shall approve the use of the inerting medium and shall personally supervise introduction of the inerting medium into the space to be inerted, except in situations where an inerting medium has been introduced prior to the vessel's arrival at the repair facility. A Marine Chemist, in all cases, shall personally conduct tests to determine that the oxygen content of the inerted space is at or below 6 percent or 50 percent of the amount required to support combustion, whichever is less. The Marine Chemist shall be readily available during the entire period of work and shall determine that the oxygen level in the inerted space is maintained at or below 6 percent or 50 percent of the amount required to support combustion, whichever is lower. On vessels not utilizing cargo space–inerting systems, a Marine Chemist shall specify the safe disposal and securing of the inerting medium following completion of the repair work on the inerted space and adjacent spaces.

5.2.2 All cargo pumps and cargo lines, inert gas lines, and crude oil wash lines shall have been flushed with water, blown with steam or air, or inerted.

5.2.2.1 All valves to the inerted spaces shall be positioned in such a manner and tagged as to prevent or, by written notice, restrict operation.

5.2.2.2 All vent lines (unless they are inerted) shall be inspected to ensure they are free of gas, vapor, and product.

5.2.3 All spaces to be inerted shall be sufficiently intact, and remain sufficiently intact, to retain the inerting medium. All valves, hatches, and other openings to the inerted spaces, except those controlling the inerting medium, shall be closed and secured.

5.2.4 Care shall be exercised in the selection of methods and materials used for cleaning or inerting to avoid incompatibility with previous cargoes.

5.2.5 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of Section 5.3, and all other spaces

(with the exception of tanks described in 5.1.3) shall be inerted in accordance with the requirements of 7.1.8 or 7.1.9, as applicable.

5.2.6 Compartments or spaces on which external repairs or alterations are to be undertaken on the external boundaries (deck or shell) shall be permitted to be inerted instead of being cleaned as described in Section 5.2, and all other spaces (with the exception of tanks described in 5.1.3) shall be inerted in accordance with the requirements of 7.1.8 or 7.1.9, as applicable.

5.3* Where a Safe Condition Is to Be Obtained by Cleaning Certain Compartments and by Securing the Other Compartments. *[See Figure B.1, part (e).]*

5.3.1 Nonadjacent spaces containing atmospheres exceeding 10 percent of the LEL shall be closed and secured, and those spaces shall be noted on the Certificate.

5.3.2 Cargo pumps and cargo lines, and crude oil wash lines to the spaces involved in the scope of work, shall have been flushed with water or blown with steam or air.

5.3.2.1 Vent lines, unless they are inerted to the space involved in the scope of work, shall be inspected to ensure they are free of gas, vapor, and product.

5.3.3 Compartments or spaces in which internal repairs or alterations are to be undertaken and all adjacent compartments, including those diagonally adjacent thereto, shall be cleaned to comply with the applicable requirements of Section 5.1. All other applicable spaces shall be closed and secured in a manner to prevent or, by written notice, restrict opening or operation.

5.4* Where a Safe Condition Is to Be Obtained by Cleaning Some Compartments, by Inerting Some Compartments, and by Securing Some Compartments. *[See Figure B.1, part (f).]*

5.4.1 Cargo pumps and cargo lines, inert gas lines, and crude oil wash lines to the spaces involved in the scope of work shall have been flushed with water, blown with steam or air, or inerted.

5.4.1.1* All valves to the inerted spaces shall be tagged and secured in such a manner as to prevent or, by written notice, restrict opening or operation.

5.4.1.2 Unless they are inerted, vent lines to the spaces involved in the scope of work shall be inspected to ensure they are free of gas, vapor, and product.

5.4.2 Nonadjacent spaces containing atmospheres exceeding 10 percent of the LEL shall be closed and secured in a manner to prevent or, by written notice, restrict opening or operation, and those spaces shall be noted on the Certificate.

5.4.3 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of Section 5.1; and all adjacent compartments, including those diagonally adjacent thereto, shall be inerted to comply with the applicable requirements of 7.1.8 and Section 5.2. All other compartments shall be closed and secured in compliance with 5.3.1. With respect to inerted spaces, the requirements of 5.2.1 shall apply.

5.4.4 Compartments or spaces on which external repairs or alterations are to be undertaken on the external boundaries (deck or shell) shall be permitted to be inerted by gas instead of being cleaned as described in Section 5.1. All adjacent compartments, including those diagonally adjacent thereto, shall be inerted or cleaned to comply with applicable requirements of 7.1.8 and Sections 5.1 and 5.2. All other applicable spaces shall be closed and secured in compliance with 5.3.1.

5.5* Cargo Heater Coils.

5.5.1 All steam-supplied cargo heater coils to the spaces involved, except those to the inerted spaces, shall have been made safe by one of the following means:

(1) Steaming
(2) Flushing with water
(3) Blowing with air
(4) Inerting

5.5.2 Coils in cargo tanks that have been used for chemicals that could react with water or steam shall be cleaned in accordance with the requirements of 5.2.4.

5.5.3 On coiled vessels using thermal heating oils [260°C (500°F) or greater], the Marine Chemist shall be satisfied as to the integrity of the heater coils in the prescribed work areas.

5.6 Electric Welding Operations. When determined by the Marine Chemist to be necessary, electrical welding ground cables shall be connected to the ship's structure as close as possible to the point of welding, with a safe current-carrying capacity equal to or exceeding the specified maximum output capacity of the units that they service.

5.7 Requirements for Use of a Designated Berthing Area for Cleaning, Gas Freeing, or Inerting.

5.7.1 Vessels that have not been cleaned, gas freed, or inerted shall proceed to a designated berth, selected and set apart with due regard to the hazards of the location and to the hazards to adjacent property.

5.7.2 The degassing, cleaning, or inerting of vessels at such designated berths shall be carried out in accordance with the requirements of Section 5.1 or Section 5.2, as appropriate, before they are shifted to other berths. No repairs involving hot work, other than in boiler or machinery spaces when specifically certified by a Marine Chemist, shall be undertaken on any vessel in such designated berth until it has been degassed and cleaned or inerted in accordance with the requirements of Section 5.1 or Section 5.2, as appropriate, nor shall such repairs be then undertaken if another vessel that has not complied with these requirements is in the designated berth at the same time.

5.8* Vessel Fuel Oil Tanks. No hot work shall be permitted immediately adjacent to any vessel's fuel oil tanks unless the work has been authorized by the Marine Chemist.

Chapter 6 Procedures for the Marine Chemist Prior to Issuance of a Certificate

6.1* Calibration and Function Verification. The accuracy and sampling integrity of instruments used by the Marine Chemist shall be verified before each day's use.

6.1.1 Calibration of sensors shall be verified using a known concentration of test gas.

6.1.2 A record of the verification of accuracy or calibration shall be maintained for at least 3 months.

6.2 Determination of Conditions. The Marine Chemist shall personally determine conditions, and shall be permitted to

issue a Marine Chemist's Certificate setting forth in writing that the prescribed work to a vessel can be undertaken with safety. The Marine Chemist shall, whenever possible, physically enter each compartment or space and conduct a visual inspection to the extent necessary to determine the atmospheric or fire hazards that exist. The Marine Chemist shall carry out tests within each compartment or space, ensuring compliance with the minimum applicable requirements prior to issuing a Certificate.

6.2.1 The Marine Chemist's determinations shall include a visual inspection and tests of the spaces to be certified, and for repair or alterations involving hot work, all adjacent spaces and other spaces/areas that can be affected by the hot work shall be treated in accordance with 7.1.4(4) and 7.1.4(5). The inspection shall include spaces or areas where products of hot work such as sparks, slag, or embers can act as ignition sources. The determinations also shall include the following:

(1) The three previous loadings
(2) Nature and extent of the work
(3) Starting time and duration of the work
(4) Tests of cargo and vent lines at manifolds and accessible openings associated with the scope of work on or in the compartments concerned
(5) Verification that pipelines that could release hazardous materials into spaces that will be certified for entry and/or hot work are either disconnected, blanked off, or otherwise blocked by a positive method, or the valves are positioned and tagged in such a manner to prevent, or by written notice restrict, operation
(6) Tests of cargo heating coils

6.2.2 In spaces that are not cargo tanks or are not adjacent to cargo tanks, the Marine Chemist shall carry out tests to determine the atmospheric or fire hazards that could exist within each affected compartment or space and any adjacent spaces that could be affected by hot work, ensuring compliance with the minimum applicable requirements prior to issuing a Certificate.

Chapter 7 Standard Safety Designations and Conditions Required

7.1 General. The standard safety designations in 7.1.1 through 7.1.10 shall be used where applicable in preparing Certificates.

