NFPA 306
Standard for the Control of Gas Hazards on Vessels

1997 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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Control of Gas Hazards on Vessels

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This edition of NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, was prepared by the Technical Committee on Gas Hazards and acted on by the National Fire Protection Association, Inc., at its Annual Meeting held May 19–22, 1997, in Los Angeles, CA. It was issued by the Standards Council on July 24, 1997, with an effective date of August 15, 1997, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This edition of NFPA 306 was approved as an American National Standard on August 15, 1997.

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, and adopted in 1962, 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 marks the 75th year for these requirements, incorporates a new standard safety designation that reflects a common approach to an industry practice. The new designation is also supported by other changes to the document, including expanded inspection of vessel piping systems.

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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.

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in membership may have occurred. A key to classifications is found at the back of this document.

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.

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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 Appendix A.

Information on referenced publications can be found in Chapter 7 and Appendix E.

Chapter 1 General

1-1 Scope.

1-1.1 This standard applies to vessels carrying or burning as fuel flammable or combustible liquids. It also applies to vessels carrying or having carried flammable compressed gases, 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 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 hereinafter described. This standard is also applicable to those spaces on vessels that might not contain sufficient oxygen to permit safe entry.

1-1.6 This standard applies to land-side confined spaces or other dangerous atmospheres located within the boundaries of a shipyard or ship repair facility.

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 is safe for entry or work.

1-3* Emergency Exception. Nothing in this standard shall be construed as prohibiting the immediate drydocking of a vessel whose safety is imperiled (the vessel is sinking or is seriously damaged), making it impracticable to clean and gas free in advance.

1-4* Governmental Regulations. Nothing in this standard shall be construed as superseding existing requirements of any governmental or local authority. Attention of owners, repairers, and chemists is directed to the "Rules and Regulations for Tank Vessels" and other rules and regulations for vessel inspection of the United States Coast Guard and the "Occupational Safety and Health Standards" of the United States Department of Labor, which prescribe an inspection prior to making repairs involving riveting, welding, burning, or similar fire-producing operations 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.

1-5 Definitions. Unless expressly stated elsewhere, the following terms shall, for the purpose of this standard, have the meanings indicated.

Adjacent Spaces. Those spaces in all directions from subject space, including all points of contact, corners, diagonals, decks, tank tops, and bulkheads.

Certificate. See Marine Chemist's Certificate.

Chemical. Any compound, mixture, or solution in the form of a solid, liquid, or gas that may 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.

Coiled Vessels. Tank vessels using a closed system of heating coils that use thermal oil as the heating medium.

Flammable. The words "flammable" and "inflammable" are interchangeable or synonymous terms for the purpose of this standard.

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 40 psia (2.76×10^5 Pa).

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

Marine Chemist. The holder of a valid Certificate issued by the National Fire Protection Association in accordance with the "Rules for Certification of Marine Chemists," establishing the person's qualifications to determine whether construction, alteration, repair, or shipbreaking of vessels, which may involve hazards covered by this standard, can be undertaken with safety.

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

Marine Chemist's Certificate (Certificate). A written statement issued by a Marine Chemist in the form and manner prescribed by this standard. It states the conditions that the Marine Chemist found at the time of inspection.

Materials.

(a) **Flammable Liquid.** Any liquid having a flash point (closed cup) below 80°F (26.6°C) and having a vapor pressure not exceeding 40 psi absolute (2068.6 mm Hg) at 80°F (26.6°C).

1. *Grade A.* Any flammable liquid having a Reid vapor pressure of 14 lb (9.6×10^4 Pa) or more.

2. *Grade B.* Any flammable liquid having a Reid vapor pressure under 14 lb (9.6×10^4 Pa) and over $8^1/_2$ lb (5.9×10^4 Pa).

3. *Grade C.* Any flammable liquid having a Reid vapor pressure of $8^1/_2$ lb (5.9×10^4 Pa) or less and a flash point of 80°F (26.6°C) or below.

