U.S. Department of Homeland Security

United States Coast Guard

Foreign Gas Carrier Examiner (FGCE) Tactics, Techniques, and Procedures (TTP)

U.S. Coast Guard
Force Readiness Command
(FORCECOM)

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United States Coast Guard

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COAST GUARD TACTICS, TECHNIQUES, AND PROCEDURES, CGTTP 3-72.6A

Subj: FOREIGN GAS CARRIER EXAMINER (FGCE) TACTICS, TECHNIQUES, AND PROCEDURES (TTP)

Ref:
(a) Development System and Standards Tactics, Techniques, and Procedures (TTP), CGTTP 1-01 (series)
(b) Evidence of Compliance by Foreign Vessels, 46 U.S.C., Subtitle II, Part B, Chapter 37 § 3711
(c) Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154
(d) Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (GC Code), 1983 edition, IMO Resolution A.328(IX)
(e) International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), 1993 Edition, IMO Resolution MSC.30(61)
(f) International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), 2016 Edition, IMO Resolution MSC.370(93)
(g) Code for Existing Ships Carrying Liquefied Gases in Bulk (EGC Code), Resolution A.329(IX)
(h) SOLAS: Consolidated Text of the International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988: Articles, Annexes and Certificates (Incorporating all amendments in effect from 1 July 2014), International Maritime Organization (IMO)
(i) USCG Marine Safety Manual, Vol. I: Administration and Management, COMDTINST M16000.6 (series)
(j) USCG Marine Safety Manual, Vol. II: Materiel Inspection, COMDTINST M16000.7 (series)
(k) COMDT (CG-ENG) Alternate Pressure Relief Valve Settings on Vessels Carrying Liquefied Gases in Bulk in Independent Type B & Type C Tanks Policy Letter 16710 No. 04-12 of 8 Aug 12
(l) COMDT COGARD WASHINGTON DC 191819Z MAR 10/ALSAFETY, Cargo Compressor Room Entries During Port State Control Exams and Law Enforcement Boardings of Liquefied Petroleum Gas (LPG) Carriers

(m) Risk Management (RM), COMDTINST 3500.3 (series)
(n) Tanker Safety Guide Liquefied Gas, International Chamber of Shipping (ICS), Third Edition, 2018
(o) Liquefied Gas Handling Principles On Ships and In Terminals, SIGTTO, Fourth Edition 2016
(p) Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29)
(q) Amendments to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) (Harmonized system of survey and certification), MSC.17(58)
(r) COMDT (CG-ENG-5) Acceptance of Increased Design Vapor Pressure for Membrane Tanks on Liquefied Gas Carriers memo 16700 of 25 Oct 2018
(s) International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, Including 2010 Manila Amendments, STCW Convention and STCW Code, 2017 Edition
(t) Control of Pollution of Noxious Liquid Substances in Bulk, MARPOL Annex II
(u) Revised Guidelines for the Maintenance and Inspection of Fire Protection Systems and Appliances, International Maritime Organization (IMO), MSC.1/Circ. 1432
(v) World Health Organization, International Medical Guide for Ships, 3rd Edition
(w) Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), 1994 Edition
(x) Life-Saving Appliances (LSA) Code, International Maritime Organization (IMO), 2017 Edition
(y) International Fire Safety Systems (FSS Code), International Maritime Organization (IMO), 2015 Edition
(z) Port State Control Examiner, Tactics, Techniques, and Procedures (TTP), CGTTP 3-72.12 (series)
(aa) Guidelines for the Maintenance and Inspection of Fixed Carbon Dioxide Fire-Extinguishing Systems, International Maritime Organization (IMO), MSC.1/Circ. 1318
(bb) Vapor Control Systems, 46 CFR Part 39
(cc) Guidelines for Safe Access to Tanker Bows, International Convention on Load Lines (ICLL) 1966, as amended, IMO Resolution MSC.62(67)
(dd) Adoption of Guidelines for Emergency Towing Arrangements on Tankers, IMO Resolution MSC.35(63)
(ee) ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers, SIGTTO 2009
(ff) An Introduction to the Design and Maintenance of Cargo System Pressure Relief Valves on Board Gas Carriers, SIGTTO 1998
(gg) Definitions, 33 CFR § 156.105

(hh) Definitions, 33 CFR § 154.105
(ii) National Fire Protection Association (NFPA) 77: Recommended Practice on Static Electricity, 2019 Edition
(jj) COMDT (CG-5P) Port State Control Information for February 2016, Command Email of 26 Feb 16
(kk) Methane (LNG) as Fuel, 46 CFR Part 154.1854(a)
(ll) Foreign Flag Vessel: Certificate of Compliance Endorsement Application, 46 CFR § 154.22(a)(9)(i)(B)
(mm) MSC Guidelines for Review of a Subchapter O Endorsement Application, Marine Safety Center (MSC), Procedure Number: C1-43
(nn) Special Equipment, Machinery, and Hull Requirements, 46 CFR Part 32

1. PURPOSE. To provide port state control officers (PSCOs) with Coast Guard Tactics, Techniques, and Procedures (CGTTP) on Certificate of Compliance (COC) examinations of foreign-flagged liquefied gas carriers.

2. ACTION. This CGTTP publication applies to PSCOs. Internet release authorized.

3. CGTTP AFFECTED. This publication supersedes the Foreign Gas Carrier Examiner (FGCE) Tactics, Techniques, and Procedures (TTP), CGTTP 3-72.6.

4. DISCUSSION. To support the Assistant Commandant for Prevention Policy COMDT (CG-5P's) mission objective, this publication details the tasks and steps required to effectively, efficiently, and safely conduct examinations of liquefied gas carriers. This tactics, techniques, and procedures (TTP) publication was authored and validated by accomplished performers and subject matter experts in the field. TTP publications adhere to a life-cycle maintenance periodicity unless triggered by other revision requirements.

5. DISCLAIMER. This TTP publication is not a substitute for applicable legal requirements, nor is it itself a rule. It is intended to provide guidance for Coast Guard personnel and is not intended to, nor does it, impose legally binding requirements on any party outside the Coast Guard.

6. CHANGES. This TTP publication contains major changes. Review of the entire document is advised due to substantial revisions. A high-level summary of changes is provided below.

1. Updated to better align with current policy and FGCE performance qualification standards (PQS).

2. Updated to incorporate the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), **2016 Edition**, IMO Resolution MSC.370(93), where noted.

3. Updated to align with current TTP standards.

7. DISTRIBUTION. U.S. Coast Guard Force Readiness Command (FORCECOM) Training Division (FC-T) posts an electronic version of this TTP publication to the CGTTP Library on CGPortal. In CGPortal, navigate to the CGTTP Library by selecting **Training & Education**, then select the **TACTICS, TECHNIQUES, AND PROCEDURES** link. FC-T does not provide paper distribution of this publication.

8. USCG FORMS. The USCG electronic forms referenced in this publication are available on the CGPortal website.

9. REQUEST FOR CHANGES. Field feedback regarding this TTP publication, or any other located in the CGTTP Library, may be provided via email to: D05-SG-M-FORCECOM-TPTC-PRODUCTFEEDBACK@uscg.mil.

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Chapter 1: Introduction

Introduction

This chapter overviews the contents of this Coast Guard tactics, techniques, and procedures (CGTTP) publication. It also defines the use of notes, cautions, and warnings in this CGTTP publication. See Appendix A: Glossary and Acronyms for an explanation of terms and acronyms used in this CGTTP publication.

Per reference (a), Development System and Standards Tactics, Techniques, and Procedures (TTP), CGTTP 1-01 (series), *"CGTTP is NOT policy and is not used to replace or fix policy gaps."*

In This Chapter

This chapter contains the following sections:

Section A: Introduction

A.1. Background and Performance Objectives

The Liquefied Gas Carrier National Center of Expertise (LGC NCOE) was established to raise the Coast Guard's competency, capabilities, and consistency in the field of liquefied gas carrier safety, security, environmental requirements, and examinations. The LGC NCOE is a detached unit of the Coast Guard Traveling Inspector Staff COMDT (CG-5P-TI) and is collocated with Marine Safety Unit (MSU) Port Arthur, Texas.

Per reference (b), Evidence of Compliance by Foreign Vessels, 46 U.S.C. § 3711, Subtitle II, Part B, and reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154, Subpart B- Inspections and Tests, foreign-flagged liquefied gas carriers arriving in the United States must participate in the Certificate of Compliance (COC) exam process.

NOTE:

It is not the Coast Guard's intention during every COC examination to inspect each item listed in either this publication, the United States Coast Guard Foreign Gas Carrier Job Aid, or the United States Coast Guard Port State Control Examiner Job Aid. The scope and depth of the inspection is determined by the leading port state control officer (PSCO).

The depth and scope of the examination is determined by the PSCO based on their observations of the following:

- Condition of the ship.
- Operation of ship system(s).
- Competency of the crew.

A.2. Scope

The scope of this tactics, techniques, and procedures (TTP) publication begins when a foreign gas carrier is scheduled for a COC gas initial, renewal, or annual examination and ends once the Marine Information for Safety and Law Enforcement (MISLE) activity for the examination has been completed. This CGTTP publication aligns with the U.S. Coast Guard Foreign Gas Carrier Examiner (FGCE) Port State Control Officer Performance and Qualification Standard (series).

Additionally, consult the LGC NCOE website in the Web Video Lessons (LGC TV) section for a variety of gas carrier and liquefied natural gas (LNG)-as-fuel video based training.

A.3. Target Audience

This publication is intended for use by Coast Guard PSCOs during COC exams on foreign-flagged liquefied gas carriers. It is only meant to enhance the United States Coast Guard Foreign Gas Carrier Job Aid and is focused on the cargo specific tasks/steps performed by a PSCO who holds the FGCE certification. The additional COC tasks/steps performed by the port state control examiner (PSCE) are found in the United States Coast Guard Port State Control Examiner Job Aid.

A.4. Governing References and Abbreviated Citations

The following references are considered governing references within this publication. As such, they will be called "The Gas Codes" when referred to collectively. Individual instances will use the following abbreviated citations/reference letters.

- Reference (d), Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (GC Code), 1983 edition, IMO Resolution A.328(IX).
    - Reference (d), GC Code.
- Reference (e), International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), 1993 edition, IMO Resolution MSC.5(48).
    - Reference (e), IGC Code 1993 Edition.
- Reference (f), International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), 2016 edition, IMO Resolution MSC.370(93).
    - Reference (f), IGC Code 2016 Edition.
- Reference (g), Code for Existing Ships Carrying Liquefied Gases in Bulk (EGC Code), Resolution A.329(IX).
    - Reference (g), EGC Code.

Additionally, the following reference will be abbreviated as follows from this point forward:

- Reference (h), SOLAS: Consolidated Text of the International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988: Articles, Annexes and Certificates (Incorporating all amendments in effect from 1 July 2014), International Maritime Organization (IMO).
    - Reference (h), SOLAS.

- Reference (i), USCG Marine Safety Manual, Vol. I: Administration and Management, COMDTINST M16000.6 (series).
  - Reference (i), MSM Vol. I.
- Reference (j), USCG Marine Safety Manual, Vol. II: Materiel Inspection, COMDTINST M16000.7 (series).
  - Reference (j), MSM Vol. II.

A.5. Exclusions and Assumptions

The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) citations in this TTP publication are primarily from reference (e), IGC Code 1993 Edition. Currently, the vast majority of vessels in service require use of either reference (e), or earlier versions, but some sections of reference (f), IGC Code 2016 Edition, might also apply. Reference (f), also applies to new vessels whose keels are laid, or which are at a similar stage of construction, on or after 1 July 2016. See the following Note.

NOTE:

It is important to pay close attention to the applicability requirements and dates in all versions of the IGC Code. If you see three asterisks like this: ★★★, it means the IGC Code (2016 Edition) is different than what is explained in this TTP publication. See Appendix B: IGC Code Equivalency Table for a full list of differences.

The IGC Code 1993 Edition frequently uses permissive and recommendatory language. The Coast Guard has interpreted SOLAS Chapter VII, Regulation 13 as mandating the provisions of the IGC Code 1993 Edition and Coast Guard inspectors must treat the Code's recommendations as mandatory requirements in accordance with this TTP.

This publication cites Safety at Life at Sea (SOLAS) regulations from reference (h), SOLAS. In some cases, the regulations in reference (h), may not apply due to the keel laid date of the vessel. Port state control (PSC) personnel need to pay close attention to the applicability dates of the SOLAS chapters and regulations when conducting PSC exams. References provided might not be the only applicable law or policy. Refer to the cited authority for guidance, then contact your servicing legal office if clarification is needed.

A.6. Disclaimer Statement

This CGTTP publication cannot cover every foreign gas carrier examiner (FGCE) scenario that might arise. Such cases might result in the need to deviate from guidance in this publication. You can deviate from the TTP as

necessary to complete the task with greater safety, effectiveness, or efficiency. Do not take such deviations lightly. Temper any decision to deviate with maturity and a complete understanding of the mission, members' capabilities, and equipment. Whenever possible, consult your unit chain of command before deviation. Report TTP adjustment needs per the Request for Changes paragraph located in the letter of promulgation.

A.7. Registered Trademark Disclaimer

The use of registered trademarks in this TTP publication is not an endorsement of these products or companies by the United States Coast Guard (USCG), the Department of Homeland Security (DHS), or the Federal Government. This TTP publication has not been prepared, approved, or licensed by any entity that created or produced products referenced herein. Therefore, any use of third-party logos or trademarks is non-commercial in nature and constitutes a nominative fair use.

A.8. Best Practice

Throughout this TTP publication, the term "best practice" is defined as an innovative or modified practice that results in an improved or more effective response that could merit adoption by other units, platforms, or commands.

Section B: Notes, Cautions, and Warnings

B.1. Overview The following definitions apply to notes, cautions, and warnings found in TTP publications.

NOTE: **An emphasized statement, procedure, or technique.**

CAUTION: **A procedure, technique, or action that, if not followed, carries the risk of equipment damage.**

WARNING: ***A procedure, technique, or action that, if not followed, carries the risk of personal injury or death.***

Chapter 2:
Pre-Exam (PE) Preparation

Introduction This chapter discusses pre-exam (PE) preparations.

In This Chapter This chapter contains the following sections:

Section A: Certificate of Compliance (COC), Form CG-3585

A.1. Certificate of Compliance (COC), Form CG-3585

Prepare the Certificate of Compliance (COC), Form CG-3585 for issuance to the vessel:

- Obtain this information from the vessel's arrival information, including the Continuous Synopsis Record (CSR).

NOTE: **Do not solely rely on MISLE for completed Form CG-3585 information.**

NOTE: **If the vessel also has an International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (IPP NLS) certificate, only check the second block in Form CG-3585 Particulars of Ship section to designate the vessel to carry the listed products. Refer to Appendix C: Sample Certificate of Compliance (COC), Form CG-3585 for more information.**

NOTE: **If necessary, contact the vessel's agent to request additional information or documentation.**

NOTE: **Vessel name, International Maritime Organization (IMO) number, Flag, owner, and operator manager (management company) should agree with the Certificate of Registry or CSR.**

Deadweight tonnage (DWT) should agree with the SOLAS Cargo Ship Safety Construction Certificate (CSSCC) or the Cargo Ship Safety Certificate (CSSC), as applicable.

- Print a copy of the most recent Subchapter "O" Endorsement (SOE) located in the documents section of the vessel's MISLE file. The USCG Marine Safety Center's (MSC) current template listed status is "in process."
  - ➢ In the Certificates section of MISLE, open and print the SOE master copy/template uploaded by the MSC, taking into account the following guidance:
    - o It might be necessary to click **Show All Certificates** to locate the appropriate document. See Figure 2-1.

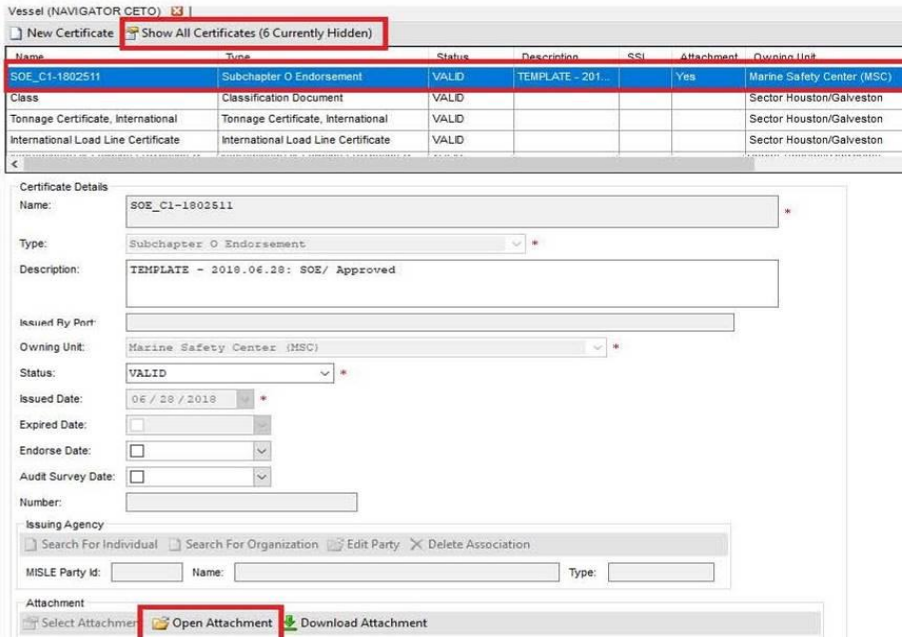

Figure 2-1 Finding MSC template SOE in MISLE

- Use the MSC template and NOT a scanned copy from a previous inspection.
- If multiple SOEs from MSC are available in MISLE, choose the most recent one. SOEs are assigned numbers based on the year of issuance, so higher numbers are more recent, for example, SOE_C1-1802511 is newer than SOE C1-1602512.

NOTE:

Reference (k), COMDT (CG-ENG) Alternate Pressure Relief Valve Settings on Vessels Carrying Liquefied Gases in Bulk in Independent Type B & Type C Tanks Policy Letter 16710 No. 04-12 of 8 Aug 12, might cause the SOE to change. Ensure most recent SOE is issued. Refer to Chapter 15: Follow Up (FU) Actions for further guidance.

- Review and compare the SOE to the vessel's Certificate of Fitness (COF) for any changes or errors (pay particular attention to the maximum allowable relief valve setting (MARVS) section).
- Ensure the cargo listed on the advanced notice of arrival (ANOA) is an authorized cargo on the SOE.

- Forward the COC and SOE to the office in charge, marine inspections (OCMI), or designated representative for signature.