7.1.1* The designation ATMOSPHERE SAFE FOR WORKERS requires that in the compartment or space so designated, the following criteria shall be met at the time the Certificate is issued:

(1)*The oxygen content of the atmosphere is at least 19.5 percent and not greater than 22 percent by volume.
(2)*The concentration of flammable materials is below 10 percent of the lower explosive limit (LEL).
(3)*Any toxic chemicals in the atmosphere associated with cargo, fuel, tank coatings, inerting mediums, adjacent spaces, or fumigants are within permissible concentrations at the time of the inspection.

Exception: Further testing for toxic materials shall not be required if previous testing indicates that these materials have been eliminated or are not capable of regeneration to hazardous levels while maintained as directed on the Marine Chemist's Certificate.

(4)*The residues or chemicals remaining in a certified space are not capable of producing toxic materials that exceed permissible concentrations under existing atmospheric conditions while maintained as directed on the certificate.

7.1.1.1 If any of the conditions of 7.1.1(1), (2), (3), or (4) do not exist, then the designation NOT SAFE FOR WORKERS or ENTER WITH RESTRICTIONS shall be used.

7.1.2 The designation NOT SAFE FOR WORKERS indicates that the compartment or space so designated shall not be entered by personnel.

7.1.3 The designation ENTER WITH RESTRICTIONS indicates that in all spaces so designated, entry for work shall be permitted only if conditions of proper protective equipment, clothing, time, or any or all of the aforementioned, as appropriate, are as specified. The designation ENTER WITH RESTRICTIONS is not intended to apply to spaces with immediately dangerous to life or health (IDLH) atmospheres except to install ventilation equipment or for emergency rescue.

7.1.3.1 The Certificate shall include a statement describing the specific conditions of personal protection equipment, clothing, time, or any or all of the aforementioned. These areas shall be listed on the Certificate under the heading "Restrictions."

7.1.4 The designation SAFE FOR HOT WORK requires that in the compartment or space so designated, the following criteria shall be met at the time the Certificate is issued:

(1)*The oxygen content of the atmosphere is not greater than 22 percent by volume.
(2)*The concentration of flammable materials in the atmosphere is less than 10 percent of the LEL.
(3)*The residues, scale, or soft and greasy preservative coatings in the entire space are cleaned sufficiently to prevent the spread of fire and are not capable of producing a higher concentration than permitted by 7.1.4(1) or (2) under existing atmospheric conditions in the presence of hot work and while maintained as directed on the Certificate.
(4)*All spaces adjacent to cargo tanks certified "SAFE FOR HOT WORK," as well as all cargo tanks adjacent to a hot work site, have combustible gas readings less than 10 percent of the LEL and have been cleaned sufficiently of residues, scale, or preservative coatings to prevent the spread of fire, or have been inerted.
(5) Non-cargo tank spaces adjacent to cargo spaces certified "SAFE FOR HOT WORK" are treated in accordance with Marine Chemist requirements and acknowledged on the Certificate.
(6) Spaces such as passageways, living spaces, or store rooms that are not adjacent to cargo tanks, and are undergoing hot work, meet the requirements of 7.1.4(1) and 7.1.4(2). These spaces, along with any adjacent spaces, shall be treated in accordance with the Marine Chemist's instructions and be free of material that could ignite under conditions of work or be protected with barriers to prevent the spread of fire.
(7) Engine room or fire room bilges, or other machinery spaces, or spaces that have not contained flammable or combustible cargo, fuels, or oils are treated in accordance with the Marine Chemist's requirements.

7.1.4.1 If any of the conditions of 7.1.4(1), (2), (3), or (4) do not exist, the designation NOT SAFE FOR HOT WORK shall be used.

7.1.5 The designation NOT SAFE FOR HOT WORK indicates that in, or on, the compartment or space so designated, hot work shall not be permitted.

7.1.6 The designation SAFE FOR LIMITED HOT WORK indicates that all of the following criteria shall be met at the time the Certificate is issued:

(1) Any compartment or space so designated meets the requirements of 7.1.4(1) and 7.1.4(2), unless inerted in accordance with 7.1.8.
(2) The Certificate shall include a statement describing the specific location and type of the hot work. The Marine Chemist shall also be permitted to list any areas to be excluded from hot work. These areas shall be listed on the Certificate under the heading "Limitations."
(3) The space meets one of the following conditions:
   (a) The space or compartment is inerted in accordance with 7.1.8, and the hot work is limited to the specific location or locations described in the "Limitations" in 7.1.6(2). At the time of the inspection, the Marine Chemist verifies that the atmosphere of the adjacent space(s) meets the requirements of 7.1.4(4) or 7.1.4(5) or is inerted.
   (b) The space or compartment meets the requirements of 7.1.4(1), 7.1.4(2), and 7.1.4(3); adjacent spaces meet 7.1.4(4) or 7.1.4(5); and the hot work is not allowed on pipelines. The hot work restrictions shall be listed under "Limitations" in accordance with 7.1.6(2). The marine chemist verifies that the concentration of flammable materials in the atmosphere is less than 10 percent of the LEL or that the space is inerted in accordance with 7.1.8.
   (c) Portions of the space or compartment meet the requirements of 7.1.4(3) and 7.1.4(4), or 7.1.4(5), as well as the applicable portions of 5.1.3, and the hot work is limited to the location or locations described in the "Limitations" in 7.1.6(2).
   (d) In compartments or spaces on vessels that are not considered cargo or fuel tanks and have not contained and are not subject to concentrations of combustible, flammable, or toxic liquids, vapors, or gases, the Marine Chemist shall survey the spaces and the adjacent spaces in accordance with 6.2.1. The Certificate shall include a statement under the heading "Limitations" that describes the locations and type of hot work, and instructions for the competent person to maintain safe work conditions.

7.1.7 The designation SAFE FOR SHIPBREAKING requires that the compartment so designated shall meet the criteria of 7.1.4(1) through 7.1.4(4). The residual combustible materials designated shall not be capable of producing fire beyond the extinguishing capabilities of the equipment on hand.

7.1.8 The designation INERTED requires that one of the following procedures shall have been completed in the compartment or space so designated:

(1)*Carbon dioxide or other nonflammable gas acceptable to the Marine Chemist shall have been introduced into the space in sufficient volume to maintain the oxygen content of the atmosphere of the space at or below 6 percent or 50 percent of the amount required to support combustion, whichever is less. *(See Annex E.)* The Marine Chemist shall note on the Certificate the kind of inert gas, the methods for maintaining safe conditions, and the measures for safe disposal of the inert gas upon completion of repairs in accordance with 5.2.1. Closing and securing of hatches and other openings, except vents, shall be permitted to be used as "safe disposal" methods by the Marine Chemist.
(2) Spaces other than cargo tanks and fuel tanks shall have been filled to overflow with water, and the water level shall be maintained throughout the intended work. Valves shall be tagged or by written notice positioned to restrict operation to maintain the water level. If any headspace remains in the tank, it shall meet the requirements of 7.1.4(2).
(3) The space shall have been filled with water so that the water level is a minimum of 0.9 m (3 ft) above the intended exterior hot work and the atmosphere of the headspace meets the requirements of 7.1.4(2). The water level shall be maintained throughout the intended work by tagging valves in a position to maintain the water level. Any such procedure shall be approved by the Marine Chemist.
(4)*All valves, vent lines, and other openings to the inerted spaces shall be positioned in such a manner and tagged as to prevent or, by written notice, restrict operation.

7.1.9 The designation INERTED FOR FLAMMABLE COMPRESSED GAS requires that individual pressure tanks with a working pressure of 3.45×10^5 Pa (50 psi) or more shall constitute a safe condition for such work not directly involving these tanks or their pipelines when a positive pressure is maintained on the tanks by the flammable vapors, and when special precautions are observed under carefully controlled conditions as specified on the Certificate.

7.1.10 The designation SAFE FOR LAY-UP requires that the tank ship so designated shall meet any of the following conditions at the time the Certificate is issued:

(1) The vessel is cleaned in accordance with the provisions in Section 5.1, and the vessel is inspected weekly by the responsible owner's representative to ensure that no change in conditions occurs.
(2) All the cargo tanks are discharged of cargo, the residues are not capable of producing more than 10 percent of the LEL, and the vessel is inspected weekly by the responsible owner's representative to ensure that no change in conditions occurs.
(3) All the cargo tanks are inerted to less than 8 percent oxygen, or 50 percent of the amount of oxygen required to support combustion, whichever is less. Thereafter, the responsible owner's representative shall be in constant attendance, and the vessel shall be reinspected daily until stabilized; and, thereafter, the responsible owner's representative shall maintain daily inspections and records of oxygen content.