(b) **Combustible Liquid.** Any liquid having a flash point (open cup) at or above 80°F (26.6°C).

1. *Grade D.* Any combustible liquid having a flash point below 150°F (65.5°C) and above 80°F (26.6°C).

2. *Grade E.* Any combustible liquid having a flash point of 150°F (65.5°C) or above.

(c) **Toxic Materials.** Any material whose properties contain the inherent capacity to produce injury to a biological system. This is dependent on concentration, rate, method, and site of absorption.

Repair Classifications.

(a) ***Hot Work**. Any construction, alteration, repair, or shipbreaking operation involving riveting, welding, burning, the use of powder-actuated fastening tools, or similar fire-producing operations. Grinding, drilling, abrasive blasting, or similar spark-producing operations shall be considered hot work unless deemed otherwise by a Marine Chemist.

(b) **Cold Work.** Any construction, alteration, repair, or shipbreaking that does not involve heat-, fire-, or spark-producing operations.

(c) **Work Below Deck.** Work in or on enclosed spaces surrounded by shell, bulkheads, and overheads.

(d) **Work in the Open.** Work performed from open decks or in spaces from which the overhead has been completely removed.

Secured. Closed in a manner to avoid accidental opening or operation.

Shipbreaking. The breaking down of a vessel's structure for the purpose of scrapping the vessel; includes the removal of gear, equipment, or any component part of a vessel.

Tanker Designations.

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

(b) **Tank Ship.** Any tank vessel propelled by power or sail.

(c) **Tank Barge.** Any tank vessel not equipped with a means of self-propulsion.

Vessel. Includes every description of watercraft used, or capable of being used, as a means of transportation on water.

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

Chapter 2 Minimum Requirements for Issuance of Marine Chemist's Certificate and Maintenance Conditions

2-1 The Marine Chemist Shall Personally Determine Conditions. A Marine Chemist shall be permitted to issue a 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.

2-2 Procedures Prior to Issuance of a Certificate.

2-2.1 The calibration of all instruments used by the Marine Chemist shall be verified 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.

2-2.2 The Marine Chemist's determinations shall include a visual inspection and tests of the spaces to be certified and spaces adjacent thereto. The determinations also shall include the following:

(a) The three previous cargo loadings

(b) Nature and extent of the work

(c) Starting time and duration of the work

(d) Tests of cargo and vent lines at manifolds and accessible openings

(e) Verification that pipelines that could release hazardous materials into spaces that will be certified SAFE FOR WORKERS or SAFE FOR 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 accidental operation

(f) Tests of cargo heating coils

2-3 Standard Safety Designations and Conditions Required. The following standard safety designations shall be used where applicable in preparing Certificates, cargo tank labels, and other references.

2-3.1 SAFE FOR WORKERS requires that in the compartment or space so designated the following criteria shall be met:

(a) *The oxygen content of the atmosphere shall be at least 19.5 percent and not greater than 22 percent by volume.

(b) *The concentration of flammable materials shall be 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 shall be within permissible concentrations at the time of the inspection.

Exception to (c): 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.

(d) *The residues or materials associated with the work authorized by the Certificate shall not be capable of producing uncontrolled toxic materials under existing atmospheric conditions while maintained as directed on the Certificate.

If any of the conditions of 2-3.1(a), (b), (c), or (d) do not exist, then the designation NOT SAFE FOR WORKERS or ENTER WITH RESTRICTIONS shall be used.

2-3.2 NOT SAFE FOR WORKERS indicates that the compartment or space so designated shall not be entered by personnel.

2-3.3* ENTER WITH RESTRICTIONS indicates that in all spaces so designated, entry for work shall be permitted only if conditions of proper protective equipment, or clothing, or time, or all of the aforementioned, as appropriate, are as specified.

2-3.4 SAFE FOR HOT WORK requires that in the compartment or space so designated the following criteria shall be met:

(a) *The oxygen content of the atmosphere shall not exceed 22 percent by volume.