Section B: Safety Meeting

B.1. Safety Meeting

The lead FGCE meets with the examination team to discuss the scope of the exams. This helps ensure the exams are conducted efficiently and safely. Discuss and review the following:

- Per reference (i), MSM, Vol. I, verify examination team is outfitted with appropriate personal protective equipment (PPE) to include:
  - Hard hat.
  - Eye Protection.
  - Coveralls (best practice is to wear long sleeves while examining liquefied gas carriers due to the low temperature and flammability characteristics of the cargoes carried).
  - Gloves.
  - Safety toed boots.
  - Hearing protection.
  - Flashlight.
  - Foul weather gear appropriate for current or anticipated conditions.
  - If boarding the vessel at sea, personal flotation device (PFD) or anti exposure coveralls (i.e., mustang or dry suit) per reference (m), Rescue and Survival Systems Manual COMDTINST M10470.10 (series).
- Reference (i), requires personnel working near liquefied cargoes to wear atmospheric monitors and alarms (i.e., multi-gas meters).
  - Verify each team member has a multi-gas meter that is fully charged and calibrated before leaving the office.
- Per reference (i), verify examination team has emergency escape breathing devices (EEBD).

WARNING:

Do not don the EEBD to enter a hazardous area. The EEBD is for emergency ESCAPE only. If a known hazard exists in any space, do not enter until the hazard is corrected and the space is declared safe for entry.

- Be familiar with EEBD procedures in the event an emergency escape situation arises.
    - Select an EEBD model based on unit policy and/or forecast outdoor low temperature.
    - Examine EEBD for serviceability and defects per manufacturer's recommended inspection procedure before use.

- Determine if a marine chemist is required.

WARNING:

Coast Guard policy does not require a marine chemist to certify a liquefied gas carrier's cargo compressor room as safe, before Coast Guard personnel entry. In addition to unit policy, reference (l), COMDT COGARD WASHINGTON DC 191819Z MAR 10/ALSAFETY, Cargo Compressor Room Entries During Port State Control Exams and Law Enforcement Boardings of Liquefied Petroleum Gas (LPG) Carrier (Appendix D: Confined Space Safety Alert 2010), and reference (i), MSM Vol. I, provide guidance to personnel on assessing the risks associated with cargo compressor room entry. Use all references to assess risks and determine if a marine chemist must clear a cargo compressor room before entry.

- Before boarding a vessel, the PSCO ensures each team member is aware of the applicable safety hazards associated with the vessel's cargo. Conduct pre-exam risk assessment per reference (m), Risk Management (RM), COMDTINST 3500.3 (series). Review list of cargoes and evaluate with the cargo data sheets, safety data sheet (SDS), and Emergency Response Guide for applicable hazards such as:
    - Cryogenic (frostbite).
    - Flammability.
    - Toxicity.
    - Asphyxia (suffocation).
    - Chemical burns.

NOTE: **Reference (n), Tanker Safety Guide Liquefied Gas, International Chamber of Shipping (ICS), Third Edition, 2018, and reference (o), Liquefied Gas Handling Principles On Ships and In Terminals, SIGTTO, Fourth Edition 2016, are excellent references for hazards and characteristics of cargo(s). Recommend both as references for units with gas carrier expectations.**

NOTE: **Identify unit policy for exposures.**

- Review risk for any special operations such as nighttime exams and offshore boarding.
- Evaluate exam team's fitness and rest period.
- Advise team members to be aware of how current and evolving on-site environmental conditions (such as wind speed/direction) may affect risks, and to reevaluate those risks as conditions change.
- Caution team members to power down marine inspector (MI)/PSCO tablets, cellular phones and other personal electronic devices before boarding vessel. Their use on board is only authorized in gas-safe spaces.

WARNING: ***MI/PSCO tablets, cellular phones and other personal electronic devices are NOT certified intrinsically safe spaces and their use in gas-dangerous zones poses an unacceptable risk to personnel, the vessel, and the port.***

Section C: Gas Code Applicability

C.1. Gas Code Chart

Table 2-1 shows the applicable code based on a vessel's keel laid date and what kind of COF document is issued.

Code	Resolution	Applicability (keel laid date)
EGC Code	MSC.A.329(IX)	≤31DEC1976
GC Code	MSC.A.328(IX)	01JAN1977 – 30JUN1986
1993 IGC Code	MSC.5(48) *"original IGC Code"*	01JUL1986-30SEP1994
	MSC.30(61) "*1993 edition of IGC Code"*	≥01OCT1994
	MSC.32(63)	≥01JUL1998
	MSC.59(67)	≥01JUL1998
	MSC.17(58) *harmonizes survey reqts b/t SOLAS and IGC Code*	Entry into force 3FEB2000, applies to keel laid ≥01JUL1986
	MSC.103(73)	≥01JUL2002
	MSC.177(79)	≥01JAN2007
	MSC.220(82)	≥01JUL2008
2016 IGC Code	MSC.370(93)	≥01JUL2016

Table 2-1 Gas Code chart

Section D: Gas Carrier (Ship) Types/Containment Systems

D.1. Gas Carrier Types

Liquefied gas carriers are typically divided into two main groups; liquefied petroleum gas (LPG) and LNG. There are currently 39 cargoes listed in Chapter 19 of reference (e), IGC Code 1993 Edition. The following are cargoes most commonly carried on LPG carriers trading in the U.S.:

- Butane (C_4H_{10}).
- Propane (C_3H_8).
- Butadiene (C_4H_6).
- Propylene (C_3H_6).
- Vinyl chloride monomer (VCM) (C_2H_3Cl).
- Anhydrous ammonia (NH_3).
- Ethane (C_2H_6).
- Ethylene (C_2H_4).

LNG gas carriers are designed to carry liquefied natural gas which is comprised mostly of methane (CH_4).

All gas carriers are classified into four ship types based on the hazard potential of the cargoes carried. These classes are:

- **1G**: Requires the maximum preventative measures to prevent the escape of the cargoes carried.
- **2G**: Requires significant preventative measures to prevent the escape of the cargoes carried.
- **2PG**: A gas carrier less than 150 meters in length, requires significant preventative measures to prevent escape of cargoes carried and where those cargoes are carried in independent Type C tanks designed for a MARVS of at least 0.7 bar gauge (BARG) and a cargo containment system design temperature of -55 degrees Celsius or above.

NOTE: **Consider all gas carriers of this description that are over 150 meters in length as a type 2G gas carrier.**

- **3G**: Requires moderate preventative measures to preclude the escape of the cargoes carried.

When discussing the physical properties of liquefied gases, it is relatively easy to compare them to water. If you were to heat a pot of water, what would happen? The water molecules would absorb the heat energy and begin to vaporize into steam. If you were to turn off the burner and let the vapors return to ambient temperature and pressure (somewhere between 0-100 degrees Celsius, and 1 bar), the water molecules would return to their natural liquid phase. Liquefied gas cargoes are no different.

At ambient pressure and temperature, the gas cargoes would be found in a gaseous phase but when cooled via reliquefaction plants, the cargo transitions into a liquid. If cooling the cargo is not an option you can liquefy the gas by applying enough pressure through compressors to make it change phases. Keep in mind the cargo would need to remain pressurized at atmospheric temperature.

Gas cargoes are transported as liquids, and they are carried in one of the following three conditions:

- A pressure greater than atmospheric.
- At a temperature below ambient.
- A combination of both.

Generally, LPG gas carriers are fully pressurized, semi-pressurized and refrigerated, or fully refrigerated.

- Fully pressurized.
  - Tanks are horizontal, cylindrical, or spherical pressure vessels.
  - Cargo kept at atmospheric temperature and pressure.
- Semi-pressurized and refrigerated.
  - Tanks are either cylindrical, spherical, bi-lobe, or tri-lobe.
  - Cargo is cooled to some degree, maximum working pressure ranging between 5-7 bar.
- Fully refrigerated.
  - Tanks are prismatic.
  - Cargo is cooled well below ambient temperature, which reduces pressure inside the cargo tank – maximum working pressure of 0.7 bar.

LNG is a cryogenic cargo that is transported near atmospheric pressure. Although some LNG gas carriers are fitted with refrigeration (reliquefaction) systems, most rely on other means to control pressure and temperature of the cargo. Most LNG gas carriers rely on containment systems that use highly efficient insulation around the tanks and consumption of boil-off gas (BOG), whether in propulsion boilers, diesel engines and/or gas combustion units (GCUs).

D.2. Containment Systems

Reference (e), IGC Code 1993 Edition, identifies four different types of cargo containment systems (tank types, see Figure 2-2). Depending on the cargo's temperature at atmospheric pressure, a specific type of tank may require a complete or partial secondary barrier (see Figure 2-3).

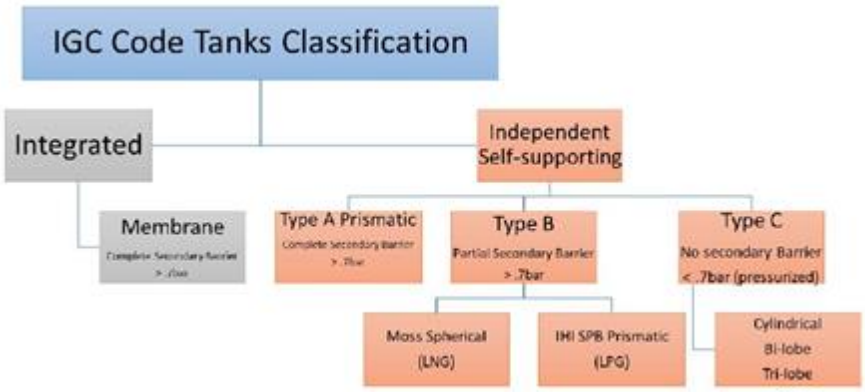

Figure 2-2 More common cargo containments systems for LNG gas carriers

Cargo temperature at atmospheric pressure	–10 °C and above	Between –10 °C and –55 °C	Below –55 °C
	No secondary barrier required	Hull may act as the secondary barrier	Separate secondary barrier, where required
Basic tank type			
Integral		*Tank type not normally allowed*	
Membrane		Complete secondary barrier	
Semi-membrane		Complete secondary barrier	
Independent Type A Type B Type C		Complete secondary barrier Partial secondary barrier No secondary barrier required	
Internal insulation Type 1 Type 2		Complete secondary barrier Complete secondary barrier is incorporated	

Figure 2-3 Secondary barrier determination chart

1. Independent or self-supporting (A, B or C). These tanks are completely self-supporting and do not form part of the ship's hull. However, structurally they introduce loads and forces that will need to be accommodated for, so they influence the structural design of the ship but do not contribute to the hull strength.
   a. **Type A:** Normally a self-supporting prismatic tank with cargoes carried in a fully refrigerated condition near atmospheric pressure.
   b. **Type B**: Normally a sphere but reference (e), IGC Code 1993 Edition, allows for constructing containment systems from plane surfaces.
   c. **Type C**: Normally a horizontal cylindrical pressure vessel. This type is used in fully pressurized and semi-pressurized gas carriers and also used as deck tanks on LPG gas carriers.
2. Membrane.
   a. This type of system is based on a very thin primary barrier (membrane) and a full secondary barrier, both supported by layers of insulation.
3. Semi-membrane.
4. Integral (part of the hull, like a conventional tank vessel).

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Chapter 3:
Certificates and Documents (CD) Examination

Introduction

This chapter discusses collection and review of all pertinent vessel certificates and documents (CD) for validity, certification, and endorsements.

In This Chapter

This chapter contains the following sections:

Section A: International COF (ICOF) – IGC Code

A.1. Overview

Gas carriers in compliance with reference (e), IGC Code 1993 Edition, receive an international COF (ICOF). The certificate is issued under the authority of reference (q), Amendments to the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) (Harmonized system of survey and certification), MSC.17(58), for vessels with a keel laid date of 01 July 1986 and later.

A.2. Conducting Examination

Verify the following:

- Certificate references the appropriate IMO resolution based on the vessel's keel laid date.
- Certificate is valid. Certificate is valid for 5 years except for extenuating circumstances per reference (p), Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29).
- Vessel's Administration or any person or organization duly authorized issued the certificate.
- Certificate authorizes carriage of the cargo(es).
- Certificates identifies any alternative arrangements, equivalencies and exemptions granted.
- Completion of the required intermediate survey, if applicable.
- Status of the annual surveys, if applicable.

Per reference (p), Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29), the same requirements are valid for all gas ships, regardless of which version of the gas code applies. Survey types described the Harmonized System of Survey and Certification (HSSC) are shown in Table 3-1.

Survey Type	Description
Initial Survey (GI)	Completed before initial issue of the ICOF.
Annual Survey (GA)	Completed within 3 months before or after each anniversary date * of the ICOF.
Intermediate Survey (GIn)	Completed within 3 months before or after the second anniversary date * or within 3 months before or after the third anniversary date * of the COF, and should take the place of one of the annual surveys.
Renewal Survey (GR)	Completed before the COF is renewed.
** Anniversary date means the day and the month of each year corresponding to the date of expiration of the ICOF.* **NOTE: An ICOF is no longer valid if the annual or intermediate survey is not completed within the periods specified in reference (e), IGC Code 1993 Edition**.	

Table 3-1 Time windows for surveys carried out under the gas codes

NOTE: **Always compare and verify the information on the ICOF to the SOE. Pay particular attention to tank construction, MARVS, products authorized, and conditions of carriage.**

NOTE: **Per reference (j), MSM Vol. II, transportation of cargo(es) not listed on the vessel COF is grounds for denial of entry to port, expulsion from port, or detention. An ICOF might have an addendum for additional cargoes.**

Section B: COF – GC Code

B.1. Overview

Gas carriers in compliance with reference (d), GC Code, receive a COF. The certificate is issued under the authority of reference (d), for vessels with a keel laid date of 31 December 1976 to 30 June 1986.

B.2. Conducting Examination

Verify the following:

- Certificate references the appropriate IMO resolution based on the vessel's keel laid date.
- Certificate is valid. COFs are never valid for longer than five years from the date of the initial or periodical (renewal) survey.
- Vessel's Administration or any person or organization duly authorized issued the certificate.
- Certificate authorizes carriage of the cargo(es).
- Certificate identifies any alternative arrangements or equivalencies.
- Completion of the required intermediate survey, if applicable.
- Status of the annual surveys, if applicable.

NOTE:

Confirm ambient design temperatures (air and water) are correct for the locations authorized on the SOE, particularly if operating in Alaska.

MARV settings listed on COF correspond with current onboard configuration and cargo(es) carried. Example: COF lists two MARV settings, 8 bar for ethane and 9 bar for methane. Vessel is currently carrying ethane but utilizing the 9 bar MARVS.

Per reference (p), Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29), the same requirements are valid for all gas ships, regardless of which version of the gas code applies. Survey types described in the HSSC are shown in Table 3-1.

NOTE:

Always compare and verify the information on the COF to the SOE. Pay particular attention to tank construction, MARVS, products authorized, and conditions of carriage.

NOTE: **The MSC transposes information provided in vessel's COF to create the SOE. On occasion, the COF on a vessel with type "A" tanks only indicates a 0.25 BARG setting, and yet the vessel is using a higher setting, typically between 0.4 or 0.5 BARG while conducting cargo operations. This is correct. To verify this when encountered, refer to paragraph 5 of the COF, *"ships must be loaded in accordance with the loading conditions provided in the approved loading manual, stamped and dated."* Then review the Cargo Loading or Operations Manual to confirm that the ship is in compliance with procedures.**

NOTE: **Do not write deficiencies when the SOE is incorrect because the SOE is a USCG document. Instead, the vessel or company submits a new COF to the MSC (msc@uscg.mil) requesting correction to MARV settings or cargo details and a new SOE will be issued.**

Section C: COF – Code for Existing Ships Carrying Liquefied Gases in Bulk (EGC Code)

C.1. Overview

Ships that were either built to reference (g), EGC Code, or pre-dated it, are required to comply with reference (d), GC Code, to the extent that they are able to do so. They will receive a COF issued under the authority of reference (d). Those areas of the Code that they are not able to comply with will be identified on the COF. The ship will then be held to reference (g), requirements for those specific areas.

Per reference (g), COFs shall identify the aspects of the GC Code, with which the ship cannot comply.

NOTE: **Ships unable to comply with reference (d), but still receiving a COF are authorized but not common. If this situation occurs contact the LGC NCOE.**

C.2. Conducting Examination

Verify the following:

- Certificate references the appropriate IMO resolution based on the vessel's keel laid date.
- Certificate is valid. COFs are never valid for longer than five years from the date of the initial or periodical (renewal) survey.
- Vessel's Administration or any person or organization authorized issued the certificate.
- Certificate authorizes carriage of the cargo(es).
- Certificate identifies any alternative arrangements or equivalencies.
- Completion of the required intermediate survey, if applicable.
- Status of the annual surveys, if applicable.
- Certificate identifies the aspects of the GC Code that the vessel does not meet for vessels with a COF issued under reference (g).

Per reference (p), Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29), the same requirements are valid for all gas ship, regardless of which version of the gas code applies. Survey types described in the HSSC are shown in Table 3-1.

NOTE: **Always compare and verify the information on the COF to the SOE. Pay particular attention to tank construction, MARVS, products authorized, and conditions of carriage.**

Section D: SOE

D.1. Overview

The MSC generates a SOE at the completion of the Subchapter "O" Plan Review process. The SOE is part of the COC for gas carriers and is required by reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154. Refer to reference (j), MSM Vol. II, for COC guidance. Refer to reference (r), COMDT (CG-ENG-5) Acceptance of Increased Design Vapor Pressure for Membrane Tanks on Liquefied Gas Carriers memo 16700 of 25 Oct 2018, for SOE guidance.

A vessel's SOE will never change so long as there is no cargo related change made to the vessel's COF or a vessel name change. To ensure you print out the most recent SOE in MISLE, print off the one with the most recent serial number issued by MSC. Each SOE will be identified first by a letter than a number, such as C1. It will then be followed by a dash (-) and 7 numbers. The first two numbers identify the year that the SOE was generated and the remaining 5 numbers are the sequential number for that SOE generated by MSC. For example, C1-1797643 is newer than C1-1238573.

Refer to Appendix E: Example Subchapter O Endorsement (SOE) for sample.

D.2. Conducting Examination

Verify the following:

- Cargo containment system(s) aboard the vessel is/are accurately identified on the SOE.
- MARVS are set no higher than the values indicated on the SOE.
- Cargo(es) authorized for carriage are also authorized on the IMO gas code COF.
- Any special restrictions noted are complied with.
- The most current SOE from the vessel's MISLE documents is present.
  - ➢ Review and compare SOE to COF for any changes or errors (Pay particular attention to the MARVS section).
- Ensure the cargo listed on the ANOA is an authorized cargo on the SOE.

NOTE: **If a vessel is NOT authorized for carriage of cargoes in Alaskan waters because of requirements per reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154, the following statement is included on the SOE in Paragraph 12: Special Restrictions: *"Based on the ambient design temperatures listed in the vessel's IMO Certificate of Fitness, the cargoes authorized for carriage in Paragraph 4 may not be carried in Alaskan waters."***

NOTE: **For more guidance see Plan Review Guidelines (PRGs) published by the USCG Marine Safety Center (MSC).**

Section E: Allowable Loading Limits and Temperatures for Each Product

E.1. Overview

Per reference (e), IGC Code 1993 Edition, masters of liquefied gas carriers shall receive and permanently keep information on the maximum allowable loading limits for each cargo tank. Tanks should not be more than 98 percent liquid full at the reference temperature, unless a higher fill limit is allowed by the Administration.