7.1.10.1 Preparation of vessels for lay-up shall be in accordance with NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up.*

7.1.10.2 Failure to comply with the requirements of 7.1.10 shall void the Certificate.

Chapter 8 The Marine Chemist's Certificate

8.1 Preparation of Certificates. When the Marine Chemist is satisfied that the related requirements necessary for the safe conduct of the work have or have not been met, a Certificate shall be prepared in accordance with this standard.

8.1.1 The Certificate shall be written legibly. If ink stamps are used, all copies of the Certificate shall be stamped and legible.

8.1.2 The Certificate shall include instrument test results of the Marine Chemist's inspections and tests, for all spaces tested including adjacent spaces as required by the standard.

8.1.2.1* Limits of detection (LOD) for toxic test results shall be indicated on the Certificate.

8.1.3 Any additional requirements or qualifications issued by the Marine Chemist shall be specified on the Certificate, such as the following:

(1) Frequency and type of such additional tests, inspections, qualifications, and other instructions as the Marine Chemist specifies
(2) Conditions under which the Marine Chemist shall be consulted or recalled

8.1.4 Such qualifications and requirements shall include precautions, including protective equipment and devices, necessary to eliminate or minimize hazards that could be present from combustibles, protective coatings, or residues from cargoes. These qualifications shall include limitations or restrictions, if any, on the areas where work is to be done and shall be listed on the Certificate.

8.2 Issuance of Certificates. The Certificate shall be completed, and a signature for receipt of the Certificate shall be obtained, signifying the understanding of the conditions and limitations and the requirements for maintaining conditions under which it is issued. Any additions to or deletions from such a Certificate after obtaining a signature for receipt shall void the Certificate and require reissuance.

8.2.1 If the Certificate is issued in connection with commencement of repair work, it shall be delivered to and signed for by the ship repairer or his or her authorized representative.

8.2.2 If the Certificate is issued for purposes other than the commencement of repair work, it shall be delivered to and signed for by the person who authorized the inspection or an authorized representative.

8.3 Obtaining the Marine Chemist's Certificate. It shall be the responsibility of the Certificate requester to retain the services of the Marine Chemist and to obtain copies of the Marine Chemist's Certificate in accordance with the provisions of this section.

8.3.1 It shall be the responsibility of the Certificate requester to provide the master of the vessel and the representatives of the vessel owner with copies of such Certificate. Receipt and understanding of the Certificate shall be acknowledged by signature of the person designated in 8.2.1 or 8.2.2, as applicable.

8.3.2 It shall be the responsibility of the person signing for receipt of the Certificate to securely post the Certificate in a conspicuous place aboard the vessel before a space is entered or work is started.

8.3.3 It shall be the responsibility of the Certificate requester, vessel owner, or their representative to ensure that all access openings to spaces designated NOT SAFE FOR WORKERS, including inerted spaces, shall be appropriately labeled with a warning sign, which shall read "NOT SAFE FOR WORKERS" and which shall remain in place unless recertified.

8.3.4 Only one requester shall be listed on the certificate. The requester shall be responsible for providing a statement of the scope of the work at the time of the Marine Chemist's inspection. The requester listed on the Certificate shall be responsible for maintaining the Certificate in accordance with Section 8.4 and with 29 CFR 1915.15. If the requester is a host employer in a multi-employer workplace, then the host employer shall be responsible for maintaining the Certificate for all contract employers unless the host employer requires contract employers to obtain and maintain their own Certificate.

8.4 Maintaining the Responsibility for Conditions. In order for the Certificate to be maintained, the following conditions shall be met by the Certificate requester, vessel owner, or their representative:

(1) The conditions documented on the Certificate shall be inspected by the shipyard competent person within 1 day unless otherwise noted on the Certificate.
(2) Throughout the course of repairs or alterations, conditions on the Certificate shall be maintained on the vessel by testing and visually inspecting all certified spaces, including all adjacent spaces, accessory piping, valves, coils, and so on, that were part of the original inspection.
(3)*Unless otherwise stated on the Certificate, certified spaces, including spaces adjacent to hot work, where work is being done shall be reinspected daily, or more often as necessary, by the shipyard competent person prior to entry or hot work.
(4) It is the responsibility of the Certificate requester or vessel owner, or the requester's or owner's representative, to ensure that the prescribed work is carried out at the original location within the facility for which the Certificate was issued, unless movement is authorized within that facility by the Marine Chemist on the Certificate. If movement is authorized within the facility, a reinspection shall be performed by a competent person. The Marine Chemist shall include on the Certificate the nature of any tests to be performed after the move is complete and prior to beginning work.
(5) The calibration of all instruments used by a competent person to maintain a Marine Chemist's Certificate shall be verified by either the competent person, another qualified individual, or metrology laboratory, before each day's use by using a known concentration of test gas in a manner consistent with the manufacturer's recommendations. A record shall be maintained for at least 3 months.
(6) Certificates not maintained according to the requirements in 8.4(1) through (5) shall be void.

Chapter 9 Additional Requirements for Flammable Cryogenic Liquid Carriers

9.1 Scope.

9.1.1* The design and operational characteristics of tank, cargo-handling, and related systems on vessels carrying flammable cryogenic liquid cargoes shall be fully appreciated by the Marine Chemist in making the determinations required by Section 6.2 of this standard. This chapter describes the conditions required before repairs can be made in spaces that

have carried or have been exposed to flammable cryogenic liquid cargoes in their liquid or vapor form.

9.1.2 This chapter supplements the factors to be considered prior to issuance of the Certificate in accordance with Section 6.2.

9.1.3 Only those Marine Chemists who have evidenced the required additional experience, training, and knowledge shall be authorized to issue Certificates under the requirements of Chapter 9. Such Marine Chemists shall receive a special endorsement on the Marine Chemist's Certificate issued them by the National Fire Protection Association.

9.2 Definitions. The following terms related to flammable cryogenic liquid carriers and defined in Chapter 3 shall apply to this chapter:

(1) Cargo Area *(3.5.1)*
(2) Cargo Containment System *(3.5.2)*
(3) Cryogenic Liquid *(3.5.3)*
(4) Hold Space *(3.5.4)*
(5) Interbarrier Space *(3.5.5)*
(6) Primary Barrier *(3.5.6)*
(7) Secondary Barrier *(3.5.7)*

9.3 Minimum Requirements.

9.3.1 All minimum requirements for issuance of the Certificate as set forth in Chapters 6, 7, and 8 of this standard shall be met prior to commencement of hot work or entry in spaces that have carried or been exposed to flammable cryogenic liquids or their vapors.

9.3.2 The special safety designation SAFE FOR REPAIR YARD ENTRY shall apply only to flammable cryogenic liquid carriers and describes vessels whose compartments and spaces either have been tested by sampling at remote sampling stations, with results indicating that the atmosphere tested is above 19.5 percent oxygen and less than 10 percent of the lower explosive limit (LEL), or have been inerted in accordance with 7.1.8.

9.3.3 Vessels whose cargo containment systems have not met the criteria of 9.3.2 shall be permitted to undergo specific limited repairs in locations outside those spaces. However, such repairs or alterations shall not be undertaken until a Certificate is obtained. When undergoing such repairs, the vessel shall be berthed in a special location selected with due regard to the hazards of the location and to hazards to adjacent property. Should the Marine Chemist have reason to question the safety of any aspect of the site selection, he or she shall consult the proper governmental authorities.

9.3.4 Because interbarrier spaces or insulation could contain pockets of cargo vapors that can be released over varying time periods, the Marine Chemist shall inspect for gas concentration and combustible materials before work in or on the boundaries of such places is begun.

9.3.5 The following information shall be used by the Marine Chemist as a guide for making his or her inspection:

(1) Description and schematic arrangement of provisions for inerting cargo tanks, hold spaces, or interbarrier spaces, as applicable
(2) Description and instruction manual for calibration of the cargo leak detector equipment
(3) Schematic plan showing locations of leak detector(s) and sampling points
(4) Schematic plan(s) of liquid and vapor cargo piping
(5) U.S. Coast Guard Letter of Compliance and Certificate of Fitness for foreign flag vessels, or the Certificate of Inspection and Certificate of Fitness for U.S. flag vessels
(6) The recent history of cargoes handled with special reference to outturn and any pertinent unusual incidents encountered

9.4 Minimum Conditions.

9.4.1 Minimum conditions that shall prevail prior to the issuance of a Certificate for spaces that have contained or been exposed to flammable cryogenic liquids or their vapors shall be as set forth in Chapter 5, insofar as they are applicable, and as set forth in Section 9.4.