(b) *The concentration of flammable materials in the atmosphere shall be less than 10 percent of the lower explosive limit.

(c) The residues, scale, or preservative coatings shall be cleaned sufficiently to prevent the spread of fire and shall not be capable of producing a higher concentration than permitted by 2-3.4(a) or (b) under existing atmospheric conditions in the presence of hot work and while maintained as directed on the Certificate; or, in the case of the ship's fuel oil tanks, lube tanks, engine room or fire room bilges, or other machinery spaces, shall be treated in accordance with the Marine Chemist's requirements.

(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 shall be inerted; or, in the case of the ship's fuel tanks, lube tanks, or engine room or fire room

bilges, or other machinery spaces, shall be treated in accordance with the Marine Chemist's requirements.

If any of the conditions of 2-3.4(a), (b), (c), or (d) do not exist, the designation NOT SAFE FOR HOT WORK shall be used.

2-3.5 NOT SAFE FOR HOT WORK indicates that in the compartment so designated, hot work shall not be permitted.

2-3.6 SAFE FOR LIMITED HOT WORK requires that in any compartment or space so designated one of the following shall be met:

(a) Portions of the space shall meet the requirements of 2-3.4(a), (b), (c), and (d), as well as the applicable portions of 3-1.3.

(b) The space shall be inerted in accordance with 2-3.8, adjacent spaces shall be treated in accordance with 2-3.4(d), and hot work shall be restricted to specific locations.

(c) Portions of the space shall meet the requirements of 2-3.4(a), (b), (c), and (d); and the nature or type of hot work shall be limited or restricted.

This designation shall be followed by a statement describing the limitations or restrictions on the hot work.

2-3.7 SAFE FOR SHIPBREAKING requires that the compartment so designated shall meet the criteria of 2-3.4(a) through (d). The residual combustible materials designated shall not be capable of producing fire beyond the extinguishing capabilities of the equipment on hand.

2-3.8 INERTED requires that one of the following procedures shall have been completed in the compartment or space so designated:

(a) *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 enclosed space at or below 8 percent or 50 percent of the amount required to support combustion, whichever is less.

(b) The kind of gas and the safe disposal and securing of gas inerting media shall be noted on the Certificate by the Marine Chemist upon completion of repairs. Closing and securing of hatches and other openings, except vents, shall be permitted to be used as a "safe disposal" method by the Marine Chemist.

(c) The space shall have been flooded with water, provided that any hot work is performed at least 3 ft (0.9 m) below the water level and provided that the gas content of the atmosphere above the water does not exceed l0 percent of the lower explosive limit, and provided that such procedure is approved by a Marine Chemist.

2-3.9 INERTED FOR FLAMMABLE COMPRESSED GAS requires that individual pressure tanks with a working pressure of 50 psi (3.45×10^5 Pa) 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.

2-3.10 SAFE FOR LAY-UP requires that the tank ship so designated shall meet any of the following conditions:

(a) The vessel shall have been cleaned in accordance with the provisions in Section 3-1, and the vessel shall be inspected weekly by the responsible owner's representative to ensure that no change in conditions occurs.

(b) All the cargo tanks shall have been discharged of cargo, the residues shall not be capable of producing more than 10 percent of the lower explosive limit, and the vessel shall be inspected weekly by the responsible owner's representative to ensure that no change in conditions occurs.

(c) All the cargo tanks shall have been inerted to less than 8 percent oxygen or 50 percent of the amount to support combustion, whichever is less; a 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.

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

2-4 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 form and manner prescribed by this standard.

2-4.1 The Certificate shall include the frequency and type of such additional tests, inspections, qualifications, and other instructions as the Marine Chemist specifies.

2-4.2 The Certificate shall state conditions under which the Marine Chemist shall be consulted or recalled.