Historically, only LNG gas carriers were authorized to load to 98.5 percent because they use BOG as fuel, resulting in lower cargo levels as the loaded voyage progresses. However, a vessel's Flag Administration can authorize above 98 percent liquid full taking into account the shape of the cargo tank, location of pressure relief valves, accuracy of level and temperature gauges, the loading temperature of the cargo, and if the vessel's relief valves would remain in the cargo tank's vapor phase in a 15 degree list.

Information for each product aboard includes:

- Applicable loading temperature.
- Applicable maximum reference temperature.

CAUTION:

Tank levels outside of specified ranges can result in tank damage from excessive sloshing.

E.2. Conducting Examination

Do the following:

- Examine the COF to determine authorized tank levels and authorized minimum temperatures for cargoes aboard.
- Verify that cargo information available to the master includes reference temperatures and cargo tank relief valve set pressures. Find cargo information on SDSs.
- Verify that tank liquid levels shown on the gauging system do not exceed authorized levels.

Section F: Cargo Tank Pressure Relief Valves Documentation

F.1. Overview

Reference (e), IGC Code 1993 Edition, and reference (d), GC Code, identify three documentary requirements for cargo tank pressure relief valve settings (MARVS).

1. MARVS servicing paperwork (e.g., "set and seal" certificate): required for all ships.
2. MARVS changing procedures: only required for ships authorized to use multiple MARV settings.
3. MARVS changes logged in official log book: only required for ships authorized to use multiple MARV settings.

F.2. Conducting Examination

Per reference (e), and reference (d):

- All ships are required to have servicing paperwork for the pressure relief valves.
- Only ships authorized multiple relief valve settings are required to have MARVS changing procedures and MARVS changes logged in the official log book.

For MARVS servicing paperwork, verify the following:

- Documentation is from an "Administration accepted" competent authority (e.g., Recognized Organization [RO]) attesting to the proper setting of the cargo tank pressure relief valves. See Appendix F: Survey Report Example.

NOTE: **Reference (e), and reference (d), do not require a set period for servicing of the MARVS; rather, they require that when the MARVS are serviced, the competent authority must attest to the proper setting and sealing of these valves. Practically, Class Rules require that the MARVS are disassembled and overhauled at 5 year intervals (each special survey).**

NOTE: **Some vessels will conduct in-situ "pop tests" of the valves at more frequent intervals. Since this does not involve removing the sealing wires, attestation from the competent authority is not required for this action.**

For MARVS changing procedures, verify the following:

- Flag State Administration approval of procedures for changing cargo tank pressure relief valves.

NOTE: **If the vessel is fitted with deck tank(s) that have multiple relief valve settings, ensure that the procedures addresses these valves as well.**

NOTE: **The applicable Gas Codes also require that the procedures address changing of the pressure alarm set-points when the relief valves are changed. Properly changing the alarm set-points is vital to ensure that the alarm is received prior to valve actuation.**

For logging of MARVS changes, verify the following:

- All changes in MARV settings are logged in the official log book (e.g., deck log).

NOTE: **Confirm that logbook entries accurately reflect that changes in MARV settings took place at the appropriate time(s), as delineated in the applicable Gas Codes and the MARVs changing procedures. For example, for a LPG carrier with "at sea" and "in harbor" MARV settings, and currently using the "in harbor" MARV settings, no logbook entry upon arrival in port documenting changing from the "at sea" to the "in harbor" MARV settings would be grounds for an expanded exam.**

Section G: Crew Training Documentation

G.1. Overview

Reference (s), International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, Including 2010 Manila Amendments, STCW Convention and STCW Code, 2017 Edition, specifies additional requirements for mariners serving on liquefied gas carriers.

G.2. Conducting Examination

Verify the following:

- Each officer and rated individual with specific duties and responsibilities related to cargo operations or cargo equipment holds a certificate in basic training for liquefied gas tanker operations.
- The master, chief engineer, chief mate, second engineer, and anyone responsible for cargo-related operations holds a certificate in advanced training for liquefied gas tanker cargo operations.
- All officers with specific cargo duties hold an appropriate Certificate of Proficiency issued or endorsed by the Flag Administration that demonstrates compliance with reference (s).

NOTE: **At a minimum, certificate must reference Chapter V: Standards Regarding Special Training Requirements for Personnel on Certain Ship Types, Section A-V/1-2: Mandatory Minimum Requirements for the Training and Qualifications of Masters, Officers and Ratings on Liquefied Gas Tankers of reference (s).**

Section H: IPP NLS

H.1. Overview

LPG gas carriers might also have authorization to carry noxious liquid substances (NLS) cargoes. In reference (e), IGC Code 1993 Edition, and reference (d), GC Code, an asterisk (*) next to each cargo listed in Chapter 19 identifies these NLS cargoes.

The governing document for a gas carrier is the ICOF/COF issued under the applicable Gas Carrier Code. However, per reference (t), Control of Pollution of Noxious Liquid Substances in Bulk, MARPOL Annex II, NLS cargoes are only authorized when the vessel is issued an IPP NLS.

NLS products are dual regulated and in addition to complying with reference (e), or reference (d), they also must comply with the certification and documentation portions of reference (t) to include the NLS certificate, the Procedures and Arrangements Manual (P&A Manual), the Shipboard Marine Pollution Emergency Plan (SMPEP), and the Cargo Record Book.

H.2. Conducting Examination

Verify the following:

- Certificate is valid. A Certificate is valid for 5 years except for extenuating circumstances per reference (p), Survey Guidelines Under the Harmonized System of Survey and Certification (HSSC), 2015, IMO Resolution A.1104(29).
- Vessel's Administration or any person or organization duly authorized issued the certificate.
- Certificate authorizes carriage of the NLS cargo(es).
- Completion of the required intermediate survey, if applicable.

NOTE: **Per reference (t), the intermediate survey must be complete within three months before or three months after the second or third anniversary date of when the certificate was issued.**

- Status of the required annual surveys, if applicable.

NOTE: **Per reference (t), the annual surveys must be complete within three months before or three months after the anniversary date of when the certificate was issued.**

Section I: Certificate of Inhibition

I.1. Overview

Polymerization is the process of monomer molecules reacting together in a chemical reaction to form polymer chains or three-dimensional networks. Polymerization produces heat and causes significant pressure buildups. This can pose a risk to the vessel, crew, and port. If polymerization does occur, the cargo will become warmer and more viscous and a solid unpumpable polymer might be formed.

To prevent these deleterious effects, the applicable Gas Codes require that certain cargoes be carried inhibited. When Chapter 19 of reference (e), IGC Code 1993 Edition, requires a cargo be carried inhibited, the vessel must have a Certificate of Inhibition as documentary evidence that the cargo is sufficiently inhibited.

I.2. Conducting Examination

Verify the following is indicated:

CAUTION:

It is very important that the gas carrier use the proper types and amounts, maintain effective temperature control of, and monitor the lifespan of any inhibitors. This is extremely critical for the safe storage and carriage of certain cargoes primarily to reduce the detrimental effects of polymerization and any detrimental impacts to the gas carrier and/or the port.

- Name of inhibitor.
- Amount of inhibitor added to the cargo(es).
- Date inhibitor was added.
- Normal expectation of the inhibitor's effective lifetime.
- Inhibitor temperature limitations that may affect its effectiveness.
- Any actions the crew is required to take when the length of the voyage exceeds the effective lifetime of the inhibitor.

NOTE:

Transporting cargo(es) with an inhibitor without the required/valid Certificate of Inhibition is grounds for detention. For ports where cargo is loaded, the certificate may not be available until after the loading is completed.

NOTE: **Sometimes a Certificate of Inhibition states that if the length of the voyage exceeds the effective lifetime of the inhibitor then just add more. It is important for you to confirm that the ship actually has more inhibitor onboard and that they can effectively add it. Many times they do not or if they do, there is no practical way to safely add it. In these cases, it is very important for you to address this with the master/crew. Transport of substances to be inhibited without valid inhibitor certificate is a detainable situation per reference (j), MSM Vol. II.**

Section J: Dry Powder Servicing Report

J.1. Overview

Reference (u), Revised Guidelines for the Maintenance and Inspection of Fire Protection Systems and Appliances, International Maritime Organization (IMO), MSC.1/Circ. 1432, is the guiding article for maintenance, testing, and inspection of a gas carrier's firefighting dry chemical powder system. Reference (u), allows the ship's crew to carry out the inspections required on the vessel's fixed firefighting system. However, some of the recurring inspections on the systems are conducted by a third party service technicians. This includes the required annual, two-year and ten-year inspections and servicing.

J.2. Conducting Examination

Verify the following:

- Dry Chemical Powder Annual Testing and Inspection Report.
  - Visual inspection of components.
  - Pressure regulators within calibration.
  - System was agitated with nitrogen.
- Dry Chemical Powder Two-Year Testing and Inspection Report.
  - Blow down discharge lines to clear obstructions.
  - Operational test of section valves.
  - Content of propellant gas cylinders.
  - Conduct moisture analysis of dry chemical powder.
  - Pressure test the safety valve and discharge hose of dry chemical powder containment vessels.
- Dry Chemical Powder Ten-Year Servicing Report.
  - All dry chemical powder containment vessels require hydrostatic or non-destructive testing by a third party.

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Chapter 4:
Logs and Manuals (LM) Examination

Introduction

This chapter discusses collection and review of all vessel documents for validity, proper certification, and endorsement.

In This Chapter

This chapter contains the following sections:

Section A: ★★★Cargo Operations Manual

A.1. Overview

Per reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154, liquefied gas carriers are required to have adequate cargo information on board to assist crews with safely managing the cargo(es) carried. Typically the information is contained in a manual known as the Cargo Operations Manual. On some ships, similarly useful information relating to cargo pumps, compressors and other cargo machinery is broken out into a separate manual known as a Cargo Machinery Manual. The format for presenting cargo information is not specified, so vessels may elect to keep this information on a computer database rather than in a "paper" manual.

A.2. Conducting Examination

NOTE:

Be familiar with the general contents of the Cargo Operations Manual before conducting the cargo portion of the exam. One strategy for familiarizing yourself with its contents is to read the sections that address the cargo tests, alarms, and shutdowns that you will witness during the course of the exam (e.g., fixed gas detection, pressure alarms, cargo level alarms, etc.). This can also help improve communication with the crew in case of a language barrier.

Examine the Cargo Operations Manual and verify the following:

- Contents meet regulation 18.1.1 of reference (e), IGC Code 1993 Edition.
- Crew members having duties related to the handling of liquefied gas cargoes have familiarity with, and a working knowledge of, the Cargo Operations Manual.

Section B: Loading and Stability Information

B.1. Overview

The master of a liquefied gas carrier is supplied with a Loading and Stability Information Booklet per the applicable Gas Carrier Code and reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154. In addition to the stability booklet, reference (f), IGC Code 2016 Edition, requires all vessels (including vessels built prior to 1 July 2016) to be fitted with a stability instrument capable of verifying compliance with intact and damage stability requirements by the first renewal survey after 1 July 2016.

B.2. Conducting Examination

Verify the following:

- Vessel is fitted with a stability instrument (if required based on phase-in date).
- Satisfactory to the Administration (RO).
- Booklet contains details of typical service conditions, to include loading, unloading, and ballast conditions.
- Booklet contains a summary of the gas carrier's survival capabilities.

Section C: P&A Manual

C.1. Overview

Per reference (t), Control of Pollution of Noxious Liquid Substances in Bulk, MARPOL Annex II, every ship certified to carry a category X, Y or Z NLS shall have aboard a P&A Manual. The purpose of this manual is to identify the physical arrangements and operational procedures for the handling of these cargoes.

NOTE:

All gas carriers that transport cargoes also covered by reference (e), IGC Code 1993 Edition, [noted by a * in Chapter 19 of reference (e)] must have the following documentation:

- **P&A Manual (Chapter 4, Section C).**
- **Cargo Record Book (Chapter 4, Section D).**
- **SMPEP for NLS (Chapter 4, Section E).**
- **IPPNLS (Chapter 3, Section H).**

C.2. Conducting Examination

Verify the following:

- P&A Manual is approved by the Flag Administration.
- P&A Manual is in the standard format per reference (t).

NOTE:

When examining the P&A Manual, pay particular attention to Addendum C: Ventilation Procedures, as residues from these high vapor pressure cargoes will be removed by ventilation vice water washing. In addition, confirm that the P&A Manual includes the NLS categories X, Y, Z, and OS, and not the old NLS categories A, B, C, and D that were used prior to January 1, 2007.

Section D: Cargo Record Book

D.1. Overview

When an LPG gas carrier is authorized to carry NLS it must comply with requirements outlined in reference (t), Control of Pollution of Noxious Liquid Substances in Bulk, MARPOL Annex II. This includes having a readily available for inspection Cargo Record Book aboard.

Certain liquefied gases with boiling points near ambient temperature (propylene oxide (C_3H_6O); boiling point 34 degrees Celsius) are regulated under not only the applicable Gas Codes but also under reference (t), due to their pollution potential. One of the requirements of reference (t), is to have a Cargo Record Book onboard. Thus, when a gas carrier is authorized to carry one or more NLS cargoes (the applicable cargoes are identified by a "*" after their name in the table located in Chapter 19 of reference (e), IGC Code 1993 Edition, and reference (d), GC Code), the vessel must have a Cargo Record Book onboard and available for inspection.

D.2. Conducting Examination

Verify the following:

- Cargo Record Book is properly formatted per reference (t).

NOTE: **When a vessel with a COF for liquefied gas is authorized to carry any of the products also regulated by reference (t), the vessel must also have a NLS certificate and meet the requirements of reference (t). Specifically, the vessel must have a P&A Manual, a Cargo Record Book, and a SMPEP.**

NOTE: **Per reference (t), every applicable ship shall be provided a Cargo Record Book, whether as part of the ship's official log-book or otherwise, in the form specified in reference (t). Vessel is not deficient unless determined per reference (t), cargo is aboard and not logged.**

- Each entry is signed by the officer-in-charge (OIC) of the operation.
- Each page is signed by the master.

NOTE: **The applicable cargoes are identified by a "*"after their name in the table located within Chapter 19: Summary of Minimum Requirements of reference (e), and reference (d).**

Section E: SMPEP for NLS

E.1. Overview

Per reference (t), Control of Pollution of Noxious Liquid Substances in Bulk, MARPOL Annex II, every ship of 150 gross tons and above certified to carry NLS shall have aboard a SMPEP for NLS. The plan outlines procedures for personnel aboard to reduce or control the discharge of NLS following an incident.

NOTE:

All gas carriers that transport cargoes also covered reference (e), IGC Code 1993 Edition, [noted by a * in Chapter 19 of reference (e)] must have the following documentation:

- **P&A Manual (Chapter 4, Section C).**
- **Cargo Record Book (Chapter 4, Section D).**
- **SMPEP for NLS (Chapter 4, Section E).**
- **IPPNLS (Chapter 3, Section H).**

E.2. Conducting Examination

Verify the following:

- Flag Administration approved the plan.
- Authorities or people to contact in the event of an incident are identified.

Chapter 5:
General Health (GH) and Safety Examination

Introduction

This chapter discusses the various requirements and procedures for conducting a general health (GH) and safety examination. It is vital to consider that regulations under 14.4 of reference (e), IGC Code 1993 Edition, are pertinent to vessels carrying products for which those specific paragraphs are listed in the Special Requirements column of the table in Chapter 19. Therefore, aforementioned provisions are only applicable to individual products.

In This Chapter

This chapter contains the following sections:

Section A: Decontamination Showers and Eye Wash Stations

A.1. Overview

Per the Gas Codes, decontamination showers and eye wash stations are required on liquefied gas carriers.

The requirement to carry this equipment depends on the specific cargoes that the vessel is authorized to carry and can be found in Chapter 19: Summary of Minimum Requirements of the relevant Code.

A.2. Conducting Examination

Verify the following:

- Suitably marked. (see Figure 5-1).

Figure 5-1 Suitably marked decontamination shower and eye wash station

- Capable of operating in all ambient conditions.
- Located on deck taking into account the layout and size of the vessel.

Section B: Respiratory and Eye Protection for Emergency Escape Purposes

B.1. Overview

Per reference (e), IGC Code 1993 Edition, respiratory and eye protection for emergency escape purposes are required on liquefied gas carriers. The requirement to carry this equipment depends on the specific cargoes that the vessel is authorized to carry and can be found in Chapter 19: Summary of Minimum Requirements of the relevant Code.

B.2. Conducting Examination

Verify the following:

- ★★★One of each is provided for each person aboard and two additional sets of respiratory and eye protection are permanently located on the bridge for navigation watch personnel.
- Respirator is not a filter type.
- Self-Contained Breathing Apparatus (SCBA) with 15 minutes of air supply.
- Identified for escape purposes only and is not used for cargo handling or firefighting purposes.
- Equipment is labeled correctly (not for cargo handling and/or firefighting).

Section C: Personnel Safety Equipment

C.1. Overview

Per reference (e), IGC Code 1993 Edition, liquefied gas carriers shall have sufficient personnel safety equipment aboard to protect personnel from hazards.

C.2. Conducting Examination

Verify the following:

- ★★★At least two sets of personnel safety equipment are on board. See Figure 5-2.

Figure 5-2 Safety equipment

- ★★★Each set of personnel safety equipment contains the required equipment as follows:
  - One SCBA with at least 1,200 liters of free air.
  - Protective clothing, boots, gloves and tight fitting goggles.
  - Steel-cored rescue line.
  - Explosion proof lamp.
- An adequate supply of compressed air is available as required by relevant Code.
- Compressed air used for safety equipment is inspected once a month by a gas carrier's officer.
- ★★★Compressed air used for safety equipment is inspected and tested once a year by an expert.

NOTE:

An expert typically is a third party who conducts servicing and inspections on compressed air equipment used for breathing purposes. However, reference (e), IGC Code 1993 Edition, does not specify who is considered an expert. On some gas carriers, Flag State might designate a crewmember as an expert to service the compressed air. This is done through an attestation letter after the crewmember receives additional training or holds a specific competency for that equipment.

- ★★★If the vessel has a cargo capacity of more than 2,000 cubic meters (m^3), two additional sets of safety equipment are provided with at least three spare charged air bottles for each additional set.

Section D: First Aid Equipment

D.1. Overview

Per reference (e), IGC Code 1993 Edition, liquefied gas carriers shall have additional first aid equipment. Refer to reference (v), World Health Organization, International Medical Guide for Ships, 3rd Edition, for a description of required additional first aid equipment.

D.2. Conducting Examination

Verify the following:

- That a stretcher, suitable for hoisting an injured person from a space below, is available in a readily accessible location (see Figure 5-3).

Figure 5-3 Stretcher

- That first aid equipment is available per reference (v).
- Oxygen (O_2) resuscitation equipment is aboard.
- That medicine(s) is/are aboard for those cargoes specifically identified in Chapter 19: Summary of Minimum Requirements of the relevant Code.