9.4.2 When vessels are undergoing repairs, no venting of cargo tanks, systems, or other spaces that could contain inert gas or flammable vapors shall take place without approval of the Marine Chemist. Any other activity that could similarly alter the atmosphere in the vicinity of the repair work shall be permitted to be undertaken only with such approval.

9.4.3 Vessels that are capable of burning cargo boil-off as a fuel for their main propulsion system or for other purposes shall be inspected to ensure that gas supply lines to the fire room or other spaces have been properly secured, inerted, or otherwise properly treated prior to repairs to this system.

9.4.4 Prior to the opening of cargo machinery or systems for repairs, such equipment shall have been purged and ventilated to remove cargo vapor or inert gas.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.8 The Marine Chemist, as a shipyard safety professional, should take note of any observed physical hazards in a tank or confined or enclosed space, and convey that information to those individuals who are empowered and qualified to correct such hazards. Some examples of physical hazards are, among others, broken or rusted ladder rungs, engulfment, entrapment, obvious electrical hazards, and noise hazards.

A.1.3 In all emergency situations, all necessary precautionary measures should be undertaken as soon as is practical to provide safe conditions satisfactory to the Marine Chemist.

A.1.4 All applicable regulations, requirements, and standards should be consulted. Some of the requirements in this standard might exceed minimum governmental regulations to better protect personnel and property.

A.3.2.1 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many

circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.5 Combustible Material. See 29 CFR 1915 Subpart P for guidance when doing hot work near these materials, and NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, for additional information on doing hot work around combustible material.

A.3.3.6 Competent Person. In accordance with OSHA's Shipyard Industry standard (29 CFR 1915.7), competent persons are required to be designated by their employer. The employer also has to ensure that the designated competent person has specific skills, knowledge, and abilities based on the criteria set forth in 29 CFR 1915.7. Maritime confined space safety training is available from NFPA, many Marine Chemists, and other safety or training professionals.

In addition to the criteria outlined in 29 CFR 1915.7, the following content is suggested as a minimum for competent person training:

(1) *Hazard Description and Recognition*
   (a) Relevant terms, fire and explosion theory, relevant chemistry (including concepts of flash point, explosive range, the role of oxygen, classification of fuels, and solvent vapor pressure)
   (b) Relevant shipboard structures, locations, and systems
   (c) Toxicity of materials and concepts of exposure guidance
   (d) Toxicity resources, guidance, and standards: the ACGIH TLVs, OSHA's Maritime Standards
   (e) MSDS information and skills

(2) *Hazard Evaluation and Measurement*
   (a) Instrumentation theory, operation, maintenance, calibration, and hands-on training (including the workings and limitations of the combustible gas meter, the oxygen meter, colorimetric detector tube systems, and specific gas electrochemical sensors)
   (b) Preparation for and execution of shipboard confined space testing

(3) *Hazard Prevention, Control, and Elimination*
   (a) Regulations: Scope and Application of 29 CFR 1915 and NFPA 306
   (b) The responsibilities and interactions of the competent person and NFPA Certificated Marine Chemist
   (c) NFPA Marine Chemist's standard safety designations
   (d) Control of ignition sources
   (e) Ventilation theory and application
   (f) Key aspects of respiratory protection
   (g) The fire watch
   (h) Written competent person records
   (i) Marine Chemist's Certificate

(4) *Practical Application Simulation*
   (a) Hands-on actual or simulated exercises, using instruments involving the students, as guided by the instructors
   (b) Practice and reviewed exercises in recordkeeping and certifications

(5) *Examination*

A.3.3.12.1 Combustible Liquid. Definition applies as determined by the test procedures and apparatus set forth in Chapter 4 of NFPA 30, *Flammable and Combustible Liquids Code*. Combustible liquids are classified as Class II or Class III as follows:

(1) Class II Liquid — Any liquid that has a flash point at or above 37.8°C (100°F) and below 60°C (140°F)
(2) Class IIIA — Any liquid that has a flash point at or above 60°C (140°F), but below 93°C (200°F)
(3) Class IIIB — Any liquid that has a flash point at or above 93°C (200°F)

A.3.3.12.3 Flammable Liquid. Definition applies as determined by the test procedures and apparatus set forth in Chapter 4 of NFPA 30, *Flammable and Combustible Liquids Code*. Flammable liquids are classified as Class I as follows:

(1) Class I Liquid — Any liquid that has a closed-cup flash point below 37.8°C (100°F) and a Reid vapor pressure not exceeding 2068.6 mm Hg (40 psia) at 37.8°C (100°F), as determined by ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*

Class I liquids are further classified as follows:

(1) Class IA — Those liquids that have flash points below 22.8°C (73°F) and boiling points below 37.8°C (100°F)
(2) Class IB — Those liquids that have flash points below 22.8°C (73°F) and boiling points at or above 37.8°C (100°F)
(3) Class IC — Those liquids that have flash points at or above 22.8°C (73°F), but below 37.8°C (100°F)

A.3.3.13 Marine Chemist. Activities of a Marine Chemist, as defined in this standard, are limited to the inspection and certification procedures described in this standard and consulting services connected therewith.

A.3.3.16 Requester. The requester of the Marine Chemist Certificate is generally considered to be one of the following: vessel owner, vessel repairer, shipbreaker, or vessel builder.

A.3.3.17 Secured. Examples of a secured condition include dogged down, bolted down, removing or locking the valve handwheel, and labeled.

A.3.3.20 Vessel. Offshore drilling, production and/or storage vessels can be included in this definition.

A.3.4.2 Hot Work. Grinding, drilling, abrasive blasting, or similar spark-producing operations should always be considered hot work when conducted in the presence of accumulations of flammable gases, flammable or combustible liquids, their vapors, or accumulations of other common combustible materials.

A.3.5.1 Cargo Area. Where applicable, the cofferdams, ballast tanks, or void spaces located at the after end of the aftermost hold space, or at the forward end of the forwardmost hold space, are excluded from the cargo area.

A.3.5.2 Cargo Containment System. If the secondary barrier is part of the hull structure, it can be a boundary of the hold space.

A.5.1 The requirements of this section can be used in preparing other spaces such as fuel tanks, landside spaces, or hollow structures covered by the standard as appropriate.

A.5.1.3(B) This test can be performed by exposing a sample of the residue or preservative coating to a strong open flame and observing the ease with which it ignites or burns. This test should be performed off the vessel or in an area approved for hot work.

A.5.2 See A.5.1.

A.5.3 See A.5.1.

A.5.4 See A.5.1.

A.5.4.1.1 The valves to the inerted compartments referenced in this requirement do not include those valves that are part of a fixed inert gas system used in controlling the introduction of the inerting medium into the subject space. During the inerting process, the valves on the inert gas line to a subject space are used by qualified individuals to regulate inert gas flow and/or pressure in the inerted space.

A.5.5 See A.5.1.

A.5.8 On dry cargo vessels, miscellaneous vessels, passenger vessels, and shipyard employment land-side operations, no hot work is permitted adjacent to any vessel's or other fuel oil tanks unless the work has been authorized by the Marine Chemist. When the adjacent space contains flammable or combustible liquids with a flash point at or below 65.6°C (150°F), or flammable gases and the distance between such spaces and the hot work is greater than 7.6 m (25 ft), then a competent person can visually inspect and test the space. [If the hot work is 7.6 m (25 ft) or closer to the adjacent space containing such flammables, then a Marine Chemist must certify the hot work.]

A.6.1 It is recognized that in limited circumstances, the Marine Chemist might not be able to transport compressed calibration gas by air. In these limited cases, the Marine Chemist should make every attempt to verify the accuracy of their instruments prior to use.

A.7.1.1 Spaces adjacent to spaces that are certified by the Marine Chemist might or might not be open at the time of inspection. It is generally recognized that adjacent spaces pose a reduced risk to workers performing cleaning or other cold work in certified spaces. The Marine Chemist should consider those risks presented by adjacent spaces at the time of the inspection and prepare the Certificate based upon the knowledge of work described to the Marine Chemist by the vessel repairer, shipbreaker, or vessel builder. See statement on Certificate that highlights ". . . spaces not listed on the Certificate are not to be entered unless authorized on another Certificate and/or maintained in accordance with Subpart B, 29 CFR 1915."

A.7.1.1(1) It is important that any change from ambient oxygen levels, either up or down, be investigated. The range of 19.5 percent to 22 percent has been selected for reasons of the accuracy of the meter and the precision with which it can be read.

A.7.1.1(2) The level of 10 percent of the LEL should not be used to determine the toxic level. It is to be used in those instances where a fire hazard would be present, such as with hydrogen, methane, and so forth, but not be a toxic hazard.