2-4.3 Such qualifications and requirements shall include precautions, including protective equipment and devices, necessary to eliminate or minimize hazards that could be present from protective coatings or residues from cargoes. These qualifications also shall include limitations or restrictions, if any, on the areas where work is to be done.

2-4.4 The Certificate shall include instrument test results of the Marine Chemist's inspections and tests.

2-5 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 under which it is issued. Any additions to or deletions from such a Certificate after obtaining a signature for receipt shall render the Certificate invalid and require reissuance.

2-5.1 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 authorized representative.

2-5.2 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 his authorized representative.

2-6 Responsibility for Obtaining Certificate and Maintaining Conditions.

2-6.1 Work authorized by the Certificate shall commence within 24 hours unless otherwise noted on the Certificate.

2-6.2 It is the responsibility of the vessel repairer, shipbreaker, or vessel builder to retain the services of the Marine Chemist, to secure copies of his Certificate, and 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 2-5.1 or 2-5.2, as applicable.

2-6.3 Throughout the course of repairs or alterations, conditions on the Certificate shall be maintained on the vessel by full observations of all qualifications and requirements.

2-6.4 It is the responsibility of the vessel repairer, shipbreaker, or vessel builder 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, 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.

2-6.5 It is 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.

2-6.6 All access openings to spaces designated NOT SAFE FOR WORKERS, including inerted spaces, shall be appropriately labeled with a warning sign, which reads "NOT SAFE FOR WORKERS," and which shall remain in place unless recertificated.

Chapter 3 Preparing Vessels for Issuance of a Marine Chemist's Certificate

3-1 Where a Safe Condition Is to Be Obtained Entirely by Cleaning. See Appendix Figure B-1(b).

3-1.1 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 shall have been flushed with water, blown with steam or air, or inerted.

3-1.2 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 2-3.1, 2-3.4, or 2-3.6 or with both 2-3.1and 2-3.6 or with both 2-3.1 and 2-3.4, as applicable.

3-1.3 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 (a) and (b) below. 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 180°F (82.2°C) 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 2-3.4. 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 2-3.4. An ignitability test shall be performed on the residues or preservative coatings prior to issuing a Certificate.

3-1.4 The residues or preservative coatings in all compartments concerned (with the exception of tanks described in 3-1.3) shall be such that the conditions of either 2-3.1 or 2-3.4 or both 2-3.1 and 2-3.4, as applicable, shall be met.

3-2 Where a Safe Condition Is to Be Obtained by Both Cleaning and Inerting or Entirely by Inerting. See Appendix Figures B-1(c) and (d).

3-2.1 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 8 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 8 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.

3-2.2 All piped cargo fire-extinguishing systems within the cargo tanks and vent lines, except those in the inerted spaces, shall have been flushed with water, blown with steam or air, or inerted. (All valves to the inerted spaces shall be tagged and secured in such a manner as to avoid accidental opening or operation.) 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.

3-2.3 All spaces to be inerted shall be 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.

3-2.4 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of Section 3-3, and all other spaces (with the exception of tanks described in 3-1.3) shall be inerted in accordance with the requirements of 2-3.8 or 2-3.9, as applicable.

3-2.5 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 this section, and all other spaces (with the exception of tanks described in 3-1.3) shall be inerted in accordance with the requirements of 2-3.8 or 2-3.9, as applicable.

3-3 Where a Safe Condition Is to Be Obtained by Cleaning Certain Compartments and by Securing the Other Compartments. See Appendix Figure B-1(e).

3-3.1 Nonadjacent spaces containing atmospheres exceeding l0 percent of the lower explosive limit shall be closed and secured, and those spaces shall be noted on the Certificate.

3-3.2 All piped cargo fire-extinguishing systems and vent lines to the spaces involved shall have been flushed with water, blown with steam or air, or inerted; and the valves to all other compartments shall have been closed and secured. 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; and the valves shall have been closed and secured in a manner to avoid accidental opening or operation.

3-3.3 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

3-1. All other applicable spaces shall be closed and secured in a manner to avoid accidental opening or operation.