NOTE: **Reference (w), Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), 1994 Edition, is a supplement to the International Maritime Dangerous Goods Code (IMDG) Code.**

NOTE:

Reference (w), Medical First Aid Guide for use in Accidents Involving Dangerous Goods (MFAG), 1994 Edition, includes the numbers of products covered by the Code(s) and the emergency procedures to apply in the event of an incident. Reference (w), numbers related to products covered by the Code(s) are given in the Code's Table of Minimum Requirements.

Section E: Air Locks

E.1. Overview

Per reference (e), IGC Code 1993 Edition, and reference (d), GC Code, air locks are required when a gas safe/non-hazardous space opens to a gas dangerous/hazardous Zone 1. On gas carriers, they are mainly used in the entrance to the cargo machinery motor room. However, it's not uncommon for other spaces to be fitted with an air lock (i.e., nitrogen rooms, paint lockers, bow thruster rooms etc.). These gas safe/non-hazardous spaces are protected by over pressurization as required by the International Electrochemical Commission (IEC).

If a space is protected by an airlock the over pressurization within the protected space ensures that gases from the gas-dangerous area cannot enter the protected gas-safe space. A pressure switch that measures differential pressure between the protected space and the outside atmosphere is installed within the protected space. Per the applicable Gas Code, if the pressure within the protected space drops to equal the outside atmosphere pressure, all electrical equipment not of the certified safe type must de-energize.

CAUTION:

Testing of more than the airlock visual and audible alarms is not recommended as the unintended consequences associated with the stopping of cargo compressors during cargo loading operations will cause increase risk to the operation and can cause significant disruption to both the vessel and terminal.

Air locks are designed to prevent the loss of overpressure in these gas safe/non-hazardous spaces when personnel access the space from a gas dangerous/hazardous Zone 1. Air locks are also fitted with gas detection and positive ventilation within them. See Figure 5-4 and Figure 5-5.

Figure 5-4 Air lock (note the two steel doors)

Figure 5-5 Self closing mechanism, door open, and door closed indicator

E.2. Conducting Examination

Verify the following:

- Per reference (f), IGC Code 2016 Edition, the visible alarm shall indicate if one door is open. An audible alarm will sound if both doors are in the open position.
- Air lock doors are self closing (see Figure 5-5).
- Operation of the audible and visual alarms on both sides of the air lock indicating that more than one door is not in the closed position.
- No hold back arrangements on air lock doors are in place.
- Presence and condition of hatch gasket, dog contact, knife edge condition and seal when closed and dogged.

NOTE:

Electrical equipment that is not a certified safe type and is in a space protected by an airlock will de-energized upon loss of overpressure in the space. Electrical equipment that is not a certified safe type used for maneuvering and mooring, as well as the emergency fire pump(s), should not be located in spaces protected by airlocks.

Chapter 6:
Lifesaving Equipment (LS) Examination

Introduction

This chapter provides an examination overview for the lifeboats on liquefied gas carriers. Refer to reference (x), Life-Saving Appliances (LSA) Code, International Maritime Organization (IMO), 2017 Edition.

In This Chapter

This chapter contains the following sections:

Section A: Lifeboats

A.1. Overview

Lifeboats on tankers and liquefied gas carriers have additional equipment beyond what lifeboats on other ships carry. For a complete list of required equipment, see reference (h), SOLAS, which references reference (x), Life-Saving Appliances (LSA) Code, International Maritime Organization (IMO), 2017 Edition, Sections 4.8 and 4.9 respectively.

CAUTION:

Cargoes carried on liquefied gas carriers are either flammable and/or toxic. Per reference (h), and reference (x), depending on the hazard of the cargo carried, lifeboats must have a self-contained air support system and some kind of fire protection (e.g., a water spray system).

A.2. Conducting Examination

The lifeboat exam consists of 2 parts:

- Self-contained air support system.
- Lifeboat water spray system.

A.2.a. Self-Contained Air Support System Overview

A self-contained air support system is required by reference (x), to provide breathable air for the maximum personnel capacity authorized and engine combustion so the lifeboat can safely maneuver away from the vessel and any fire. In addition, it prevents the ingress of toxic fumes or gas. Supplied air is intended to provide safe breathable environment for a minimum of 10 minutes. It is also important to confirm that the lifeboat's air supply system is holding proper pressure.
See Figure 6-1.

Figure 6-1 Self-contained air support system

A.2.a.(1). Conducting Examination

In addition to the other lifeboat equipment examined as part of a normal PSC COC examination, verify the following:

- The satisfactory condition of the self-contained air support system. Look for signs of corrosion, breaches in piping, indications of poor maintenance, and failure of the system to operate properly.
    - ➢ Have the crew open the valves on the supply bottle and charge the line; this allows the inspector to witness the integrity of the system. Do not discharge the bottle into the lifeboat, it is advised that you make this clear to the crew before testing the system.
- Bottles are securely fastened within the lifeboat and in good condition (i.e., no excessive rust, pitting, leaks or other damage that could impact the integrity of the bottles).

NOTE: **There is no requirement to confirm that the bottle(s) have been hydro tested.**

- Hoses are in good condition without deformities (kinks, sharp bends, etc.) that would hinder air flow.
- The system is holding proper pressure.
- The air supply system's pressure indicators/gauges are in satisfactory condition. Trace the tubing from the regulator to supply bottle(s) and look for cracks in the glass, the absence of indicator "needles" or other indications that the pressure indicator/gauge may not be functioning properly.
- The crew can properly align the system:

NOTE: **To prevent an accidental release, ensure the regulator is closed before the crew opens the valves on the air bottles.**

- ➢ There is pressure at the regulator.
- ➢ Crew closes the valves on the air bottles.
- ➢ Air pressure is bled from the lines.

A.2.b. Lifeboat Water Spray System Overview

Per reference (x), Life-Saving Appliances (LSA) Code, International Maritime Organization (IMO), 2017 Edition, and reference (h), SOLAS, a fire protection system is required. It may be a water spray system. Usually, the water spray system is an engine driven pump that suctions sea water from under the lifeboat. This ensures that no flammable liquid is drawn into the system. Water will spray over the entire surface of the boat. Just like the self-contained air support system, the water spray system ensures the lifeboat can safely maneuver away from the vessel and any fire.

A.2.b.(1). Conducting Examination

Verify the following:

- Sea water intake for the system is below the water line.
- The stainless piping housing the water spray system is in good working condition. No excessive rust, pitting or clogs to piping restricting the flow of water.
- The water flows continuously over the lifeboat for at least 8 minutes when system is operational. Look for continuous water coverage over the housing.
    - ➢ It is rare to see the launching and operation of a lifeboat during routine COCs because the Coast Guard does not require the lifeboats to be lowered, released, and exercised UNLESS you have reason to expand the exam. During routine exams, you can verify that the vessel meets this particular requirement by reading the Classification Society report on the proper operation of this equipment. Sometimes the vessel will have digital images of the testing of the water spray system taken during routine drills. In some cases, they may have a video.
- For liquefied gas carriers authorized to carry flammable cargoes, ship's crew routinely maintains and tests the lifeboat water spray system. Ensure maintenance and tests are properly documented (logged).

NOTE: **The ship's crew normally tests a water spray system when boat(s) are lowered during routine drills. Per reference (j), MSM Vol. II, lowering, releasing, and exercising lifeboats is not required during a routine COC exam. Rely on a visual examination and ship documentation.**

NOTE: **Per reference (h), LPG gas carriers authorized to carry only toxic cargoes (i.e., anhydrous ammonia) are not required to have a water spray system.**

Chapter 7:
Firefighting Systems (FF) Examination

Introduction

This chapter provides an examination overview for a liquefied gas carrier's firefighting equipment.

In This Chapter

This chapter contains the following sections:

Section A: Fire Water Main Equipment

A.1. Overview

Fire prevention and firefighting is paramount for the safety of the crew and the vessel. Therefore it is critical that the system and all of its components are well maintained and ready for immediate use. Per reference (h), SOLAS, all gas carriers are required to have a fire main system. Requirements vary based on keel laid date (refer to Chapter 2: PE Preparations, Section C: Gas Code Applicability for more guidance).

A.2. Conducting Examination

Verify the following:

- The main piping, fittings, and nozzles are in good condition, free of excessive corrosion, pitting, and holes (unauthorized temporary repairs).
- Per reference (e), IGC Code 1993 Edition, there are at least two jets of water that can reach any part of the deck in the cargo area as well as those portions of the cargo containment system and tank covers above the deck.
- Stop valves are fitted at intervals of not more than 40 meters and in any crossovers.
- Two pumps are present.
- There are no excessive leaks from mechanical seal, valves, and flanges.
- Pumps must attain a pressure per reference (h). However, if fire main and fire pump is used as part of the water spray system, as permitted by reference (e), the pressure needs to be at least 5 BARG (73.5 psi).
- If the gas carrier's engine room is unattended, one of the vessel’s fire pumps can remotely start and connect to the fire main from the navigating bridge or other control station outside the cargo area.

Section B: Deck Water Spray System

B.1. Overview

Reference (e), IGC Code 1993 Edition, and reference (d), GC Code, require liquefied gas carriers to have a deck water spray system for cooling, fire prevention by means of rapid vapor dispersion, and crew protection (not firefighting).

★★★The system protects the following areas:

- Exposed cargo tank domes and exposed parts of the tank.
- Exposed on deck cargo storage vessels.
- Cargo liquid and vapor loading and discharge manifolds.
- Boundaries of superstructures and deck houses normally manned, cargo compressor rooms, cargo pump rooms, store rooms containing high fire risk items, and cargo control rooms that are facing the cargo area.

The system is designed to protect the cargo and gas carrier's accommodations from radiant heat in the event of a fire. Spray systems are the first line of defense and absorb a large amount of heat. See Figure 7-1.

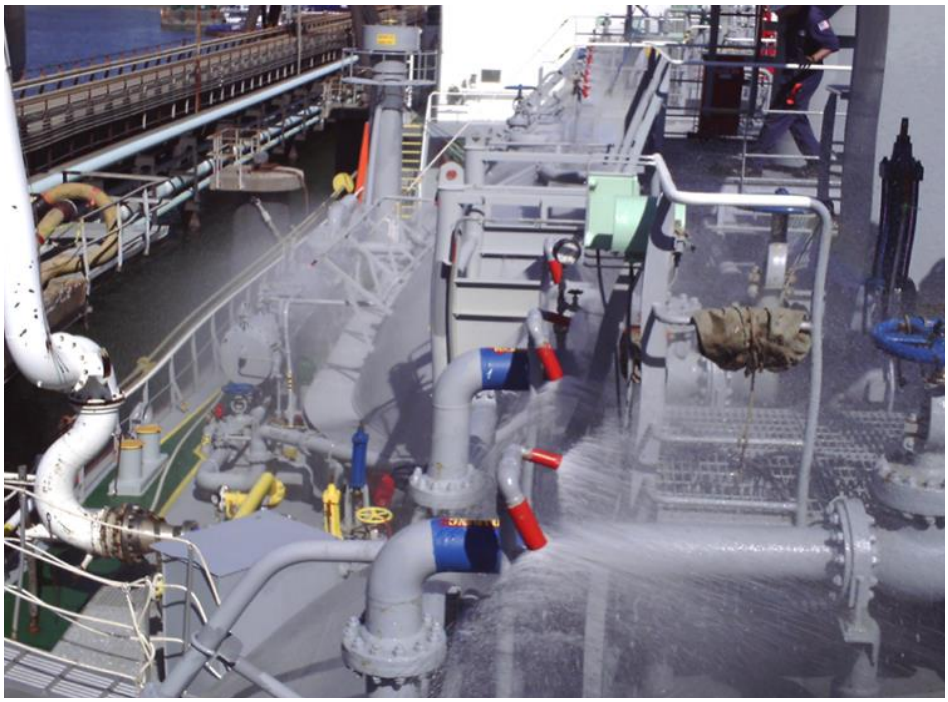

Figure 7-1 Activated deck water spray system (manifold)

B.2. Conducting Examination

Verify the following:

- ★★★If the deck water spray system is supplied by the fire pump, both systems operate simultaneously with the fire main and are capable of producing 5 BARG (73.5 psi).
  - ➢ If visual examination reveals questionable stream, require ship's crew to prove output pressure (which should be at least 5 BARG (73.5 psi) while both systems are operating). Deck water spray pumps can be started remotely outside of the cargo area.
- Verify local operation during carriage of propylene oxide (C_3H_6O) and ethylene oxide (C_2H_4O).
- Consistent spray from all nozzles and coverage of required areas per reference (e), IGC Code 1993 Edition. See Figure 7-2.

NOTE: **It is important to coordinate the teams' position throughout the vessel to verify proper coverage of the deck water spray.**

Figure 7-2 Deck water spray system (tank domes)

Section C: Dry Chemical Powder Fire-Extinguishing System

C.1. Overview

Per reference (e), IGC Code 1993 Edition, liquefied gas carriers authorized to carry flammable cargo(es), shall have a fixed dry chemical powder extinguishing system. See Figure 7-3.

Figure 7-3 Dry chemical powder fire extinguishing system

C.2. Conducting Examination

Verify the following:

- Per reference (f), IGC Code 2016 Edition, and reference (u), Revised Guidelines for the Maintenance and Inspection of Fire Protection Systems and Appliances, International Maritime Organization (IMO), MSC.1/Circ. 1432, documentation of periodic system servicing either on the system itself or by a service technician report.
- Independent self-contained dry chemical powder unit is free of corrosion, pitting, and canister deformation.

NOTE: **Per reference (e), gas carriers with a cargo carrying capacity of 1,000 m^3 or less only require one dry chemical powder fire-extinguishing unit.**

- All hoses and piping, including the inert gas storage pressure vessel(s), are connected and in good material condition (e.g., no signs of dry rot or corrosion).
- Deck monitors can protect the cargo loading and discharge manifold areas. Monitors and hoses can reach the transfer areas.
- An additional dry chemical powder unit is installed for gas carriers fitted with bow or stern loading and discharge arrangements.
- ★★★On a fixed dry powder system, the propellant bottles (inert gas pilot bottles) are in good material condition (i.e., no corrosion, wastage, or scaling).

Section D: Cargo Machinery (Compressor) Motor Room Fixed Fire-Extinguishing System

D.1. Overview

Cargo machinery (compressor) motor rooms shall have a fixed carbon dioxide (CO_2) extinguishing system installed to the satisfaction of the vessel's Flag Administration and per:

- Reference (e), IGC Code 1993 Edition.
- Reference (d), GC Code.
- Reference (h), SOLAS.
- Reference (y), International Fire Safety Systems (FSS Code), International Maritime Organization (IMO), 2015 Edition.

NOTE: **As with all fixed CO_2 systems, it is critical that the system, including all of its components, are well maintained and ready for immediate use.**

D.2. Conducting Examination

Examine the system the same as any PSC exam. See reference (z), Port State Control Examiner, Tactics, Techniques, and Procedures (TTP), CGTTP 3-72.12 (series), for further guidance.

Section E: Cargo Machinery Motor Room Fixed Fire-Extinguishing System

E.1. Overview

★★★Although not required by the Gas Codes, cargo machinery motor rooms may have a fixed CO_2 extinguishing system.

Refer to the reference (aa), Guidelines for the Maintenance and Inspection of Fixed Carbon Dioxide Fire-Extinguishing Systems, International Maritime Organization (IMO), MSC.1/Circ.1318 and reference (u), Revised Guidelines for the Maintenance and Inspection of Fire Protection Systems and Appliances, International Maritime Organization (IMO), MSC.1/Circ. 1432, for more guidance.

E.2. Conducting Examination

Examine the system the same as any PSC exam. See reference (z), Port State Control Examiner, Tactics, Techniques, and Procedures (TTP), CGTTP 3-72.12 (series), for further guidance.

Section F: Fire-fighter Outfits

F.1. Overview

Liquefied gas carriers are required to have fire-fighter outfits as required by reference (e), IGC Code 1993 Edition, in lieu of requirements of reference (h). See Figure 7-4 for an example of a fire-fighter outfit. See the following references for further guidance:

- Reference (y), International Fire Safety Systems (FSS Code), International Maritime Organization (IMO), 2015 Edition.
- Reference (e), IGC Code 1993 Edition.
- Reference (d), GC Code.

Figure 7-4 Fire-fighter outfit

F.2. Conducting Examination

Verify the following:

- Required number of fire-fighter outfits is aboard per reference (e), IGC Code 1993 Edition. See Table 7-1.

Total Cargo Capacity	Number of Outfits
5,000 cubic meters (m^3) and below	4
Above 5,000 cubic meters (m^3)	5

Table 7-1 Required number of fire-fighter outfits aboard

NOTE:

Refer to reference (e), for additional requirements related to personnel protection and safety equipment. Also see Chapter 5: General Health (GH) and Safety Examination, Section C: Personnel Safety Equipment.

- Per reference (h), SOLAS, *"fire-fighter's outfits or sets of personal equipment shall be kept ready for use in an easily accessible location that is permanently and clearly marked and, where more than one fire-fighter's outfit or more than one set of personal equipment is carried, they shall be stored in a widely separated position. Suits are in good condition (no lacerations or deterioration)."*
- All self-contained breathing apparatus as part of a fire-fighter's outfit should have a capacity of at least 1,200 liters of free air.
- Detailed requirements for each type of fire safety equipment is available in reference (y), International Fire Safety Systems (FSS Code), International Maritime Organization (IMO), 2015 Edition.

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Chapter 8:
Electrical Systems (ES) Examination

Introduction

This chapter discusses the electrical installation requirements in Hazardous zones and the procedures for conducting the electrical systems (ES) examination.

In This Chapter

This chapter contains the following sections:

Section A: Gas Dangerous and Hazardous Zone Determination and Equipment Installation

A.1. Overview

Reference (e), IGC Code 1993 Edition, and reference (d), GC Code, identifies a gas dangerous space or zone (see Figure 8-1) as an area of a vessel that a gas safe atmosphere cannot be guaranteed at all times during both normal or abnormal conditions. Because of this, the vessel must have electrical equipment installed that is certified to operate within these zones to eliminate the probability of a flammable atmosphere from coming in contact with an ignition source. To determine where, how and what kind of certified electrical equipment must be installed, reference (e), and reference (d), require vessels to follow the IEC 60079-10-1 standards.