A.7.1.1(3) Permissible concentrations can be found in the latest version of *Threshold Limit Values for Chemical Substances and Physical Agents,* published by the American Conference of Governmental Industrial Hygienists, in Subpart Z of 29 CFR 1915.1000, "Permissible Exposure Limit Value," or the value listed in the manufacturer's safety data sheet (SDS).

When determining "permissible concentrations" according to 7.1.1(3), the Marine Chemist should use the lower value of the published ACGIH's Threshold Limit Values (TLVs) or OSHA's Permissible Exposure Limit (PEL) as the primary source for compliance with this requirement. Only in the absence of a published TLV and PEL for a substance should the Marine Chemist refer to the manufacturer's SDSs to determine if any alternate value exists.

A.7.1.1(4) See A.7.1.1(3).

A.7.1.4(1) See A.7.1.1(1).

A.7.1.4(2) The terms *lower flammable limit (LFL)* and *lower explosive limit (LEL)* are used synonymously. Refer to *Fire Protection Guide to Hazardous Materials.*

It is important that any change from the levels found by the Marine Chemist be investigated. A positive change in the LEL would indicate the presence of flammable contaminants in the atmosphere.

A.7.1.4(3) For spaces that have not contained flammable or combustible cargo, fuels, or oils, the Marine Chemist can use guidance documents such as NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up,* or 29 CFR 1915 Subpart P.

A.7.1.4(4) For adjacent spaces that have not contained flammable or combustible cargo, fuels, or oils, the Marine Chemist can use guidance documents such as NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up,* or 29 CFR 1915, Subpart P.

A.7.1.8(1) The improper introduction of an inerting gas can generate sufficient static electricity for ignition. Refer to NFPA 69, *Standard on Explosion Prevention Systems,* for level of oxygen to support combustion and NFPA 77, *Recommended Practice on Static Electricity,* and industry standards such as *International Safety Guide for Oil Tankers and Terminals* (ISGOTT) and *Tanker Safety Guide* (Chemicals).

A.7.1.8(4) Valves can be opened, closed, or blanked as necessary to maintain the inert condition of the space.

A.8.1.2.1 Due to the different methods of conducting tests for toxic materials, the results should be listed as "None detected" along with the limit of detection (LOD) or less than (<) the LOD:

(1) Example 1: Benzene — None Detected LOD = 0.5 ppm.
(2) Example 2: Benzene <0.5 ppm.

A result listed as zero (0) does not provide enough information to the end user of the Certificate. Some LODs can exceed established exposure limits.

A.8.4(3) The Marine Chemist can recognize a facility's procedures and infrastructure used to minimize risk and hazards to people and equipment through engineering controls supplemented by administrative controls. As an example, mechanical exhaust ventilation for the space has been installed and will operate continuously. OSHA, in 29 CFR 1915.13, notes that the frequency of retesting the atmospheric conditions of a space should be a function of several factors, including temperature, work in the tank, period of time elapsed, unattended tanks, work breaks, or ballasting.

This section allows the rotation of work away from spaces that have been certified and worked in or on, but where work has been suspended due to schedule requirements. It requires the shipyard competent person (if not the Marine Chemist) to reinspect and establish that safe conditions remain in certified spaces and applicable adjacent spaces before work resumes in or on such spaces. Vessel or shipyard management must always be aware, however, that any suspension of work in or on a confined or enclosed space constitutes a time for significant potential accumulation of hazards, and careful and documented reinspection before reentry and resumption of work is a strict necessity and requirement.

The intent of this wording is to clarify that spaces listed on the Marine Chemist Certificate do not need to be tested by the competent person unless work is being done on or in a space. For example, spaces on a Certificate do not need to be tested

and inspected on a weekend if no work or entry is taking place. However, nothing is to prevent a competent person from testing more frequently than the minimum.

A.9.1.1 Flammable cryogenic liquid carriers present hazards due to the presence of gas-dangerous spaces. The following are examples of gas-dangerous spaces:

(1) A space in the cargo area that is not arranged or equipped in an approved manner to ensure that its atmosphere is at all times maintained in a gas-free condition.
(2) An enclosed space outside the cargo area through which any piping that could contain liquid or gaseous products passes, or within which such piping terminates, unless approved arrangements are installed to prevent any escape of product vapor into the atmosphere of that space.
(3) A cargo containment system and cargo piping.
  (a) A hold space where cargo is carried in a cargo containment system requiring a secondary barrier.
  (b) A hold space where cargo is carried in a cargo containment system not requiring a secondary barrier.
(4) A space separated from a hold space described in A.9.1.1(3)(a), above, by a single gastight steel boundary.
(5) A cargo pump room and cargo compressor room.
(6) A zone on the open deck or semienclosed space on the open deck within 3 m (9.84 ft) of any cargo tank outlet, gas or vapor outlet, cargo pipe flange, cargo valve, or entrance and ventilation opening to cargo pump rooms and cargo compressor rooms.
(7) The open deck over the cargo area and 3 m (9.84 ft) forward and aft of the cargo area on the open deck up to a height of 2.4 m (7.88 ft) above the weather deck.
(8) A zone within 2.4 m (7.88 ft) of the outer surface of a cargo containment system where such surface is exposed to the weather.
(9) An enclosed or semienclosed space in which pipes containing product are located.
(10) A compartment for cargo hose.
(11) An enclosed or semienclosed space having a direct opening into any gas-dangerous space or zone.

Annex B Examples of Safe Conditions

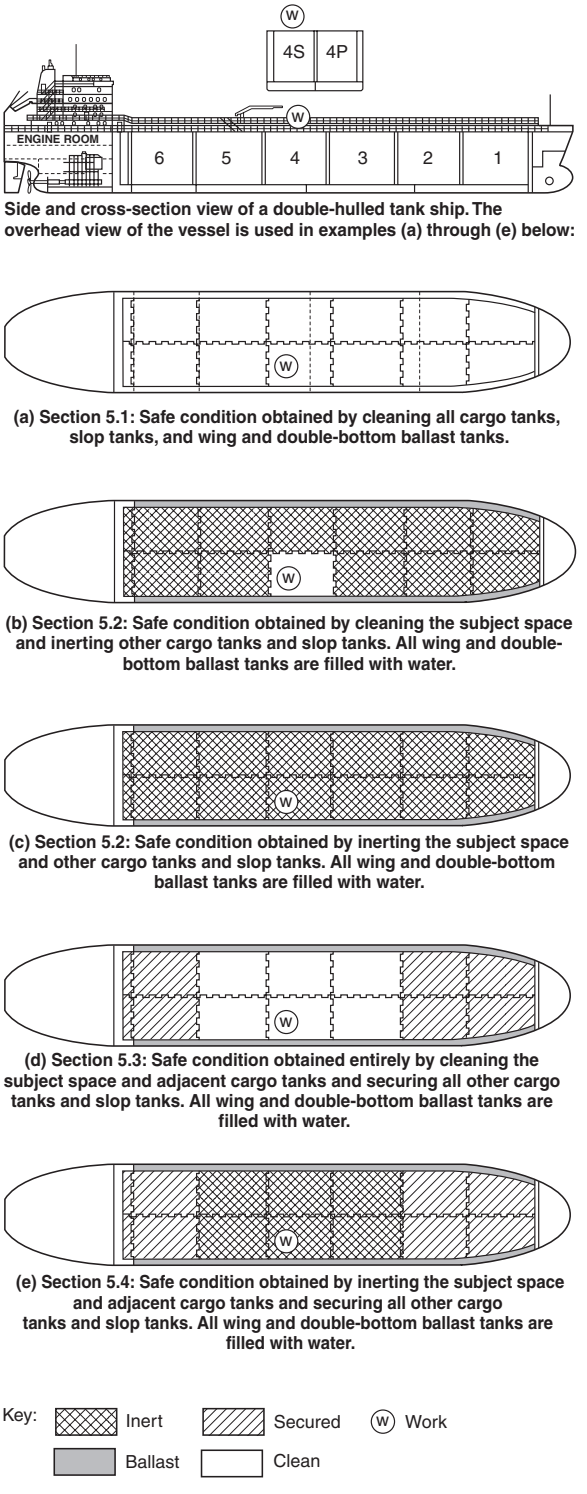
This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 General. The illustrations of a double-hulled tank ship in Figure B.1, parts (a) through (e), are examples of safe conditions discussed in Chapter 5 of this standard. In this example, hot work is planned for the deck area above the four-starboard cargo tank. The vessel is not in a dry dock. The conditions shown in the drawings correspond to Sections 5.1 through 5.4 of this standard. Although the single plane drawings show horizontal separations only, vertical compartmentation should be similarly treated.