3-4 Where a Safe Condition Is to Be Obtained by Cleaning Some Compartments, by Inerting Some Compartments, and by Securing Some Compartments. See Appendix Figure B-1(f).

3-4.1 All piped cargo fire-extinguishing systems and vent lines to the spaces involved, except those to the inerted spaces, shall have been flushed with water, blown with steam or air, or inerted; and the valves to all other compartments shall have been closed and secured in a manner to avoid accidental opening or operation. 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; and the valves shall have been closed and secured in such a manner as to avoid accidental opening or operation.

3-4.2 Nonadjacent spaces containing atmospheres exceeding l0 percent of the lower explosive limit shall be closed and secured in a manner to avoid accidental opening or operation, and those spaces shall be noted on the Certificate.

3-4.3 Compartments or spaces in which internal repairs or alterations are to be undertaken shall be cleaned to comply with the requirements of Section 3-1; and all adjacent compartments, including those diagonally adjacent thereto, shall be inerted to comply with the applicable requirements of 2-3.8. All other compartments shall be closed and secured in compliance with 3-3.1. With respect to inerted spaces, the requirements of 3-2.1 shall apply.

3-4.4 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 3-1. All adjacent compartments, including those diagonally adjacent thereto, shall be inerted or cleaned to comply with applicable requirements of Section 3-2. All other applicable spaces shall be closed and secured in compliance with 3-3.1.

3-5 Cargo Heater Coils.

3-5.1 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: steaming, flushing with water, blowing with air, or inerting.

3-5.2 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 5-3.2.

3-5.3 On coiled vessels using thermal heating oils [FP 500°F+ (260°C+)], the Marine Chemist shall be satisfied as to the integrity of the heater coils in the prescribed work areas.

3-6 Electric Welding Operations. When determined to be necessary by the Marine Chemist, 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 unit that it services.

3-7 Requirements for Use of a Designated Berthing Area for Cleaning, Gas Freeing, or Inerting.

3-7.1 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.

3-7.2 The degassing, cleaning, or inerting of vessels at such designated berths shall be carried out in accordance with the requirements of Section 3-1 or Section 3-2, 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 3-1 or Section 3-2, 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.

3-8 Adjacent Ship's Fuel Oil Tanks. No hot work shall be permitted within, on, or adjacent to any ship's fuel oil tanks unless these tanks have been cleaned or inerted, or the work has been authorized by the Marine Chemist.

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 3. 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 l0 percent of the lower explosive limit 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 cleaned or inerted to meet the appropriate designation requirements of 2-3.4 and 2-3.8. 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 2-3.4.

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 other types of military vessels shall be treated in accordance with Section 4-2.

4-3.5 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 2-3.1 or 2-3.3 and with 2-3.4 or 2-3.6, and adjacent compartments shall be cleaned to meet the requirements of 2-3.4 or shall be permitted to be inerted to meet the requirements of 2-3.8.

Exception: Spaces covered by 3-1.3, Section 3-8, and 4-3.3.

4-3.6 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 2-3.4 or 2-3.6, or shall be inerted to comply with the requirements of 2-3.8. All adjacent compartments shall be cleaned to meet the requirements of 2-3.4 or shall be permitted to be inerted to meet the requirements of 2-3.8.

Exception: Spaces covered by 3-1.3, Section 3-8, and 4-3.3.

4-4 Vessels in Lay-Up. A tank ship in lay-up shall be treated in accordance with Section 4-1. No repairs or alterations involving hot work shall be made unless authorized by the Marine Chemist in accordance with the provisions of 2-3.10.

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 2-3.9) are considered in a safe condition for such work not directly involving these tanks or their pipelines.

Chapter 5 Additional Requirements for Bulk Chemical Cargo Tanks

5-1 Scope.

5-1.1 This section describes the conditions required before repairs can be made in spaces that have carried or have been exposed to chemicals in bulk. The remaining spaces in the vessel shall comply with the applicable provisions in Chapter 4.