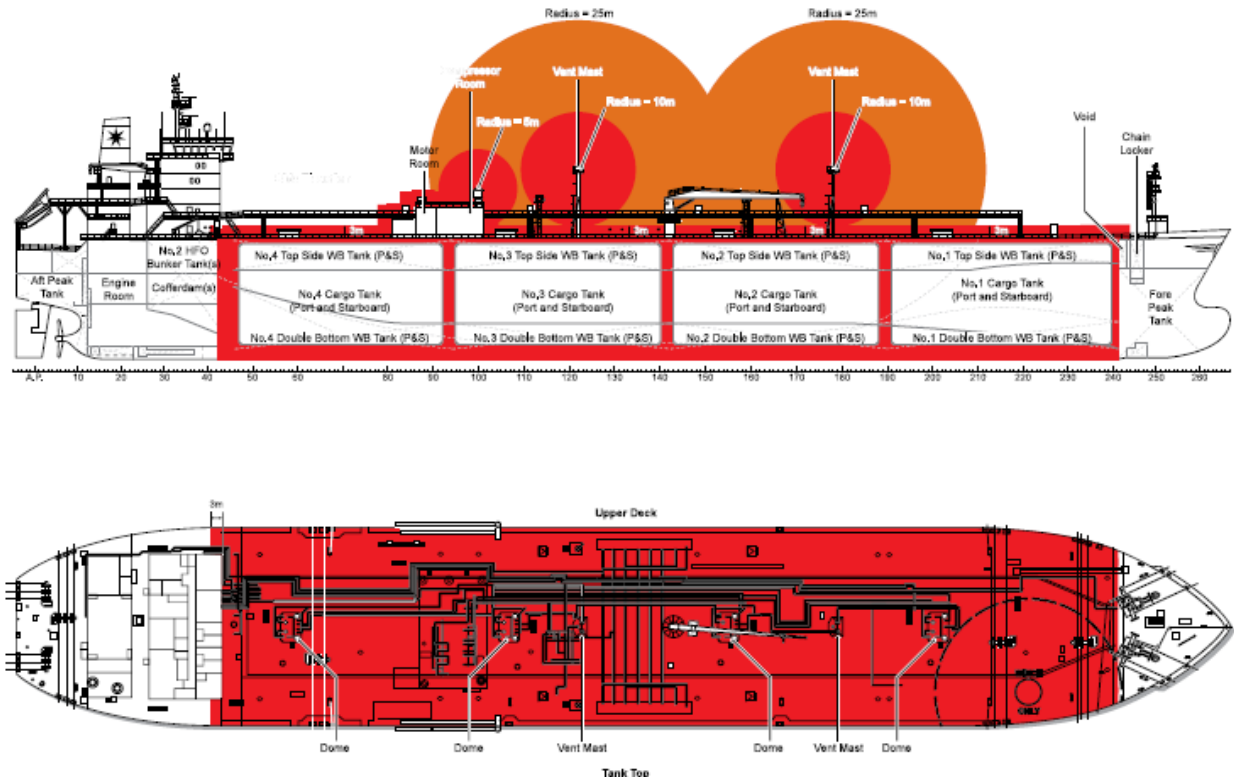

Figure 8-1 Gas dangerous areas and zones

A.2. Hazardous Areas

Hazardous areas are locations throughout the vessel where the potential for fire or explosions exists because of gases, dusts, or easily ignitable fibers or fillings in the atmosphere over a range of time scales. To reduce the risk of an explosion or fire within these hazardous areas, a vessel must mitigate the ignition source by using properly certified electrical equipment within these areas. Hazardous areas are separated by classes, zones and groups to define the level of safety required for equipment to be installed in these locations.

A.3. Classes

Classes define the general form of the flammable materials that could be present in the atmosphere and are broken up into three classes:

- **Class 1**: Flammable gases, flammable liquid produced vapors or combustible liquid-produced vapors. This is the class that equipment will be rated for on liquefied gas carriers and most other tankers.
- **Class 2**: Combustible dusts.
- **Class 3**: Ignitable fibers, or materials producing combustible filings.

A.4. Zones

Once hazardous areas are identified on a vessel, they are categorized into zones based on a realistic determination of the risk associated within these zones of the there being a flammable atmosphere present during normal or abnormal conditions. Some zone sizes are determined by default due to their normal operating conditions and are laid out in the IEC standards. However, the size of some zones can depend on the estimated area/distance over which a gas and air mixture could exist before natural dilution concentration to outside of its lower flammable limit (LFL). The areas are broken up into four different zones:

- **Zone 0**: An area in which an explosive gas atmosphere is present continuously or for long periods of time. These areas typically include places like cargo tanks or deck storage tanks
- **Zone 1**: An area in which an explosive gas atmosphere is likely during normal operations. This is typically areas immediately around cargo tank mast risers, cargo deck/tank domes, cargo pumps, cargo heaters or cargo liquid/vapor equipment which if fails would leak flammable vapors and the gas utilization unit room/ventilation hood room on vessels using boil-off gas as fuel.
- **Zone 2**: An area in which an explosive gas atmosphere is not likely to occur in normal operations and if it does occur is likely to do so infrequently and will exist for a short period only. This would include areas that open up directly to the cargo deck that are not protected by an air-lock.
- **Non-Hazardous Area (gas safe)**: An area which is designated FREE from flammable materials and atmospheres in all conditions. Typically, spaces that are protected by over pressurization AND an air-lock that open to the cargo deck are gas safe.

A.5. Gas Groups

Gas groups classify the exact flammable nature of the material that equipment could be exposed to. The specific gas group required for a hazardous area onboard a vessel is dependent on the cargo's flash-point compared to the gases used to classify different gas groups. Gas groups are broken up into three groups with sub-groups representing materials used within each gas group:

- **Gas Group I**: Below ground – Mining (Methane).
- **Gas Group II**: Above ground – Gas and vapor.
  - IIA – Propane.
  - IIB – Ethylene.
  - IIC – Acetylene and Hydrogen.
- **Gas Group III**: Above ground – Dust.
  - IIIA – Ignitable fibers (cotton lint, flax).
  - IIIB – Non-conductive dusts (grain, wood).
  - IIIC – Conductive dusts (magnesium).

A.6. Equipment Marking

It's important that examiners be able to identify electrical equipment installed and certified by the IEC standards. This is so they are able to determine if proper equipment is installed in hazardous areas.

A.6.a. Protection Methods

On IEC installed equipment, the "Ex" is the identifier that indicates it is designed and constructed to mitigate the risk of a fire or explosion in an explosive atmosphere (See Figure 8-2). Following the Ex, there is another single or set of letters to indicate what type of protection method is used (See Table 8-1) to make the equipment explosion proof. These are called Ex Protection Methods.

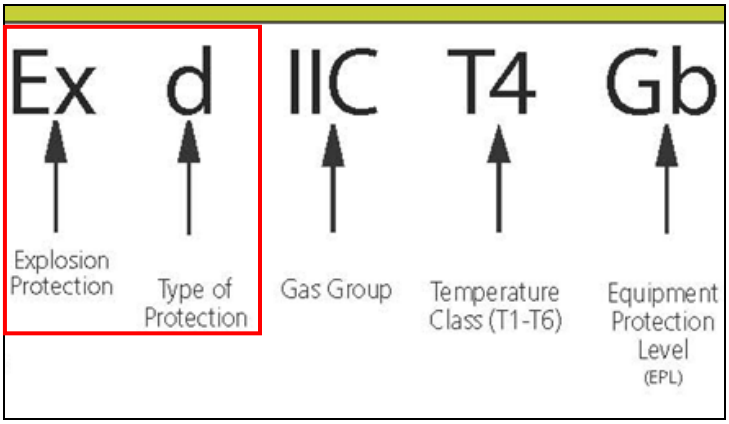

Figure 8-2 Ex protection and protection types

Type of Protection	Equipment Marking	Basic Principle	Approved Zones
Intrinsic Safety	ia & ib	By limiting and reducing the energy in the circuit with electrical barriers, high temperatures, arcs and sparks are prevented.	Zone 0 or Zone 1 or Zone 2
Flameproof Enclosures	d	If an explosion occurs inside the enclosure, the housing will withstand the pressure and the explosion will not be propagated outside the enclosure.	Zone 1
Increased Safety	e	Equipment does not contain arcing or sparking devices or have hot surfaces that might cause ignition.	Zone 1 or Zone 2
Encapsulation	m	Equipment is encapsulated with material that prevents ingress of gas and cools heat producing components.	Zone 0 or Zone 1
Non Sparking	n	Equipment will not cause sparks or arcs.	Zone 2
Oil Immersion	o	Equipment is immersed in oil which quenches arcs and sparks and cools hot spots on equipment.	Zone 1 or Zone 2
Pressurized Enclosures	p	Equipment is pressurized with at least 0.5 mbar where surrounding atmosphere cannot enter enclosure.	Zone 1 or Zone 2
Powder Filling	q	Equipment is surrounded with sand or powder medium which contains any arcs and sparks created.	Zone 1 or Zone 2

Table 8-1 Types of protection

A.6.b. Gas Groups

Most liquefied gas carriers will only need to have equipment certified as Gas Group IIA, IIB or IIC as noted in Figure 8-3. The greatest hazard in regards to electrical equipment will come from a liquid cargo/vapor leak. “II” indicates the gas group that the equipment is certified to operate in and “C” means the equipment is rated for gases categorized with Hydrogen and Acetylene. IIC is the most flammable gas group, meaning this equipment could be used for IIA and IIB as well.

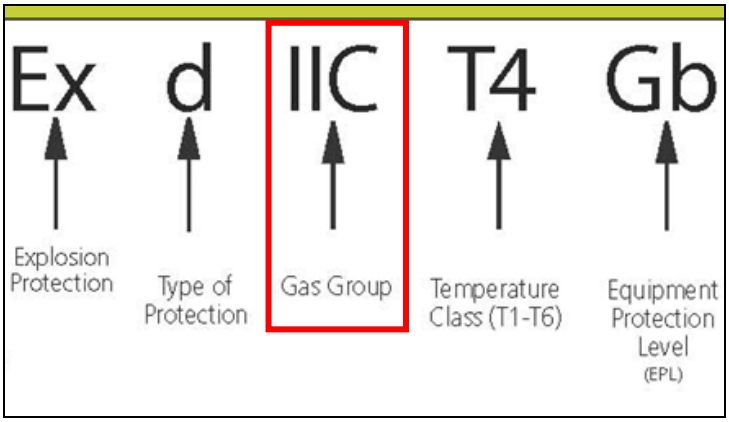

Figure 8-3 Gas Group identifier

A.6.c. Temperature Rating/Class

Electrical equipment receives a temperature code indicating its maximum surface temperature during normal and abnormal conditions without risk of igniting vapors in the space just from the surface temperature (See Figure 8-4). This code is commonly referred to as electrical equipment’s “T Rating” and the selection of equipment is based on the gas’s ignition temperature for the area in which it’s to be installed. Refer to Appendix G: Electrical Charts for the complete list of Temperature Classifications and their maximum surface temperature ratings.

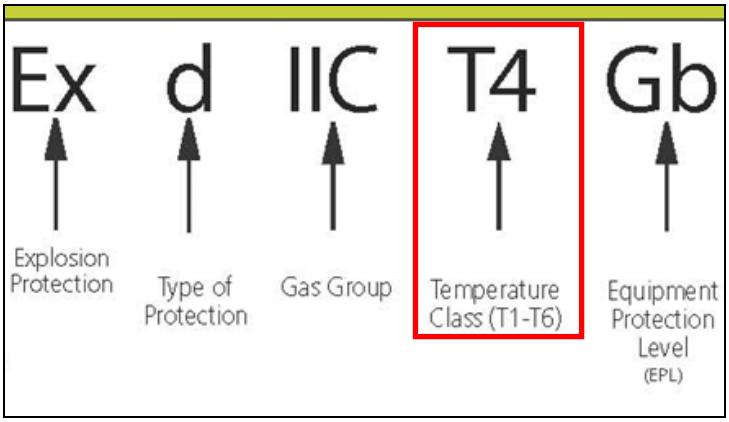

Figure 8-4 Temperature rating/class identifier

A.6.d. Equipment Protection Level (EPL)

The equipment protection level (EPL) is the level of protection assigned to electrical equipment based on its likelihood of becoming a source of ignition (See Figure 8-5). This EPL rating is independent from the type of Ex protection that the equipment is rated for as the EPL identifies the risk of the equipment could become an ignition source during normal AND abnormal or fault conditions. For gases, EPLs are broken up into three categories:

- **Ga**: Equipment has a "very high" level of protection, which is not a source of ignition in normal operations, or in case of expected failures or when subjected to a rare failure.
- **Gb**: Equipment has a "high" level of protection, which is not a source of ignition in normal operations or when subjected to expected malfunctions, although not on a regular basis.
- **Gc**: Equipment has a "increased" level of protection which is not a source of ignition in normal operations. It may be fitted with additional measures to ensure it does not become a source of ignition from expected faults.

Refer to Appendix G: Electrical Charts for a list of EPLs and the zones they are suitable for.

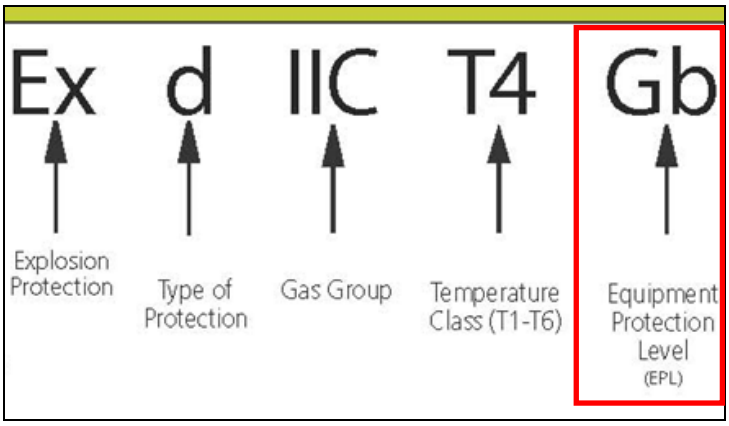

Figure 8-5 Equipment protection level identifier

A.6.e. Ingress Protection (IP) Rating

An ingress protection (IP) rating (See Figure 8-6) is used to specify the environmental protection or electrical enclosure of electrical equipment and indicates the equipment's ability to prevent solids and liquids from entering the equipment. An IP rating is comprised of two numbers. The first number the protection rating it receives is for solid objects or materials. The second number is the protection rating it receives for liquids. Refer to Appendix G: Electrical Charts for a chart with a full list of IP ratings.

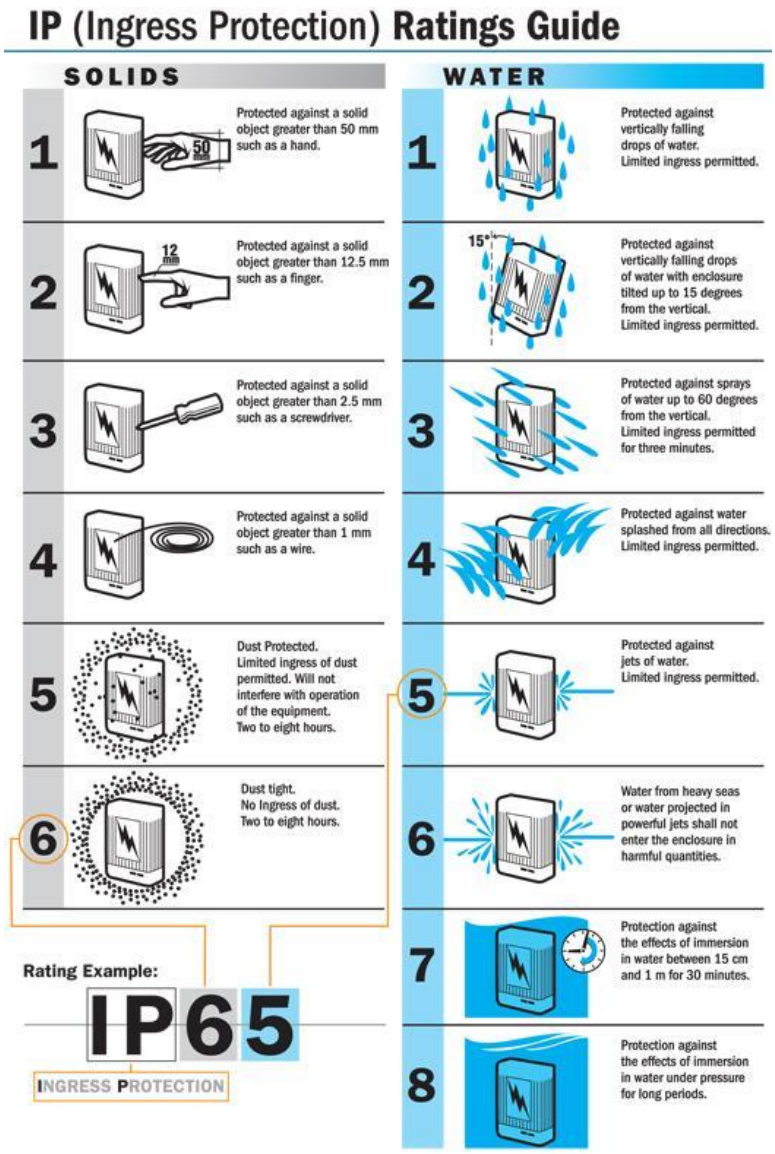

Figure 8-6 IP ratings

Section B: Electrical Installations in Gas Dangerous Zones (Open Decks and Other Spaces Other than Cargo Machinery Rooms)

B.1. Overview

Electrical equipment installed in a gas dangerous zone on a liquefied gas carrier is required to be installed and maintained per the IEC standard.

B.2. Conducting Examination

While walking throughout the different hazardous zones on the cargo deck and enclosed spaces, examiner visually verifies the following:

- Lighting fixtures must be pressurized or flame proof.
  - If there is no visible data plate or approval, or there is a concern about the data plate, refer to the vessel's Type Approval Certificates.
- Electrical equipment is intact and appear to be in good material condition.
  - The following conditions are unacceptable:
    - Broken or exposed wires.
    - Broken electrical bonding cables/straps.
    - Cracked lenses or housing.
    - Loose or missing bolts.
    - Paint or other foreign matter that could interfere with the flame path of a flame proof enclosure (See Figure 8-7).

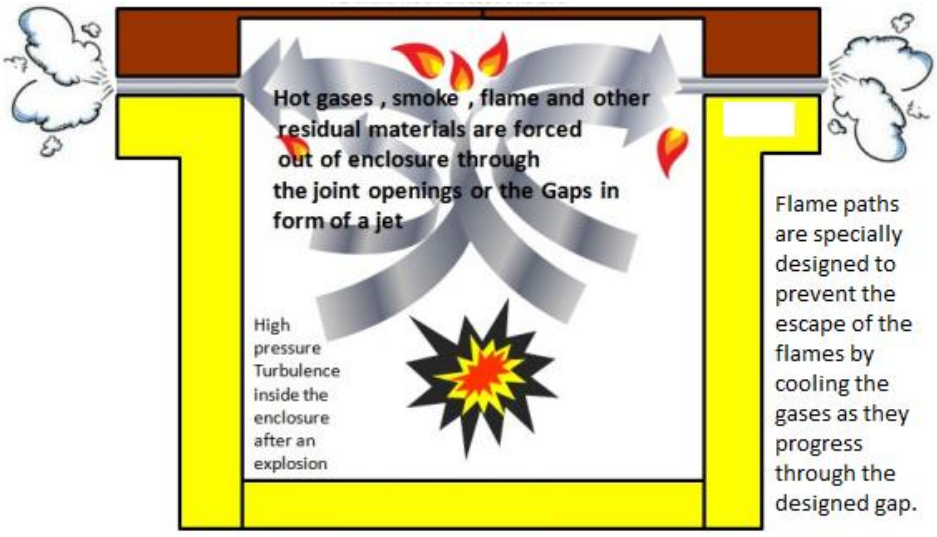

Figure 8-7 The importance of flame paths

- Degraded or missing seals.