Annex C Samples of Marine Chemist's Certificates

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Paper Marine Chemist's Certificate Form. The Certificate shown in Figure C.1 is a sample of the paper form that is filled out manually by the Marine Chemist at the completion of the inspection.



Side and cross-section view of a double-hulled tank ship. The overhead view of the vessel is used in examples (a) through (e) below:

(a) Section 5.1: Safe condition obtained by cleaning all cargo tanks, slop tanks, and wing and double-bottom ballast tanks.

(b) Section 5.2: Safe condition obtained by cleaning the subject space and inerting other cargo tanks and slop tanks. All wing and double-bottom ballast tanks are filled with water.

(c) Section 5.2: Safe condition obtained by inerting the subject space and other cargo tanks and slop tanks. All wing and double-bottom ballast tanks are filled with water.

(d) Section 5.3: Safe condition obtained entirely by cleaning the subject space and adjacent cargo tanks and securing all other cargo tanks and slop tanks. All wing and double-bottom ballast tanks are filled with water.

(e) Section 5.4: Safe condition obtained by inerting the subject space and adjacent cargo tanks and securing all other cargo tanks and slop tanks. All wing and double-bottom ballast tanks are filled with water.

FIGURE B.1 Illustrations of Safe Conditions.

C.2 Computer-Generated Marine Chemist's Certificate Form. The Certificate shown in Figure C.2 is a sample of the computer-generated form that is created by the Marine Chemist at the completion of the inspection. The printed form can be produced on letter or legal size paper and can be printed in color or in black and white.

MARINE CHEMIST CERTIFICATE
SERIAL NO. A 00000

Survey Requested by	Vessel Owner or Agent	Date
Vessel	Type of Vessel	Specific Location of Vessel
Last Three (3) Loadings	Tests Performed	Time Survey Completed

In the event of physical or atmospheric changes affecting the STANDARD SAFETY DESIGNATIONS assigned to any of the above spaces, this certificate is voided; spaces not listed on the Certificate are not to be entered unless authorized on another Certificate and/or maintained in accordance with OSHA 29 CFR 1915; or if in any doubt, immediately stop all work and contact the undersigned Marine Chemist. Unless otherwise stated on the Certifcate, all spaces and affected adjacent spaces are to be reinspected daily or more often as necessary by the competent person in support of work prior to entry or recommencement of work.

QUALIFICATIONS: Transfer of ballast, cargo, fuel, or manipulation of valves or closure equipment tending to alter conditions in pipelines, tanks, or compartments subject to gas accumulation, unless specifically approved in this Certificate, requires inspection and a new Certificate for spaces so affected. All lines, vents, heating coils, valves, and similar enclosed appurtenances are considered "not safe" unless otherwise specifically designated. Movement of the vessel from its specific location voids the Certificate unless shifting of the vessel within the facility has been specifically authorized on this Certificate.

STANDARD SAFETY DESIGNATIONS (partial list, paraphrased from NFPA 306):

ATMOSPHERE SAFE FOR WORKERS: In the compartment or space so designated (a) the oxygen content of the atmosphere is at least 19.5 percent and not greater than 22 percent by volume; (b) the concentration of flammable materials is below 10 percent of the lower explosive limit; (c) any toxic materials in the atmosphere associated with cargo, fuel, tank coatings, inerting mediums, or fumigants are within permissible concentrations at the time of the inspection.

NOT SAFE FOR WORKERS: In the compartment or space so designated, entry is not permitted.

ENTER WITH RESTRICTIONS: In the compartment or space so designated, entry for work is permitted only if conditions of proper protective equipment, or clothing, or time, or all of the aforementioned, as appropriate, are as specified.

SAFE FOR HOT WORK: In the compartment or space so designated (a) the oxygen content of the atmosphere is not greater than 22 percent by volume; (b) the concentration of flammable materials in the atmosphere is less than 10 percent of the lower explosive limit; (c) the residues, scale, or preservative coatings are cleaned sufficiently to prevent the spread of fire and are not capable of producing a higher concentration than permitted by (a) or (b); (d) all adjacent spaces containing or having contained flammable or combustible materials are sufficiently cleaned of residues, scale, or preservative coatings to prevent the spread of fire, or they are to be inerted. Ship's fuel tanks, lube tanks, or engine room or fire room bilges, or other machinery spaces, are to be treated in accordance with the Marine Chemist's requirements.

NOT SAFE FOR HOT WORK: In the compartment or space so designated, hot work is not permitted.

SAFE FOR LIMITED HOT WORK: In the compartment or space so designated (a) portions of the space are to meet the requirements for SAFE FOR HOT WORK AND PARTIAL CLEANING, as applicable; (b) the space is to be inerted, adjacent spaces are to meet the requirements for SAFE FOR HOT WORK, and hot work is restricted to specific locations; (c) portions of the space are to meet the requirements for Safe for Hot Work, as applicable, and the nature or type of hot work is to be limited or restricted.

CHEMIST'S ENDORSEMENT: This is to certify that I have personally determined that all spaces in the foregoing list are in accordance with NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, and have found the condition of each to be in accordance with its assigned designation.

The undersigned acknowledges receipt of this Certificate under NFPA 306 and understands conditions and limitations under which it was issued, and the requirements for maintaining its validity.

This Certificate is based on conditions existing at the time the inspection herein set forth was completed and is issued subject to compliance with all qualifications and instructions.

Signed _____
Name Company Date

Signed _____
Marine Chemist Certificate No.

VESSEL POSTING

 NFPA 306

FIGURE C.1 Sample of the Paper Form to Be Filled Out After Inspection for Certification.

C. M. Chemist — NFPA Certificated Marine Chemist
1 Batterymarch Park, Quincy, MA 02169
Office: 000-000-0000 Fax: 000-000-0000

MARINE CHEMIST CERTIFICATE

SERIAL 000-00000
Page 1 of 1

Survey Requested by	Vessel Owner or Agent	Date
Vessel	Type of Vessel	Specific Location of Vessel
Last Three 3 Loadings	Tests Performed	Time Survey Completed

Inspected Spaces:

Safety Designations:

Instructions:

Test Results:	**% O_2**	**% LEL**	**Toxic-1**	**Toxic-2**	**Toxic-3**	**Toxic-4**
Applies to all inspected spaces listed above	*%*	*%*	*ppm*	*ppm*	*ppm*	*ppm*

Adjacent Spaces:

Entire Vessel Instructions:

In the event of physical or atmospheric changes affecting the STANDARD SAFETY DESIGNATIONS assigned to any of the above spaces, this certificate is voided; spaces not listed on the Certificate are not to be entered unless authorized on another Certificate and/or maintained in accordance with OSHA 29 CFR 1915; or if in any doubt, immediately stop all work and contact the undersigned Marine Chemist. Unless otherwise stated on the Certificate, all spaces and affected adjacent spaces are to be reinspected daily or more often as necessary by the competent person or the authority have jurisdiction as applicable in support of work prior to entry or recommencement of work.

QUALIFICATIONS: Transfer of ballast, cargo, fuel, or manipulation of valves or closure equipment tending to alter conditions in pipelines, tanks, or compartments subject to gas accumulation, unless specifically approved on this Certificate, requires inspection and a new Certificate for spaces so affected. All lines, vents, heating coils, valves, and similar enclosed appurtenances shall be considered "not safe" unless otherwise specifically designated. Movement of the vessel from its specific location voids the Certificate unless shifting of the vessel within the facility has been specifically authorized on this certificate.

STANDARD SAFETY DESIGNATIONS: (partial list, paraphrased from NFPA 306)

ATMOSPHERE SAFE FOR WORKERS: In the compartment or space so designated (a) the oxygen content of the atmosphere is at least 19.5 percent and not greater than 22 percent by volume; (b) the concentration of flammable materials is below 10 percent of the lower explosive limit; (c) any toxic materials in the atmosphere associated with cargo, fuel, tank coatings, inerting mediums, or fumigants are within permissible concentrations at the time of the inspection.

NOT SAFE FOR WORKERS: In the compartment or space so designated, entry shall not be permitted.

ENTER WITH RESTRICTIONS: In the compartment or space so designated, entry for work is permitted only if conditions of proper protective equipment, or clothing, or time, or all of the aforementioned, as appropriate, are as specified.

SAFE FOR HOT WORK: In the compartment or space so designated (a) the oxygen content of the atmosphere is not greater than 22 percent by volume; (b) the concentration of flammable materials in the atmosphere is less than 10 percent of the lower explosive limit; (c) the residues, scale, or preservative coatings are cleaned sufficiently to prevent the spread of fire and are not capable of producing a higher concentration than permitted by (a) or (b); (d) all adjacent spaces, containing or having contained flammable or combustible materials shall be sufficiently cleaned of residues, scale, or preservative coatings to prevent the spread of fire, or they are inerted. Ship's fuel tanks, lube tanks, or engine room or fire room bilges, or other machinery spaces, are to be treated in accordance with the Marine Chemist's requirements.