5-1.2 The definitions set forth in Section 1-5 shall apply to this chapter.

5-2 Minimum Requirements.

5-2.1 All minimum requirements for issuance of the Certificate set forth in Chapter 2 of this standard are applicable to spaces that have carried or have been exposed to chemicals in bulk.

5-2.2 The designation NOT SAFE FOR WORKERS shall be used for spaces that have carried material of unknown chemical hazards. (*See 2-4.3.*)

5-2.3 Results of any chemical hazard tests shall be permitted to be noted on the Certificate.

5-3 Minimum Conditions.

5-3.1 Minimum conditions that shall prevail prior to the issuance of a Certificate for spaces that have contained chemicals in bulk shall be as set forth in Chapter 3, insofar as they are applicable, and as set forth in this section.

5-3.2 All pipelines, including heating coils, fire-extinguishing systems, and vents, together with the cargo pumps and cargo lines serving the chemical-carrying spaces, shall be initially dealt with to the satisfaction of the Marine Chemist. Care shall be exercised in the selection of methods and materials used for cleaning or inerting to avoid noncompatibility with previous cargoes.

5-3.3 Compartments having carried chemicals in bulk and that are to be cleaned shall be cleaned so that the atmosphere in those compartments is in accordance with 2-3.1 and 2-3.4, as applicable.

5-3.4 The residues in the compartments concerned shall be such that the conditions of 2-3.1 and 2-3.4, as applicable, will be met.

Chapter 6 Additional Requirements for Flammable Cryogenic Liquid Carriers

6-1 Scope.

6-1.1 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 2-1 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.

6-1.2 This chapter supplements the factors to be considered prior to issuance of the Certificate in accordance with Section 2-1.

6-1.3 Only those Marine Chemists who have evidenced the required additional experience, training, and knowledge shall be authorized to issue Certificates under the requirements of this chapter. Such Chemists shall receive a special endorsement on the Marine Chemist's Certificate issued them by the National Fire Protection Association.

6-2 Definitions.

6-2.1 The definitions set forth in Section 1-5 shall apply to this chapter.

6-2.2 The following additional definitions are applicable:

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. 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.

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. If the secondary barrier is part of the hull structure, it may be a boundary of the hold space.

Cryogenic Liquid. A refrigerated liquefied gas having a boiling point lower than –130°F (–90°C).

Gas-Dangerous Space.

(a) 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.

(b) 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.

(c) A cargo containment system and cargo piping.

1. A hold space where cargo is carried in a cargo containment system requiring a secondary barrier.

2. A hold space where cargo is carried in a cargo containment system not requiring a secondary barrier.

(d) A space separated from a hold space described in (c)1, above, by a single gastight steel boundary.

(e) A cargo pump room and cargo compressor room.

(f) A zone on the open deck or semienclosed space on the open deck within 9.84 ft (3 m) 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.

(g) The open deck over the cargo area and 9.84 ft (3 m) forward and aft of the cargo area on the open deck up to a height of 7.88 ft (2.4 m) above the weather deck.

(h) A zone within 7.88 ft (2.4 m) of the outer surface of a cargo containment system where such surface is exposed to the weather.

(i) An enclosed or semienclosed space in which pipes containing product are located.

(j) A compartment for cargo hose.

(k) An enclosed or semienclosed space having a direct opening into any gas-dangerous space or zone.

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

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

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

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.

6-3 Minimum Requirements.

6-3.1 All minimum requirements for issuance of the Certificate as set forth in Chapter 2 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.

6-3.2 The special safety designation SAFE FOR REPAIR YARD ENTRY applies 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, or have been inerted in accordance with 2-3.8.

6-3.3 Vessels whose cargo containment systems have not met the criteria of 6-3.2 shall be permitted to undergo specific limited repairs in locations outside the "gas-dangerous 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.

6-3.4 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.