- Ensure electrical supply cables are enclosed in an approved cable gland that meets the same explosion protection rating of the equipment it is fitted to.
  - Cable glands are not certified to be installed independently on equipment without associated cables.
  - If no cable gland is needed on equipment, then approved blanks that have the same explosion protection rating of the equipment they are installed on must be used.
  - Stoppers, adapters and reducers for cable glands must match the explosion protection rating of the cable gland and the equipment it's being used on.
- Where spaces are fitted with a gas tight bulkhead (i.e., between cargo compressor room and cargo motor room).
  - Any through runs of cables or equipment used is gas tight.

Chapter 9:
Instrumentation (IE) Examination

Introduction

This chapter discusses requirements and procedures for conducting the instrumentation (IE) examination.

In This Chapter

This chapter contains the following sections:

Section A: Fixed Gas Detection System

A.1. Overview

The cargoes shipped aboard liquefied gas carriers pose a risk to both personnel and equipment if released. It is vital for gas carriers to carry equipment that can detect accidental discharges and aid in the prevention of fires, explosions, and asphyxiating vapor clouds. Reference (e), IGC Code 1993 Edition, in all formats requires gas carriers to have gas detection equipment. The gas detection equipment must be capable of sampling designated areas on the vessel at intervals not exceeding 30 minutes. Continuous gas detection for boil-off gas systems are discussed in more detail in Chapter 14: Gas Fuel (GF) Supply System Examination.

Cargoes identified with T and/or F in column (f) of Chapter 19: Summary of Minimum Requirements of the relevant Code are required to be fitted with a fixed system for vapor detection systems appropriate for the cargoes on the COF. Flammable vapor detection sensors are typically either the catalytic type, infrared type or electrochemical type. Toxic vapor sensors are selected for specific cargoes carried. However, the Administration may authorize the use of portable toxic vapor detection equipment in lieu of a fixed system for most toxic cargoes.

There are two basic types of fixed vapor detection systems typically found on gas carriers:

- **Suction Gas-Sampling Systems**: These are similar to smoke sample extraction systems found on many freight vessels such as container or roll-on/roll-off (RO-RO) ships (see Figure 9-9). Gas-sampling systems use a vacuum pump to draw atmospheric samples from sample point locations, through tubing, to either a common sensor (sequential monitoring, see Figure 9-1 and Figure 9-2) or individual sensors (continuous monitoring, see Figure 9-5). Blocked sample tubes and vacuum pump or sensor failures can inhibit the effectiveness of these systems.
- **Continuous Gas-Sampling System**: These systems have independent sensors located in each space with gas detection. Each sensor is continuously analyzing the space that it's in and sends the reading to a control panel that monitors the status of each sensor.

There are commonly three types of detectors, or sensors found on gas detectors and those are catalytic, infrared, and electrochemical. See Figures 9-6, 9-7, and 9-8.

- Catalytic detectors are based upon the principle that when gas oxidizes it produces heat, and the sensor converts the temperature change via a circuit to a sensor signal that is proportional to the gas concentration. The sensor components consist of a pair of heating coils (reference and active). The active element is embedded in a catalyst. The reaction takes place on the surface of the catalyst, with combustible gases reacting exothermically with oxygen in the air to raise its temperature. This results in a change of circuit resistance and would reflect as a readout of gas being detected.
- The Infrared (IR) detection method is based upon the absorption of infrared radiation at specific wavelengths as it passes through a volume of gas. Typically two infrared light sources and an infrared light detector measures the intensity of two different wavelengths, one at the absorption wavelength and one outside the absorption wavelength. If a gas intervenes between the source and the detector, the level of radiation falling on the detector is reduced. Gas concentration is determined by comparing the relative values between the two wavelengths and then provides a gas concentration read out from the difference.
- Electrochemical sensors operates by gas coming in contact with the electrolyte, where an electrochemical reaction then occurs. An oxidation reaction the results in an electrical current flow from the reacting electrode to the constant electrode and is then measured. The measured electrical current and flow is proportional to the amount of gas present in the sensor and is reflected through the gas circuit to show the gas concentration being measured.

NOTE: **Electronic gas-sampling systems do not have a low-flow fault alarm.**

Figure 9-1 Gas detection system

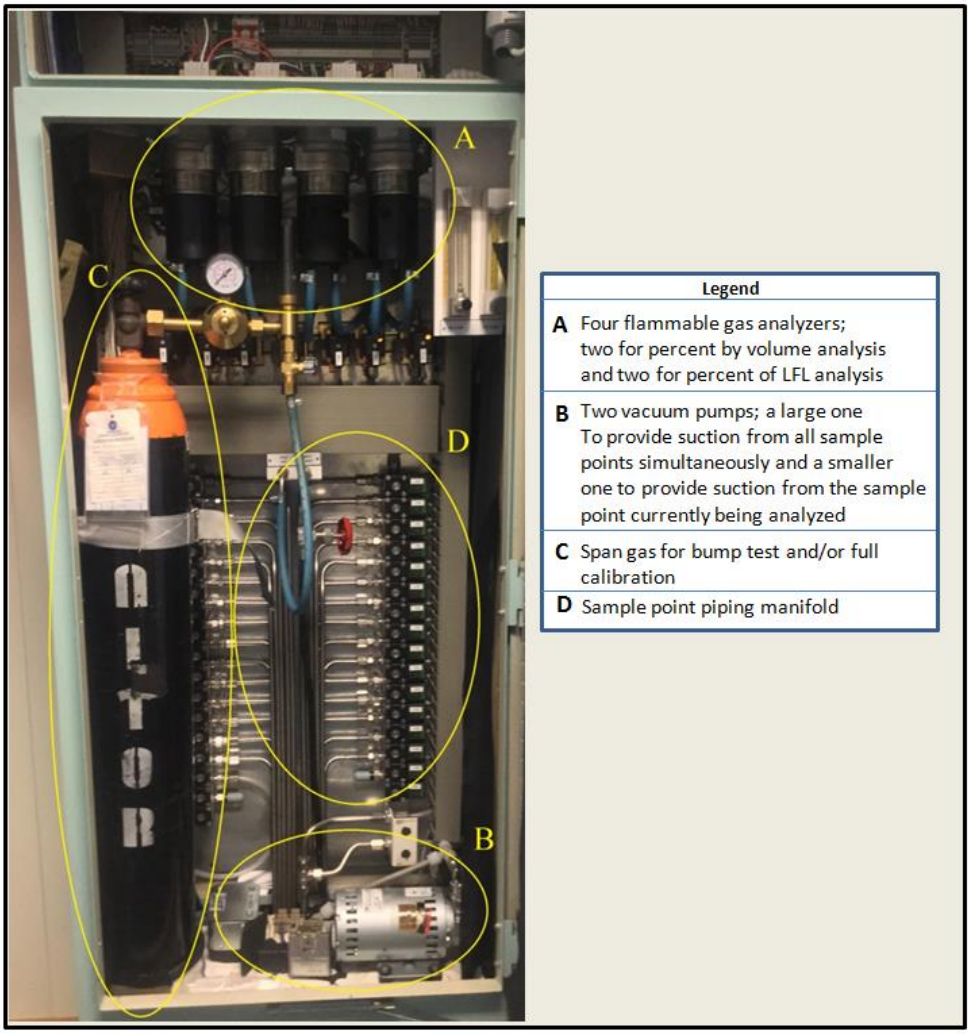

Figure 9-2 LNG gas carrier cycled gas detection cabinet interior

Figure 9-3 LNG gas carrier cycled gas detection span gas analysis certificate

Figure 9-4 Example span gas: 4 gas; 8% butane, balance nitrogen; 50% LEL

NOTE:

Note the composition is 2.5 percent by volume of CH_4 with a balance of 97.5 percent air in Figure 9-3 and Figure 9-4. Electrochemical, catalytic, and semi-conductor gas detectors require oxygen to be present to operate correctly. It is essential to verify that the balance is suitable for the provided detector as well as consult the manufacturer's operating manual to determine if the span gas is appropriate for the system.

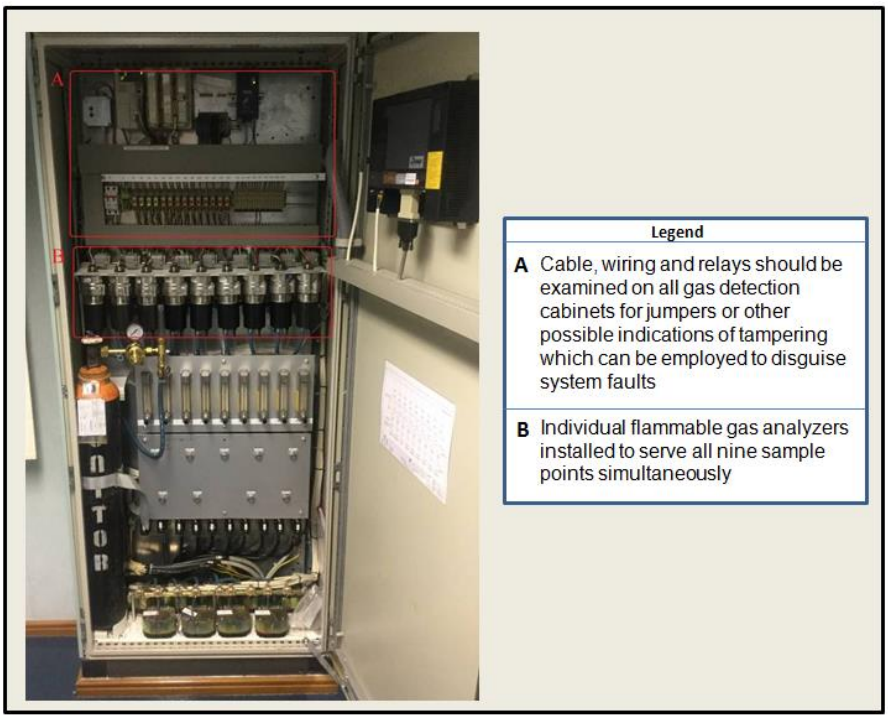

Figure 9-5 LNG gas carrier continuous gas detection cabinet interior

Figure 9-6 Combined suction (holds/un-manned spaces)/electronic (accommodations/manned spaces) fixed gas detection system

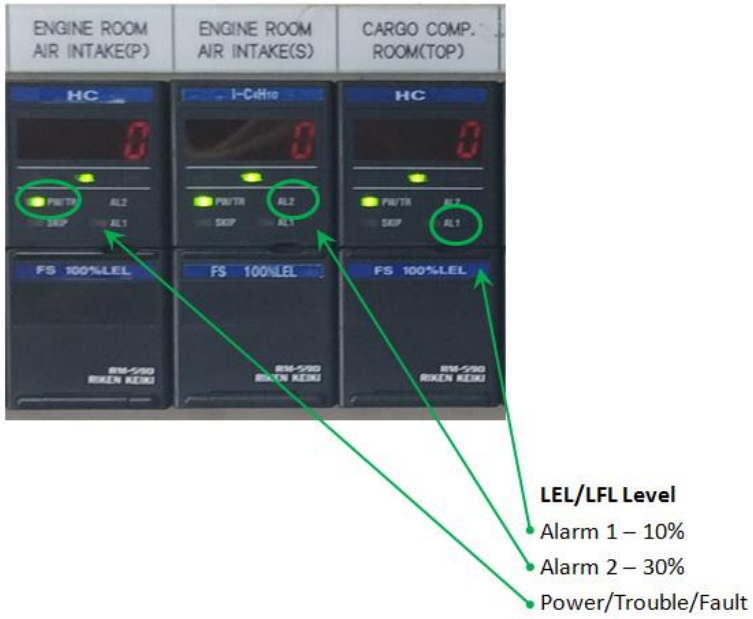

Figure 9-7 LEL/LFL display

Figure 9-8 Electronic sensor sample point

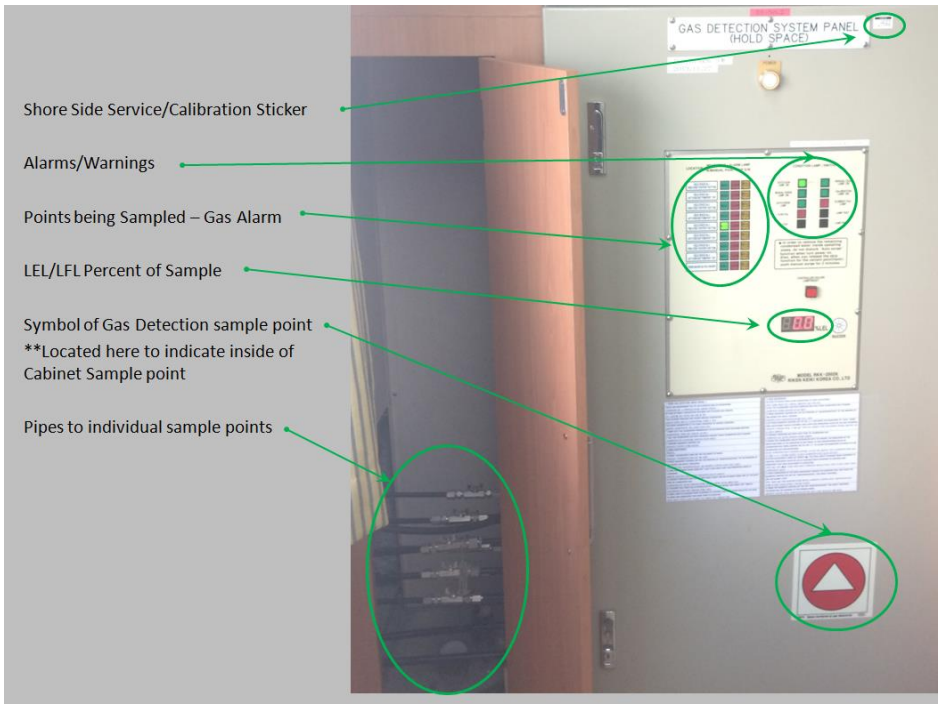

Figure 9-9 Suction type detection system

Per the Gas Codes, the systems shall alarm when the vapor concentration reaches 30 percent of the LFL in air.

For example, the LFL of CH_4 is 5 percent by volume. To calculate 30 percent LFL for CH_4 use: 5.0 x .30 = 1.5. The detection system should alarm when the concentration of CH_4 reaches 1.5 percent by volume in air.

Table 9-1 shows approximate flammable ranges and calculated values for 30 percent and 60 percent LFL for common liquefied gas cargoes. Flammable ranges can vary depending on the purity of the gas. Table 9-1 also shows the approximate vapor density for each gas which is pertinent to the locations of gas detection sample points. Gas cargoes with a vapor density less than 1.0 are lighter than air and will rise to the upper areas of a compartment. Gases with a vapor density greater than 1.0, will sink and tend to accumulate near the bottom of a compartment.

While examining liquefied gas vessel's fixed gas detection system and testing the associated alarms, it is important to know the difference between gas concentration by volume (BV) and the LFL of the gas vapor being analyzed.

If we use methane as an example, the LFL is 5 percent BV. That means the mixture is too lean to burn if there is less than 5 percent BV methane present, but at 5 percent BV, it can burn or explode if there is an ignition source. So we call 5 percent BV methane the same as 100 percent LFL.

To compute the LFL of any gas, you would divide the BV concentration by the LFL. For example, if you take 2.5 percent methane BV in air and divide it by 100 percent LFL of methane (5 percent), the result is 50 percent LFL. Conversely you can multiply the 50 percent LFL by 100 percent LFL (5 percent) to obtain the percent BV (2.5 percent).

Figure 9-10 illustrates methane's gas concentration by volume and the lower and upper flammability levels. For the illustration, LFL and lower explosive limit (LEL) are synonymous.

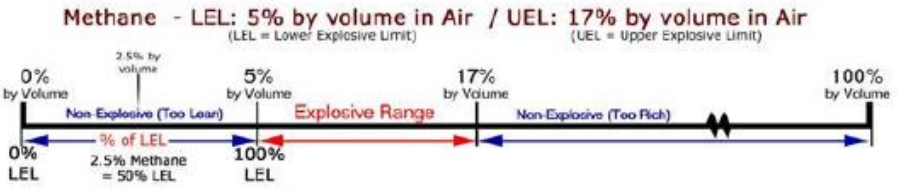

Figure 9-10 Example of LFL (LEL) and by volume range

Cargo	Vapor Detection	Flammable Range	Vapor Density *Air = 1*	IDLH (ppm)	30% LEL (% Vol.)	Liquid Density (kg/m^3)
Acetaldehyde	F+T	4 - 57%	1.52	2,000	1.2% (1,200 ppm)	0.788
Ammonia	T	14 - 28%	0.597	300	4.2% (42,000 ppm)	0.6818
Butadiene	F+T	1.1 - 12.5%	1.88	2,000	0.33% (3,300 ppm)	0.6503
i - Butane	F	1.5 – 9%	2.07		0.45%	0.6059
n - Butane	F	1.5 – 9%	2.09		0.45%	0.6059
Butylenes	F	1.6 – 10%	1.94		0.48%	0.6256
Chlorine	T	n/a	2.49	10	n/a	1.4240
Diethyl Ether*	F+T	2.0 - 36.0%	1.9	1,900	0.6% (6,000 ppm)	0.7134
Dimethylamine	F+T	2.8 – 14.4%	1.6	500	0.84% (8,400 ppm)	0.6804
Ethane	F	3.0 – 12.5%	1.048		0.9%	0.5438
Ethylene	F	3.0 – 34.0%	0.975		0.9%	0.5676
Ethylene Oxide	F+T	3.0 – 100%	1.52	800	0.9% (9,000 ppm)	0.8222
Isoprene*	F	1.5 – 9.7%	2.3		0.45%	0.6810
Isopropylamine*	F+T	2.3 – 10.0%	2.0	750	0.69% (6,900 ppm)	0.6891
Methane (LNG)	F	5 - 15%	0.55		1.59%	0.4223
Methyl Acetylene-Propadiene	F	3.4 – 10.8%	1.48		1.02%	unknown
Methyl Bromide	F+T	10.0 – 16.0%	3.27	250	3.0% (3,000 ppm)	1.7213
Methyl Chloride	F+T	8.1 – 17.2%	1.8	2,000	2.43% (2,430 ppm)	1.0043
Monoethylamine*	F+T	3.5 – 14%	1.56	600	1.05% (1,050 ppm)	0.6870
Pentanes (all isomers)*	F	1.5 – 7.8%	2.48		0.45%	0.6262
Propane	F	2.1 – 9.5%	1.55		0.63%	0.5813
Propylene	F	2.0 – 11.1%	1.48		0.6%	0.6091
Propylene Oxide*	F+T	2.1 – 38.5%	2.00	400	0.63% (6,300 ppm)	0.8590
Sulphur Dioxide	T	n/a	2.26	100	n/a	1.4611
Vinyl Chloride	F+T	4.0 – 33.0%	2.15	Carcinogen	1.2%	0.9719
Vinyl Ethyl Ether*	F+T	1.7 – 28.0%	2.5		0.51%	0.7589
Vinylidene Chloride*	F+T	7.3 – 16.0%	3.25	Carcinogen	2.19% (2,190 ppm)	1.210

Table 9-1 Flammable gas properties LEL

A.2. Required Monitoring

Alarms are located on the navigation bridge, the cargo control room, and at the gas detector readout location. Some of the newer gas detection systems are electrochemical sensors. The sensor's measuring performance is increased by means of a bias voltage being measured and kept constant by means of the reference-electrode and an electronic control circuit (so-called potentiostat circuit). These systems are normally only calibrated annually by a third party.