SAFE FOR LIMITED HOT WORK: In the compartment or space so designated (a) portions of the space meet the requirements for Safe for Hot Work and Partial Cleaning, as applicable; or (b) the space is inerted, adjacent spaces meet the requirements for Safe for Hot Work, and hot work is restricted to specific locations; (c) portions of the space shall meet the requirements for Safe for Hot Work, as applicable, and the nature or type of hot work shall be limited or restricted.

NOT SAFE FOR HOT WORK: In the compartment or space so designated, hot work is not permitted.

CHEMIST'S ENDORSEMENT: This is to certify that I have personally determined that all spaces in the foregoing list are in accordance with NFPA 306 Control of Gas Hazards on Vessels and have found the condition of each to be in accordance with its assigned designation.

The undersigned acknowledges receipt of this Certificate under NFPA 306 and understands conditions and limitations under which it was issued, and the requirements for maintaining its validity.

Signed _____
Authorized Representative Company Date

This Certificate is based on conditions existing at the time the inspection herein set forth was completed and is issued subject to compliance with all qualifications and instructions.

Signed _____
Marine Chemist CMC No.

 NFPA 306

FIGURE C.2 Sample of the Computer-Generated Form to Be Filled Out After Inspection for Certification.

Annex D Guidance to Vessel Owners and Operators When Hot Work and/or Enclosed/Confined Space Entry Is Conducted on a Vessel at Sea and a Marine Chemist Is Not Required

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 General. This standard is not written to specifically address how to perform atmospheric monitoring that is necessary to achieve safe conditions related to gas freeing, tank entry, and hot work. This standard contains guidance on the criteria for a safe condition for entry and hot work. For guidance on performance of atmospheric testing by tank vessel personnel at sea when a Marine Chemist is not required, tank vessel owners and operators can reference the following documents:

(1) API 1141, *Guidelines for Confined Space Entry On Board Tank Ships in the Petroleum Industry*
(2) *International Safety Guide for Oil Tankers and Terminals* (ISGOTT)
(3) *International Safety Guide for Inland Navigation Tank-barges and Terminals* (ISGINTT)
(4) *Recommendations for Entering Enclosed Spaces Aboard Ships*
(5) *Tanker Handbook for Deck Officers*
(6) *Tanker Safety Guide* (Liquid or Chemical)
(7) 29 CFR 1915, Subpart B
(8) Individual company safety policies and practices

Training is viewed by the Committee as a very important aspect of a successful program for entering and working in confined or enclosed spaces. Specifying "how to" perform atmospheric monitoring in the context of this document is not appropriate but should be included in the training that all responsible personnel should receive.

Annex E Limiting Oxidant Concentrations

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 Limiting Oxidant Concentration for Flammable Gases When Using Nitrogen or Carbon Dioxide as Diluents. Table E.1(a) through Table E.1(c) will enable Marine Chemists to quickly reference certain inert gases and the corresponding limiting oxygen concentrations.

Table E.1(a) Limiting Oxidant Concentrations for Flammable Gases When Nitrogen or Carbon Dioxide Are Used as Diluents

	Adjusted LOC (Volume % O_2 Above Which Deflagration Can Take Place) per 7.2.3 [of NFPA 69]			Original LOC (Volume % O_2 Above Which Deflagration Can Take Place)	
Gas/Vapor	N_2–Air Mixture	CO_2–Air Mixture	Reference*	N_2–Air Mixture	CO_2–Air Mixture
Methane	10.0	12.5	1	12.0	14.5
Ethane	9.0	11.5	1	11.0	13.5
Propane	9.5	12.5	1	11.5	14.5
n-Butane	10.0	12.5	1	12.0	14.5
n-Butyl acetate	9.0	—	9	9.0	—
Isobutane	10.0	13.0	1	12.0	15.0
n-Pentane	10.0	12.5	1	12.0	14.5
Isopentane	10.0	12.5	2	12.0	14.5
n-Hexane	10.0	12.5	1	12.0	14.5
n-Heptane	9.5	12.5	2	11.5	14.5
Ethanol	8.7	—	9	8.7	—
Ethylene	8.0	9.5	1	10.0	11.5
Propylene	9.5	12.0	1	11.5	14.0
1-Butene	9.5	12.0	1	11.5	14.0
Isobutylene	10.0	13.0	4	12.0	15.0
Butadiene	8.5	11.0	1	10.5	13.0
3-Methyl-1-butene	9.5	12.0	4	11.5	14.0
Benzene	10.1	12.0	1, 7	11.4	14.0
Toluene	9.5	—	7, 9	9.5	—
Styrene	9.0	—	7	9.0	—
Ethylbenzene	9.0	—	7	9.0	—
Vinyltoluene	9.0	—	7	9.0	—
Divinylbenzene	8.5	—	7	8.5	—
Diethylbenzene	8.5	—	7	8.5	—
Cyclopropane	9.5	12.0	1	11.5	14.0
Gasoline					
(73/100)	10.0	13.0	2	12.0	15.0
(100/130)	10.0	13.0	2	12.0	15.0
(115/145)	10.0	12.5	2	12.0	14.5

(continues)

Table E.1(a) *Continued*

Gas/Vapor	Adjusted LOC (Volume % O_2 Above Which Deflagration Can Take Place) per 7.2.3 [of NFPA 69]		Reference*	Original LOC (Volume % O_2 Above Which Deflagration Can Take Place)	
	N_2–Air Mixture	CO_2–Air Mixture		N_2–Air Mixture	CO_2–Air Mixture
Kerosene	8.0 (150°C)	11.0 (150°C)	5	10.0 (150°C)	13.0 (150°C)
JP-1 fuel	8.5 (150°C)	12.0 (150°C)	2	10.5 (150°C)	14.0 (150°C)
JP-3 fuel	10.0	12.5	2	12.0	14.5
JP-4 fuel	9.5	12.5	2	11.5	14.5
Natural gas (Pittsburgh)	10.0	12.5	1	12.0	14.5
n-Butyl chloride	12.0	—	3	14.0	—
	10.0 (100°C)	—	3	12.0 (100°C)	—
Methylene chloride	17.0 (30°C)	—	3	19.0 (30°C)	—
	15.0 (100°C)	—	3	17.0 (100°C)	—
Ethylene dichloride	11.0	—	3	13.0	—
	9.5 (100°C)	—	3	11.5 (100°C)	—
1,1,1-Trichloro-ethane	12.0	—	3	14.0	—
Trichloro-ethylene	7.0 (100°C)	—	3	9.0 (100°C)	—
Acetone	9.5	12.0	4	11.5	14.0
n-Butanol	NA	14.5 (150°C)	4	NA	16.5 (150°C)
Carbon disulfide	3.0	5.5	4	5.0	7.5
Carbon monoxide	3.5	3.5	4	5.5	5.5
Ethanol	8.5	11.0	4	10.5	13.0
2-Ethyl butanol	7.5 (150°C)	—	4	9.5 (150°C)	—
Ethyl ether	8.5	11.0	4	10.5	13.0
Hydrogen	3.0	3.2	4	5.0	5.2
Hydrogen sulfide	5.5	9.5	4	7.5	11.5
Isobutyl acetate	9.1	—	9	9.1	—
Isobutyl alcohol	9.1	—	9	9.1	—
Isobutyl formate	10.5	13.0	4	12.5	15.0
Isopropyl acetate	8.8	—	9	8.8	—
Isopropyl alcohol	9.5	—	10	9.5	—
Methanol	8.0	10.0	4	10.0	12.0
Methyl acetate	9.0	11.5	4	11.0	13.5
Propylene oxide	5.8	—	8	7.8	—
Methyl ether	8.5	11.0	4	10.5	13.0
Methyl formate	8.0	10.5	4	10.0	12.5
Methyl ethyl ketone	9.0	11.5	4	11.0	13.5
n-Propyl acetate	10.1	—	10	10.1	—
n-Propyl alcohol	8.6	—	9	8.6	—
UDMH (dimethyl-hydrazine)	5.0	—	6	7.0	—
Vinyl chloride	13.4	—	7	13.4	—
Vinylidene chloride	15.0	—	7	15.0	—

Notes:
1. See 7.7.2 [of NFPA 69] for the required oxygen level in equipment.
2. Data were determined by laboratory experiment conducted at atmospheric temperature and pressure. Vapor–air–inert gas samples were placed in explosion tubes and ignited by electric spark or pilot flame.