6-3.5 The following information shall be used by the Marine Chemist as a guide for making his or her inspection:

(a) Description and schematic arrangement of provisions for inerting cargo tanks, hold spaces, or interbarrier spaces, as applicable

(b) Description and instruction manual for calibration of the cargo leak detector equipment

(c) Schematic plan showing locations of leak detector(s) and sampling points

(d) Schematic plan(s) of liquid and vapor cargo piping

(e) 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

(f) The recent history of cargoes handled with special reference to outturn and any pertinent unusual incidents encountered

6-4 Minimum Conditions.

6-4.1 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 3, insofar as they are applicable, and as set forth in this section.

6-4.2 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.

6-4.3 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.

6-4.4 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.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix E.

7-1.1 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 312, *Standard for Fire Protection of Vessels During Construction, Repair, and Lay-Up,* 1995 edition.

Appendix A Explanatory Material

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

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.

A-1-5 Repair Classifications (a) A Marine Chemist may deem grinding, drilling, abrasive blasting, or similar spark-producing operations as posing a reduced risk from hot work being performed when the operations are isolated from atmospheres containing a concentration of any flammable or combustible substance greater than 10 percent of the lower explosive limit of that substance.

A-2-3.1(a) It is important that any change from ambient air, either above or below, should be investigated. Even though any change from ambient air is undesirable, 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. The setting of the instrument for 20.8 percent should be made in ambient air under the conditions of temperature and humidity within the compartment or space to be tested.

A-2-3.1(b) The level of 10 percent of the lower explosive limit 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 propane, methane, and so forth, but not be a toxic hazard.

A-2-3.1(c) 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, the *Permissible Exposure Limit Value* in Subpart Z of Title 29, *Code of Federal Regulations,* Part 1910.1000, or the value listed in the Manufacturers' Safety Data Sheet (MSDS).

A-2-3.1(d) See A-2-3.1(c).

A-2-3.3 The ENTER WITH RESTRICTIONS designation is not intended to apply to spaces with IDLH atmospheres except to install ventilation equipment or for emergency rescue. Other precautions that would apply to IDLH atmospheres are found in OSHA, Title 29, *Code of Federal Regulations,* Part 1915, Subpart I.

A-2-3.4(a) See A-2-3.1(a).

A-2-3.4(b) The terms "lower flammable limit" and "lower explosive limit" are used synonymously. Refer to NFPA 325, *Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids.*

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

A-2-3.8(a) 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.

A-3-1.3(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.

Appendix B

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

The illustrations in Figure B-1(a–f) are examples of safe conditions discussed in Chapter 3 of this standard. The conditions shown in the drawings correspond to Sections 3-1 through 3-4 of the standard. Although the single plane drawings show horizontal separations only, vertical compartmentation should be similarly treated.