A.3. Conducting Examination

★★★When conducting an examination of the fixed gas detection system, do the following:

- Witness a satisfactory operation of the fixed gas detection system.
- Review records or documentation showing calibration of the fixed gas detection system and verify they are in line with the vessel's Safety Management System (SMS) procedures.

NOTE: **Per reference (e), IGC Code 1993 Edition, span gas for this purpose is required aboard the ship.**

- Verify gas detection alarms at 30 percent LFL, or at such other limit for membrane tanks, as may be approved by the Administration. In the latter case, examine approval documentation.
- Verify installation of sampling points or sensors in required spaces.

NOTE: **Reference (e), and reference (d), GC Code, identify the required gas detection sampling point's spaces. Use the gas detection system section of the vessel's Cargo Operations Manual to compare actual locations with required locations.**

- Verify gas detection panel read-out stabilizes at test gas concentration.
- Verify the location within a space of the sampling points relative to the cargoes authorized for carriage (i.e., top or bottom of space) per reference (e), and reference (d).

NOTE: **Different cargoes have different vapor densities. Some cargoes are heavier than air, and some are lighter than air. For cargoes with a relative density greater than 1.0, the sampling points should be located in the lower part of the space. For cargoes with a vapor density of less than 1.0, the sampling points should be located in the upper part of the space. To determine what the relative vapor density of a cargo is, refer to the cargo's SDS or reference (n), Tanker Safety Guide Liquefied Gas, International Chamber of Shipping (ICS), Third Edition, 2018. See Table 9-1.**

- Verify the integrity of sampling pipe system (gas sampling type systems only).

NOTE: **Although not required by the Gas Codes, many systems have a low-flow fault alarm. If they do, then request a crewmember go to a specific sampling point and block it, stopping the flow of gas to the analyzing unit. A flow fault alarm should activate. If no flow fault alarm activates, this may indicate that gas is being drawn into the piping system from a location other than the sampling point and there is a breach somewhere in the sampling pipe system.**

- Location of the sample points relative to the cargoes density. See Table 9-1 for vapor densities.

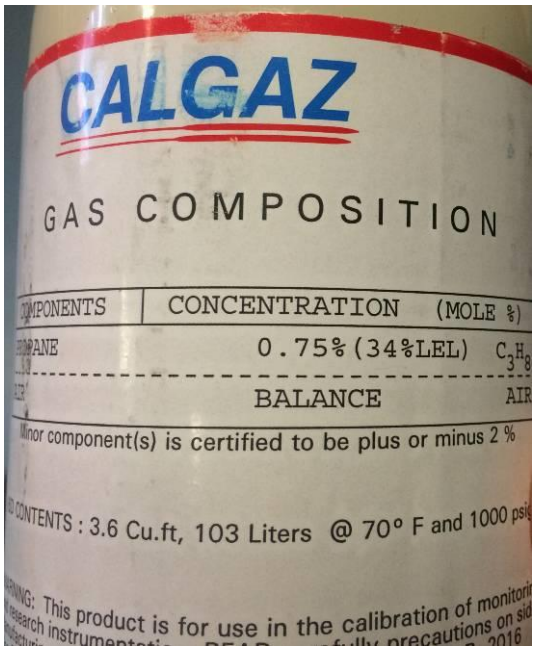

Figure 9-11 0.75% by volume propane (34% LEL) balance air

NOTE:

Span gases used for calibration or bump checks have an allowance of error for the percentage of LEL that may be detected. As shown in Figure 9-11, you can see the components making up the gas composition are certified with an allowance for error up to plus or minus two percent. It is essential to note this while witnessing tests that utilize span gases.

In Figure 9-12, the flammable gas sticker (red) is easily distinguishable from the non-flammable gas sticker (green). At a glance, you could tell what to expect from the bottle.

Figure 9-12 Example of flammable gas stickers

Section B: Portable Gas Detection Equipment

B.1. Overview

In addition to the fixed gas detection system, reference (e), IGC Code 1993 Edition, requires liquefied gas carriers to have at least two sets of portable gas detection, and a suitable instrument for the measurement of oxygen levels in inert atmospheres. These instruments are used to supplement the fixed gas detection system in any event that may render the system inoperable. In some cases, reference (e), allows portable gas detection to be used as an alternative to a permanently installed system. See Figures 9-13, 9-14, and 9-15.

Figure 9-13 Portable gas meters

Figure 9-14 Hydrocarbon meter (not a complete set)

Figure 9-15 Portable gas meter

B.2. Ship's Crew Role

The ship's crew tests the atmosphere in enclosed spaces for O_2, toxic gases, hydrocarbons and flammable vapors:

- Before entry.
- During gas freeing, inerting, and gassing up operations.
- As a quality control before changing cargoes.
- To establish a gas-free condition before dry dock or gas carrier repair yard.

There are two types of combustible gas detectors that detect hydrocarbons: infrared and catalytic. See Section A: Fixed Gas Detection System of this chapter.

NOTE:

Flammable gas detection systems employing catalytic sensors rely on combustion, so O_2 must be present in the sample for them to function correctly. Such systems must have a dilution fitting or pump to add air before the samples are analyzed to provide the needed oxygen to detect flammable vapor in inert spaces (e.g., cargo hold space).

NOTE:

Several types of meters and span gases are likely to be aboard. Detection methods include electronic photo ionization detectors (PID) and hand-held devices designed to draw samples through colorimetric tubes to detect toxic vapors.

NOTE: **The catalytic portable gas detector which relies on O_2, cannot be used in atmospheres that are inert (deficient in O_2) to check for percent LFL or percent by volume.**

B.3. Conducting Examination

Verify the following:

- Satisfactory calibration and/or preparation for use of the portable gas detection equipment.
  - Examine calibration logs for each piece of portable gas detection equipment. Logs should conform to gas carrier's SMS maintenance requirements.
  - Witness calibration of the portable O_2 sensor to ambient O_2 level (20.8 percent by volume =/- 0.2 percent). This needs to be performed in an atmosphere known to contain normal O_2 levels to ensure accurate readings when testing spaces.
  - Flammable vapor detection – Crew is familiar with operating manual for procedures. Typically, crew only performs a field function test known as a bump check, with annual calibration performed by a factory service technician. See Chapter 9: Instrumentation (IE) Examination, Section B: Portable Gas Detection Equipment NOTE regarding the use of span gas with nitrogen (N_2).
  - Toxic vapor detection can be done using chemical-specific glass tubes or electronic sensors able to detect multiple toxic substances. See Figure 9-16 and Figure 9-17.

Figure 9-16 Toxic vapor detection sensor

Figure 9-17 Toxic vapor detection tubes

- Gas carrier has appropriate tubes or sensors for each cargo aboard for which a "T" appears in column "f" of the product table in Chapter 19: Summary of Minimum Requirements of the relevant Code.
- Tubes or sensors are not expired.
- Air-tight seal for vacuum pump, bellows or suction syringe. When the suction tip is sealed, the instrument should hold a vacuum.

NOTE: **Draeger™ and Gas Tech™ are two common brands of testing "tubes" for toxics. They both operate similarly, but have different suction pumps; Gas Tech™ has a suction syringe type pump and Draeger™ has a "squeeze bellows" pump. Both types require the operator to purge air out of the equipment and hose using an exact number of "pumps", as indicated in the operating manual, in order to get an accurate reading.**

NOTE: **Toxic vapor tubes and changeable sensors can have errors of +/-25 percent depending on manufacturer's specifications.**

WARNING: ***For examiner safety, when vessels use portable gas detection equipment in lieu of fixed gas detection: The examiner needs to be situationally aware of how the crew take samples from a space before entry (i.e., cargo holds, cargo compressor room, air lock). Consider the status of, or existence of, ventilation in addition to crew use of gas sampling when evaluating the risk of entry.***

NOTE: **Per reference (e), IGC Code 1993 Edition, and reference (f), IGC Code 2016 Edition, vessel design must enable sampling without having to enter the space, taking into consideration the vapor density and toxicity of cargo being tested. For example, a vessel carrying Ammonia and relying on portable gas detection, the vessel would need to have the ability to take a sample from the top of the air lock without stepping into the air lock.**

Section C: Temperature Indicating Devices

C.1. Overview

Per reference (e), IGC Code 1993 Edition, all gas carriers are required to have at least two temperature sensors in each tank. One sensor must be located near the bottom of the tank and one near the top, below the highest allowable liquid level.

Ships fitted with a cargo containment systems with a secondary barrier, and authorized to carry cargoes at temperatures below -55 degrees Celsius also need sensors within the insulation or hull structure. These sensors are fitted with alarms to give warning when temperatures are approaching the lower limit for which the hull steel is suitable. Typically ethane, ethylene and LNG are carried below - 55 degrees Celsius.

C.2. Conducting Examination

Verify the following:

- At least two temperature indicating devices are installed in each cargo tank, one near the top and one at the bottom of the tank.
- Temperature sensors are located in the insulation space or on the hull structure adjacent to the cargo containment if vessel's containment system is fitted with a secondary barrier and is authorized to carry cargoes colder than - 55 degrees Celsius.

NOTE:

The number of devices installed on each gas carrier is to the satisfaction of the Administration. However at least two are required per the Gas Codes. Notice in Figure 9-18 the temperature differences between the top of the tank and the bottom of tank. Difference is due to tank vapors at the top versus liquid at the bottom.

Figure 9-18 Temperature indicating device readings on an LPG gas carrier

- Temperature indicating devices are marked to show the lowest Administration approved cargo tank temperature.

NOTE: **The readings of the temperature indicating devices located below the liquid level should be consistent with each other and the temperature indicating devices located above the liquid level will have a higher reading.**

NOTE: **Occasionally, temperature sensors fail in-service while tanks have liquid or vapor in them making them inaccessible for renewal. When this situation is encountered, the PSCO considers the following when determining what, if any, action to take:**

- **Whether or not redundancy exists for the failed sensor(s),**
- **Whether or not the failed sensor(s) were reported as non-conformities in the ship's SMS,**
- **Whether or not the failed sensor(s) were reported to Class, and,**
- **When the affected tank(s) or spaces will be able to be gas freed for repair/renewal (e.g., next dry docking).**

- Consistency among the readings. Report inconsistent readings to the master or chief mate.
- When cargo is carried at a temperature lower than - 55 degrees Celsius in a containment system with a secondary barrier, temperature indicating devices should be provided within the insulation or on the hull structure adjacent to cargo containment systems. Figure 9-19 shows temperature sensors surrounding a membrane tank containment system.

    - If able to, ask the crew to test the audible warning of the temperature sensors. Audible alarm should sound if prior to temperatures approaching the lowest temperature the hull steel is suitable for.

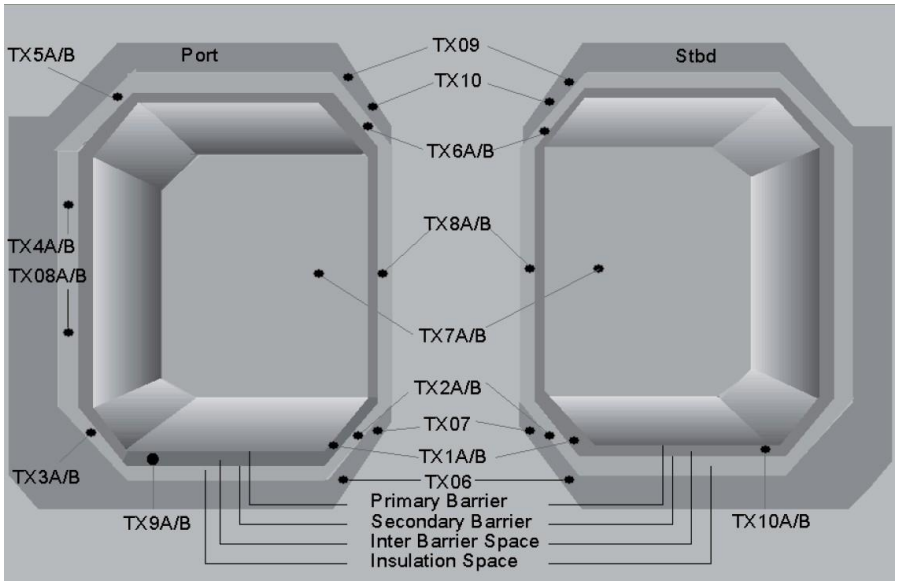

Figure 9-19 Example of temperature sensors location on a membrane containment system

Section D: Pressure Monitoring Devices

D.1. Overview

Pressure monitoring devices monitor pressure in the cargo tanks, cargo pump discharge lines, each liquid and vapor cargo manifold, and hold and inter-barrier spaces. Pressure switches are also fitted to various systems to protect equipment by using alarms and shutdowns.

D.2. Conducting Examination

Verify the following:

- Each cargo tank vapor space has a pressure gauge with an indicator in the control position.
  - Maximum and minimum allowable pressures are marked on the cargo tank pressure indicating device. Gas carriers may have one of the following methods for verifying the operation of the high pressure and low pressure alarms:
    - Changing of the alarm setting through the Integrated Automation System (IAS) in the cargo control room (CCR).
    - Inserting a specialized handle into the middle of the pressure gauge and changing the high/low alarm settings (Figure 9-20). Typically only found on LPG gas carriers.

Figure 9-20 Testing of the high/low pressure alarm using a special handle

- Isolating the cargo tank pressure and adding/releasing pressure to the pressure gauge by means of hand pump (Figure 9-21).

Figure 9-21 Testing of the high/low pressure alarm using a hand pump

WARNING:

When testing the high pressure alarm by adding pressure with a hand pump from the tank top, make certain the crew is able to isolate the pressure line from the cargo tank vapor space before connecting the pressure hand pump. Failure to isolate the pressure line would release cargo vapors and expose the crew and Coast Guard examiners to flammable/toxic vapors.

- Each cargo tank vapor space is fitted with a high pressure alarm which activates on the navigation bridge.
- Witness test of the high-pressure alarm. If a vessel is certified at two different MARV settings, the alarm should coincide with the current required MARV setting.
- Witness a test of the low-pressure alarm if vacuum protection is fitted. This alarm is also required to alarm on the navigation bridge. Operation of the cargo tank vapor space low pressure alarm, if applicable.

NOTE: **The manifold local pressure gauge required by reference (e), IGC Code 1993 Edition, is used by ship's personnel when connecting/disconnecting the cargo manifold to ensure their safety.**

- Hold/inter-barrier spaces without open communication to the atmosphere are provided with operational pressure gauges.

Section E: Overflow Control System

E.1. Overview

The overflow control system provides a warning to shipboard personnel before the cargo tanks become full. This system is not the same overflow control systems found on oil and chemical tankers and is separate from the requirements found in reference (bb), Vapor Control Systems, 46 CFR Part 39.

Each cargo tank is fitted with a high liquid level alarm operating independently of other liquid level indicators and gives an audible/visual alarm. Another sensor operating independently of the high level alarm automatically closes a shutoff valve in the cargo tank filling line or activates an emergency shutdown (ESD) to prevent the cargo tank from overflowing. Consult the Cargo Manual for further guidance.

The authorized loading limits are provided by the Administration to the master and are located on the COF. Per reference (e), IGC Code 1993 Edition, and reference (d), GC Code, ship's crew shall not load liquefied gas carriers more than 98 percent, unless authorized by the Administration. See Chapter 3: Certificates and Documents (CD) Examination, Section E.1.: Overview for more information.

E.2. Conducting Examination

Verify the following:

- High level alarm provides both an audible and visual warning.

NOTE: **On most gas carriers, you can witness system testing by a crewmember lifting up the test actuator, located underneath the screw cap (see Figure 9-22). Before testing, the crewmember should open the liquid filling valves to that particular cargo tank, so that during testing the filling valves automatically close.**

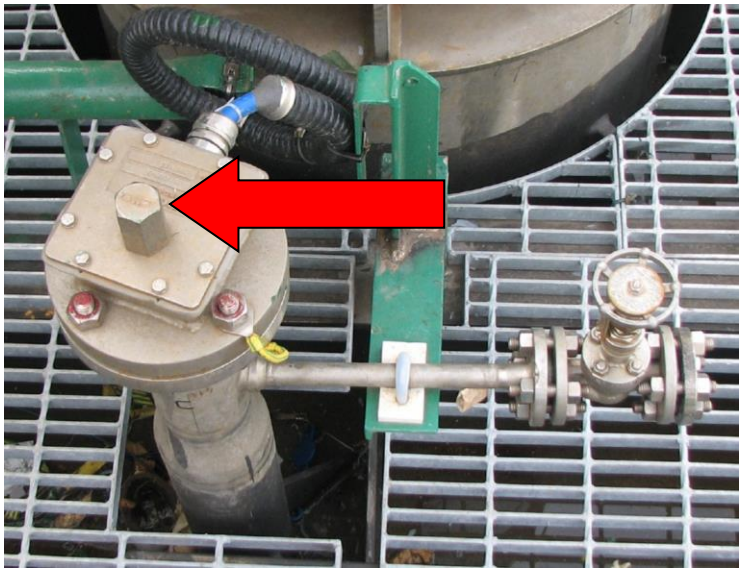

Figure 9-22 High level alarm and overfill protection float system

- Automatic shutoff valve is installed that prevents the tanks from being overfilled.

Chapter 10:
Topside Equipment Examination

Introduction

This chapter discusses the requirements and procedures for conducting the topside equipment examination.

In This Chapter

This chapter contains the following sections:

Section A: Safe Access to Tanker Bows

A.1. Overview

Protecting the crew while they work on the deck during severe weather is very important. Per reference (h), SOLAS, tankers to include gas carriers must be provided with a means to enable the crew to gain safe access to the bow.

For tankers constructed on or after 1 July 1998, the access should be utilizing either a walkway on the deck or a permanently constructed gangway of substantial strength at or above the level of the superstructure deck or the first tier of a deckhouse.

A.2. Conducing Examination

Walkways or gangways have the following per reference (cc), Guidelines for Safe Access to Tanker Bows, International Convention on Load Lines (ICLL) 1966, as amended, IMO Resolution MSC.62(67):

- Provide a continuous platform at least 1 meter in width, situated on or as near to the centerline of the ship.
- Foot-stops provided.
- Guardrails supported by stanchions and have no less than 3 courses. Stanchions should be at intervals of not more than 1.5 meters.
- Be constructed of fire-resistant and non-slip material.
- Have openings, with ladders where appropriate, to and from the deck. Openings should not be more than 40 meters apart.
- Vessels with exposed deck greater than 70 meters have shelters set in the gangways or walkways at distance intervals not exceeding 45 meters.
    - The shelter can accommodate at least one person and has weather protection on the forward, port, and starboard sides.
    - If piping or other permanent fitting obstructs the shelter, that a means of passage over the obstruction be provided.
- Shelters are free of debris and equipment that could prohibit personnel from utilizing the shelter.