*References:
1. H. F. Coward and G. W. Jones (1952).
2. G. W. Jones, M. G. Zabetakis, J. K. Richmond, G. S. Scott, and A. L. Furno (1954).
3. J. M. Kuchta, A. L. Furno, A. Bartkowiak, and G. H. Martindill (1968).
4. M. G. Zabetakis (1965).
5. M. G. Zabetakis and B. H. Rosen (1957).
6. Unpublished data, U.S. Bureau of Mines.
7. Unpublished data, Dow Chemical Co.
8. U.S. Bureau of Mines.
9. L. G. Britton (2002).
10. Unpublished data, Dow Chemical Co., 2002.
[**69:** Table C.1(a)]

Table E.1(b) Limiting Oxidant Concentrations for Combustible Dust Suspensions When Using Nitrogen as a Diluent

Dust	Median Particle Diameter by Mass (μm)	LOC (Volume % O_2 Above Which Deflagration Can Take Place), N_2-Air Mixture
Cellulosic Materials		
Cellulose	22	9
Cellulose	51	11
Wood flour	27	10
Food and Feed		
Pea flour	25	15
Corn starch	17	9
Waste from malted barley	25	11
Rye flour	29	13
Starch derivative	24	14
Wheat flour	60	11
Coals		
Brown coal	42	12
Brown coal	63	12
Brown coal	66	12
Brown coal briquette dust	51	15
Bituminous coal	17	14
Plastics, Resins, Rubber		
Resin	<63	10
Rubber powder	95	11
Polyacrylonitrile	26	10
Polyethylene, h.p.	26	10
Pharmaceuticals, Pesticides		
Aminophenazone	<10	9
Methionine	<10	12
Intermediate Products, Additives		
Barium stearate	<63	13
Benzoyl peroxide	59	10
Bisphenol A	34	9
Cadmium laurate	<63	14
Cadmium stearate	<63	12
Calcium stearate	<63	12
Methyl cellulose	70	10
Dimethyl terephthalate	27	9
Ferrocene	95	7
Bistrimethylsilyl-urea	65	9
Naphthalic acid anhydride	16	12
2-Naphthol	<30	9
Paraformaldehyde	23	6
Pentaerythritol	<10	11
Metals, Alloys		
Aluminum	22	5
Calcium/ aluminum alloy	22	6
Ferrosilicon magnesium alloy	17	7
Ferrosilicon alloy	21	12
Magnesium alloy	21	3
Other Inorganic Products		
Soot	<10	12
Soot	13	12
Soot	16	12
Others		
Bentonite derivative	43	12

Source: R. K. Eckhoff, *Dust Explosions in the Process Industries*, 2003.
Note: The data came from 1 m^3 and 20 L chambers using strong chemical igniters.
[**69:** Table C.1(b)]

Table E.1(c) Limiting Oxidant Concentrations for Combustible Dust Suspensions When Using Nitrogen as a Diluent

Dust	Median Particle Diameter by Mass (μm)	Limiting Oxidant Concentration N_2/Air (Volume % O_2 Above Which Deflagration Can Take Place)
Cellulosic Materials		
Cellulose	22	9
Cellulose	51	11
Wood flour	27	10
Food and Feed		
Pea flour	25	15
Corn starch	17	9
Waste from malted barley	25	11
Rye flour	29	13
Starch derivative	24	14
Wheat flour	60	11
Coals		
Brown coal	42	12
Brown coal	63	12
Brown coal	66	12
Brown coal briquette dust	51	15

(continues)

Table E.1(c) *Continued*

Dust	Median Particle Diameter by Mass (μm)	Limiting Oxidant Concentration N_2/Air (Volume % O_2 Above Which Deflagration Can Take Place)
Bituminous coal	17	14
Plastics, Resins, Rubber		
Resin	<63	10
Rubber powder	95	11
Polyacrylonitrile	26	10
Polyethylene, h.p.	26	10
Pharmaceuticals, Pesticides		
Aminophenazone	<10	9
Methionine	<10	12
Intermediate Products, Additives		
Barium stearate	<63	13
Benzoyl peroxide	59	10
Bisphenol A	34	9
Cadmium laurate	<63	14
Cadmium stearate	<63	12
Calcium stearate	<63	12
Methyl cellulose	70	10
Dimethyl terephthalate	27	9
Ferrocene	95	7
Bistrimethylsilyl-urea	65	9
Naphthalic acid anhydride	16	12
2-Naphthol	<30	9
Paraformaldehyde	23	6
Pentaerythritol	<10	11
Metals, Alloys		
Aluminum	22	5
Calcium/ aluminum alloy	22	6
Ferrosilicon magnesium alloy	17	7
Ferrosilicon alloy	21	12
Magnesium alloy	21	3
Other Inorganic Products		
Soot	<10	12
Soot	13	12
Soot	16	12
Others		
Bentonite derivative	43	12

Notes:

1. The data came from 1 m^3 and 20 L chambers using strong chemical igniters.
2. See R. K. Eckhoff, *Dust Explosions in the Process Industries*, 1991.

[**69:** Table C-3, 1997 edition]

Annex F Informational References

F.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

F.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Conversion, Repair, and Lay-Up*, 2011 edition.

Fire Protection Guide to Hazardous Materials, 2010 edition.

F.1.2 Other Publications.

F.1.2.1 ACGIH Publications. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

Threshold Limit Values for Chemical Substances and Physical Agents (latest edition).

F.1.2.2 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API 1141, *Guidelines for Confined Space Entry On Board Tank Ships in the Petroleum Industry,* first edition, 1994.

F.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*, 2008.

F.1.2.4 CCNR Publications. Central Commission for the Navigation of the Rhine, 2 Place de la République, 67082 Strasbourg Cedex, France.

International Safety Guide for Inland Navigation Tank-barges and Terminals (ISGINTT), first edition, 2010.

F.1.2.5 ICS Publications. International Chamber of Shipping, 38 St. Mary Axe, London, UK EC3A 8BH.

International Safety Guide for Oil Tankers and Terminals (ISGOTT), fifth edition, 2006.

Tanker Handbook for Deck Officers, Captain C. Baptist, eighth edition, 2000.

Tanker Safety Guide (Chemicals), third edition, 2002.

Tanker Safety Guide (Liquefied Gas), second edition, 1995.

F.1.2.6 IMO Publications. International Maritime Organization, 4 Albert Embankment, London, UK SE1 7SR.

Recommendations for Entering Enclosed Spaces Aboard Ships, Marine Safety Committee Circular 744, June 14, 1996.

F.1.2.7 USBM Publications. U.S. Department of the Interior, Bureau of Mines Publications, National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

Coward, H. F., and G. W. Jones, "Limits of Flammability of Gases and Vapors," Bulletin 503, U.S. Bureau of Mines, 1952.

Zabetakis, M. G., "Flammability Characteristics of Combustible Gases and Vapors," Bulletin 627, U.S. Bureau of Mines.

Unpublished data, U.S. Bureau of Mines.

Unpublished data, Dow Chemical Co.

F.1.2.8 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1915, Subpart B.

Title 29, Code of Federal Regulations, Part 1915, Subpart P.

Title 29, Code of Federal Regulations, Part 1915, Subpart Z.

Title 29, Code of Federal Regulations, Part 1915.7.

F.1.2.9 Other Publications. Britton, L.G., "Using Heats of Oxidation to Evaluate Flammability Hazards," *Process Safety Progress*, 20(1) (March 2002): 31–54.

Eckhoff, R. K., *Dust Explosions in the Process Industries*, 1991, 586.

Jones, G. W., M. G. Zabetakis, J. K. Richmond, G. S. Scott, and A. L. Furno, "Research on the Flammability Characteristics of Aircraft Fuels," Wright Air Development Center, Wright-Patterson AFB, OH, Technical Report 52-35, Supplement I, 1954, 57 pp.

Kuchta, J. M., A. L. Furno, A. Bartkowiak, and G. H. Martindill, "Effect of Pressure and Temperature on Flammability Limits of Chlorinated Combustibles in Oxygen-Nitrogen and Nitrogen Tetroxide-Nitrogen Atmospheres," *Journal of Chemical and Engineering Data*, Vol. 13, No. 3, July 1968, p. 421.

Zabetakis, M. G., and B. H. Rosen, "Considerations Involved in Handling Kerosine," *Proceedings API*, Vol. 37, Sec. III, 1957, p. 296.

F.2 Informational References. (Reserved)

F.3 References for Extracts in Informational Sections.

NFPA 69, *Standard on Explosion Prevention Systems*, 2008 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 1997 edition.