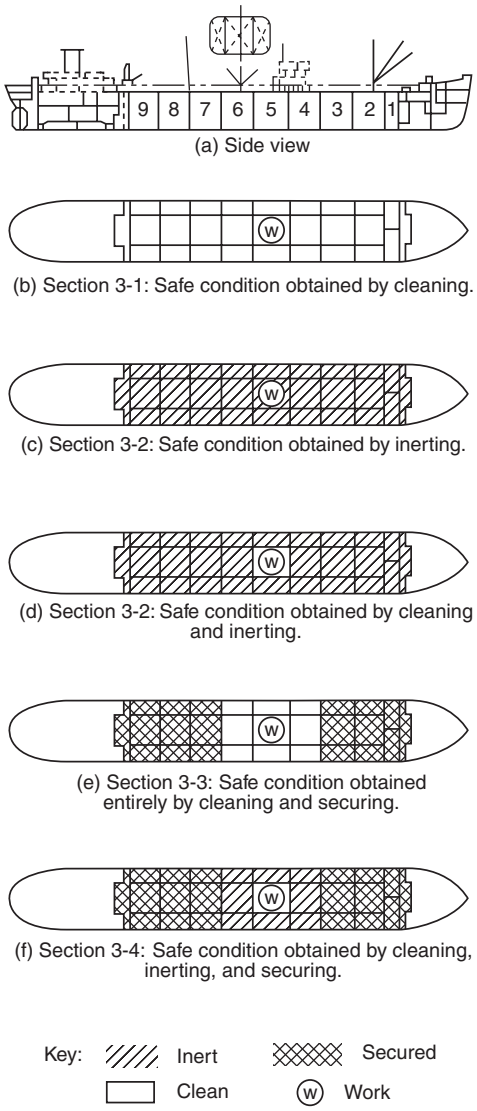

Figure B-1(a-f) Illustrations of safe conditions.

Appendix C Sample Marine Chemist's Certificate

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

This certificate is a sample of the form that is to be filled out by the Marine Chemist at the completion of the inspection.

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 any physical or atmospheric changes adversely affecting the STANDARD SAFETY DESIGNATIONS assigned to any of the above spaces, this certificate is voided; or if in any doubt, immediately stop all work and contact the undersigned Marine Chemist.

QUALIFICATIONS: Transfer of ballast 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 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 Subsections 2-3.1 through 2-3.6).

SAFE FOR WORKERS: In the compartment or space so designated (a) the oxygen content of the atmosphere shall be at least 19.5 percent and not greater than 22 percent by volume; (b) the concentration of flammable materials shall be 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 shall be 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 shall be 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 shall not exceed 22 percent by volume; (b) the concentration of flammable materials in the atmosphere shall be less than 10 percent of the lower explosive limit; (c) the residues, scale, or preservative coatings shall be cleaned sufficiently to prevent the spread of fire and shall not be 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 shall be inerted. Ship's fuel tanks, lube tanks, or engine room of fire room bilges, or other machinery spaces, shall be treated in accordance with the Marine Chemist's requirements.

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

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

Signed _____
Name 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 Certificate No.

NOTE THIS CERTIFICATE IS VALID ONLY ON MARINE VESSELS

VESSEL POSTING

Figure C-1 Sample of the form to be filled out after inspection for certification.

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

The 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. The 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 may reference the following documents:

(a) API 1141, *Guidelines for Confined Space Entry On Board Tank Ships in the Petroleum Industry*

(b) *International Safety Guide for Oil Tankers and Terminals* (ISGOTT)

(c) *Recommendations for Entering Enclosed Spaces Aboard Ships*

(d) *Tanker Handbook for Deck Officers*

(e) *Tanker Safety Guide* (Liquid or Chemical)

(f) Title 29, *Code of Federal Regulations,* Part 1915, Subpart B

(g) 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.

Appendix E Referenced Publications

E-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 7. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

E-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

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

NFPA 325, *Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids,* 1994 edition.

E-1.2 Other Publications.

E-1.2.1 ACGIH Publication. American Conference of Governmental Industrial Hygienists, P.O. Box 1937, Cincinnati, OH 45201.

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

E-1.2.2 API Publication. American Petroleum Institute, 1220 L St., N.W., Washington, DC 20005.

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

E-1.2.3 ICS Publications. International Chamber of Shipping, London, UK.

International Safety Guide for Oil Tankers & Terminals (ISGOTT), fourth edition, 1996.

Tanker Handbook for Deck Officers, Captain C. Baptist.

Tanker Safety Guide, 1995 edition.

E-1.2.4 IMO Publication. International Maritime Organization, London, UK.

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

E-1.2.5 U.S. Government Publications. U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

U.S. DOL-OSHA, *Permissible Exposure Limit Value,* Title 29, *Code of Federal Regulations,* Part 1910.1000, Subpart Z.

U.S. DOL-OSHA, Title 29, *Code of Federal Regulations,* Part 1915, Subpart I.

U.S. DOL-OSHA, Title 29, *Code of Federal Regulations,* Part 1915, Subpart B.