NOTE:

The Administration can accept an alternative or modified arrangements for tankers with space constraints. This includes; small tankers, or tankers with a substantial freeboard, such as gas carriers, provided that such alternative or modified arrangements achieve an equivalent level of safety for access to the bow. See reference (cc), for additional information.

Section B: Emergency Towing Arrangements

B.1. Overview

Tankers, to include gas carriers, may need to be towed out of danger during emergencies to preserve life and to reduce the risk of pollution. The towing arrangements should be designed to facilitate salvage and emergency towing operations.

B.2. Conducting the Examination

This applies to every tanker, to include gas carriers, of not less than 20,000 DWT. Verify the following:

- Both ends of the vessel are equipped with emergency towing arrangements.
- Arrangements are capable of rapid deployment in the absence of main power.
- Aft towing arrangements pre-rigged for rapid deployment in not more than 15 minutes.
- Forward towing arrangements capable of being deployed in not more than 1 hour.
- Shall be of sufficient strength taking in the size and deadweight of the ship.

NOTE: **For tankers, to include gas carriers, constructed before 01 July 2002 the design and construction of emergency towing arrangements shall be approved by the Administration, see reference (dd), Adoption of Guidelines for Emergency Towing Arrangements on Tankers, IMO Resolution MSC.35(63).**

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Chapter 11:
Cargo Systems (CS) Examination

Introduction

This chapter discusses the various requirements and procedures for conducting a cargo systems (CS) examination.

In This Chapter

This chapter contains the following sections:

Section A: ESD System

A.1. Overview

The ESD system and exam consists of four parts that work together:

- Fusible elements.
- Emergency shutdown valve.
- Emergency shutdown and cargo handling equipment.
- Overall functionality.

A.2. Emergency Shutdown System Overview

At several locations aboard a gas carrier (such as on the navigational bridge, cargo manifold, cargo control room, compressor room, etc.) pneumatic valves or electric push buttons are provided to activate the emergency shutdown system. Refer to reference (e), IGC Code 1993 Edition, and reference (d), GC Code, for requirements. See Figures 11-1 and 11-2 for examples.

Figure 11-1 Typical ESD activation point

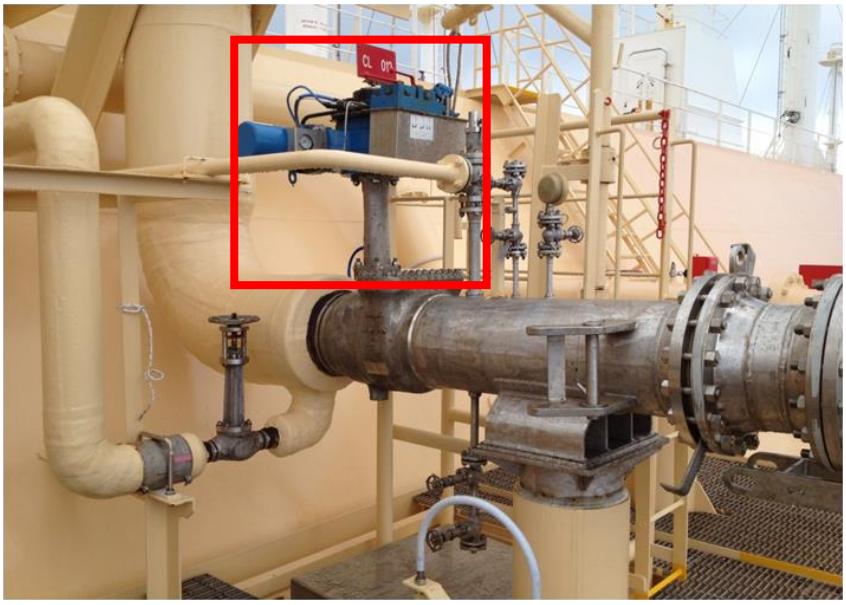

Figure 11-2 Typical ESD valve

A.2.a. Conducting Examination

Before conducting ESD test, coordinate with the chief officer to ensure there are no safety concerns. Before conducting a test of the ESD, coordinate with the chief officer to ensure there are no safety concerns. To streamline the inspection and facilitate commerce, it is advised to reference the vessel's ESD cause and effect diagram to pre-locate inspectors to witness or test components that may re-initiate an ESD such as:

- Emergency push buttons or valves.
- Cargo tank filling valves.
- Cargo tank high-pressure testing.

CAUTION:

Manipulating cargo systems may produce unintended consequences to the vessel or the facility. Consequences include:

- **Rapid pressure increases.**
- **Quickly resetting/restarting cargo compressors.**
- **Falling ice.**
- **Popping of cargo line and tank safety relief valves.**
- **Surging pressures which can travel back to the delivery source (in some locations upwards of 25 miles away from the docks).**

CAUTION: **Carefully consider possible consequences of testing when a crewmember is hesitant or recommends against testing.**

WARNING: ***When opening the valves before testing the ESD, avoid exposure. Use extreme caution and ensure all USCG inspection team members are clear of and up wind from the manifold area. Once the valves are opened and no leaks are heard (hissing) or observed, position yourself so you can witness and time the closing of the quick closing valves. If exposure occurs, immediately contact your unit.***

Verify the following:

- One of the points of shutdown is located in the cargo control room.
- The other point of shutdown (trip) should be within easy reach when spotting a hazard. In most cases, this trip is located close to the manifold. Refer to the Cargo Loading Manual, for gas carrier specific additional ESD activation locations.

A.3. Fusible Elements Overview

Fusible elements are installed to automatically actuate the emergency shutdown in the event of a fire. A thermal fuse is designed to melt at a specific temperature. This fuse can come in the form of a plug or link.

- The fusible plug uses a gland nut with the thermal fuse in the middle screwed into a pressurized pipe. After the thermal fuse melts, the pressure is released actuating an ESD. See Figure 11-3.

Figure 11-3 Fusible plug

- The fusible link is a thermal fuse used to close a circuit. Once this material melts at the designed temperature, the circuit is opened thus actuating an ESD. See Figure 11-4.

Figure 11-4 Fusible link

A.3.a. Conducting Examination

Verify the following:

- Fusible elements are installed in all locations required by the Gas Codes.

NOTE: **In addition to the required locations, fusible elements may also be found in compressor rooms and motor rooms. The Cargo Operations Manual usually lists where all of the fusible elements are located.**

NOTE: **The melting range of fusible elements is designed to melt at temperatures between 98 degrees Celsius to 104 degrees Celsius. This actuates emergency shutdown. Although not required, this may or may not activate deck water spray.**

- No paint is present on the thermal fuse.
- Proper element is used for each location (i.e., gland nut with thermal fuse, not standard bolt).

A.4. Emergency Shutdown Valve Overview

When activated, the ESDs remotely close the actuated valves, stop the cargo pumps, and stop the compressors (where appropriate). The types of isolation valves normally found on gas carriers are ball valves or butterfly valves. These valves are often fitted with pneumatic actuators and occasionally with hydraulic actuators.

Ball valves are fitted with a means of pressure relief where a hole is normally drilled between the cavity and the downstream side of the valve.

A.4.a. Conducting Examination

Verify the following:

- Each line, cargo and vapor, has an indicator displaying the position of the valve.

NOTE:

If the indicator is perpendicular to the pipe, the valve is closed. If the indicator in parallel to the pipe, the valve is open.
See Figure 11-5.

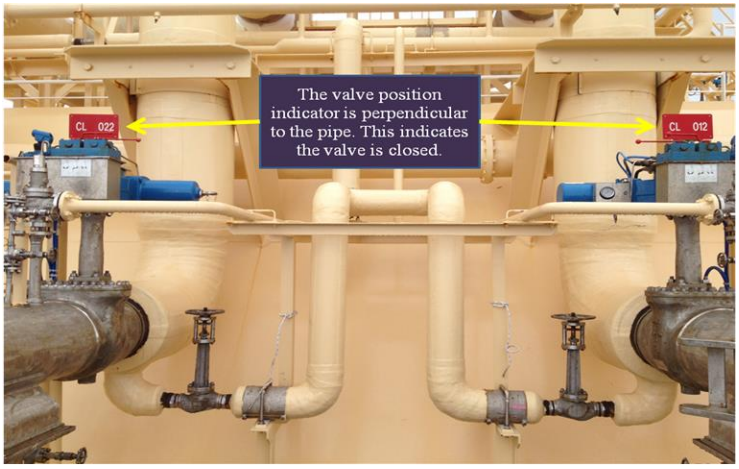

Figure 11-5 Valves position perpendicular to the pipe

- Witness operational test of ESD. See Appendix H: COMDT (CG-5P) Port State Control Information for Nov - Dec 2015 Command Email of 18 Dec 15.

NOTE:

Once the ESD is initiated, all required equipment should shut down and the quick closing valve closes within 30 seconds. Ambient temperature can influence response time.

This time requirement provides a balance between prompt valve closing in the event of fire and still guarding against potential liquid hammer caused by excessively rapid valve closure. If there is an undue delay between activation of the ESD and the start of ESD valve closing, there may be a problem that should be corrected. Often these systems, whether ESD button or pneumatic valve, can be adjusted to meet this time requirement. The operating characteristics of the ESD system should be referenced in the vessel's Cargo Operations Manual and should be in line with this requirement.

- The actual closing time is referenced in the Cargo Operations Manual and is reproducible.

A.5. Emergency Shutdown and Cargo Handling Equipment Overview	When activated, the ESDs remotely close the actuated valves, stop the cargo pumps, and stop the compressors (where appropriate).
A.5.a. Conducting Examination	Verify that cargo pumps and compressors shutdown after ESD is initiated.

NOTE: **An operational test to demonstrate this step may not always be possible. Factors precluding you from witnessing a shutdown of cargo pumps and compressors include; loading/discharging operations that are underway, pressure of cargo tanks, and the amount of time required to put the equipment back on line. Coordinate with the chief mate/master before witnessing the shutdown of pumps and compressors.**

NOTE: **More information about ESD arrangements can be found in reference (ee), ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers, SIGTTO 2009.**

Section B: Cargo Tank Pressure Relief Valves

B.1. Overview

LPG gas carriers have cargo tank relief valves which can be changed by the crew (i.e., Harbor and At Sea settings). These settings are changed by insertion or removal of spacer pieces or alternative springs, or by other similar means (See Figure 11-9). Per the Gas Codes, when cargo tank relief valve settings are changed in this manner, it must be done under the supervision of the master, and a notation must be made in the ship's log. The active setting must be displayed in the cargo control room and at each relief valve. Some Classification Societies also require the active setting be displayed on the bridge, but this is not mandated in the Gas Codes.

Cargo tank relief valves on both LNG and LPG gas carriers have provisions to make fine adjustments to the permanent settings to achieve accurate pressure or vacuum settings. For example, some relief valves have an adjusting screw that alters spring tension to make small changes in the settings. The adjusting screw is typically found under a cap located on top of the valve stem. These adjustments are made when the valve is installed or serviced. The Class Surveyor then seals the cap with a lead and wire seal or other similar means to prevent tampering.

An example of a proper anti-tamper seal can be seen in Figure 11-9, note how the wires are tied to each individual auxiliary device. Figure 11-8 xshows an improper anti-tamper seal arrangement, you can see in the photo that the tamper wire has been modified and connects the auxiliary setting device to the pilot operated relief valve.

See Chapter 3: Certificates and Documents (CD) Examination, Section F: Cargo Tank Pressure Relief Valves Documentation and Appendix F: Survey Report Example regarding documentation required by an RO.

There are two types of pressure relief valves on liquefied gas carriers:

- **Pilot operated valve**: Consists of a main valve and a pilot valve. The main valve has an unbalanced piston or diaphragm. Tank pressure is applied to the top of the piston via the pilot. As the area at the top of the piston is larger than the bottom, the valve remains closed. When the set pressure is reached, the pilot valve opens venting the space above the piston to the atmosphere, or the vent stack.
- **Spring operated valve**: A coil spring exerts pressure onto the top of the piston or valve. As the tank pressure increases, the valve-seating contact is reduced, making the setting of an exact set pressure more difficult.

NOTE: **More information can be found in reference (ff), An Introduction to the Design and Maintenance of Cargo System Pressure Relief Valves on Board Gas Carriers, SIGTTO 1998.**

B.2. Conducting Examination

Refer to LGC NCOE website for corresponding videos.

NOTE: **Independent Type A Tanks typically have 2 MARV settings; at Sea 0.25 BARG and In Harbor 0.50 BARG. Independent Type B Tanks typically have one fixed setting, often 0.25 BARG and never greater than 0.7 BARG. Independent Type C Tanks may have 2 or more MARV settings (IMO and USCG).**

Per reference (k), COMDT (CG-ENG) Alternate Pressure Relief Valve Settings on Vessels Carrying Liquefied Gases in Bulk in Independent Type B & Type C Tanks Policy Letter 16710 No. 04-12 of 8 Aug 12, ships can be authorized use of the higher IMO setting in U.S. Waters as indicated on the SOE. Always compare the MARV settings listed on the COF to the settings authorized on the SOE.

Verify the following:

- The auxiliary setting devices authorized by the COF (and more importantly by the SOE) are installed on the tank tops. See Figure 11-7.
- If there are authorized variable set points, verify the pressure alarm in use is appropriate for the current MARV setting(s) and that the MARV setting(s) are posted in the CCR and at the relief valves.
- Log entry indicates when MARV settings were changed under the supervision of the master.
- Each cargo tank with a capacity of more than 20 m_3 is fitted with two relief valves. See Figure 11-6.
- Each cargo tank with a capacity of 20 m_3 or less, including deck tanks, is fitted with at least one relief valve.
- Tamper-resistant seals are in place and intact. See Figure 11-7.
- Relief valves are connected to the highest part of the cargo tank above the deck (e.g., at the vapor dome).
- Relief valves are connected to a venting system which directs the vapor upwards (i.e., vent mast or riser), and exits at a height of not be less than B/3 or 6 meters, whichever is greater, where B is the maximum breadth of the gas carrier measured amidships.

- Vent mast or riser is fitted with a valve or other arrangement to drain water.
- No water has accumulated.

Figure 11-6 Cargo relief valves

Figure 11-7 Auxiliary setting devices

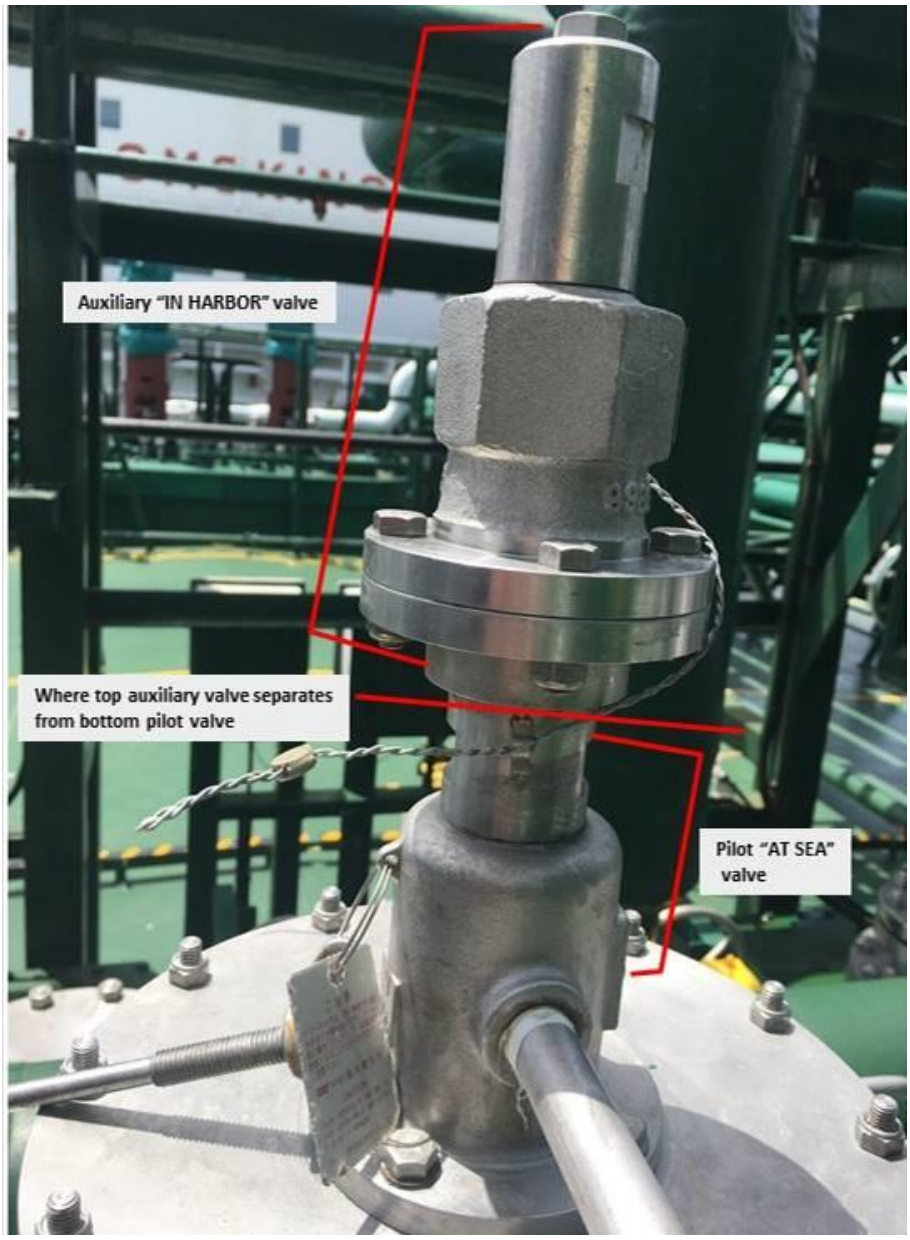

Figure 11-8 Pilot operated relief valve with incorrect set and seal wire

Figure 11-9 Relief valves stacked correctly, typical LPG set-up

Section C: Cargo Piping

C.1. Overview

Per the Gas Codes, there shall be no cargo piping below the main deck. All cargo piping must enter the tank through the tank dome. This design prevents the hull from filling with liquid or vapor in the event of a grounding or collision. Also, cargo piping must allow for thermal expansion and contraction. This is achieved by using loops, bends, and mechanical expansion joints (bellows).

NOTE:

There is no requirement for annual pressure testing of cargo lines on liquefied gas carriers. The requirement for testing of cargo lines found in reference (gg), Definitions, 33 CFR § 156.105, applies to oil and hazardous materials. However, the definition of hazardous materials in reference (hh), Definitions 33 CFR § 154.105, specifically excludes liquefied gases.

CAUTION:

Ensure cargo piping supports on a bellows is not restricted because it is an integral part of the installation. The supports are adjusted to allow for a certain amount of expansion and contraction, otherwise it would damage the piping.

C.2. Conducting Examination

Verify the following:

- Low temperature piping is thermally isolated from the adjacent hull structure.

NOTE:

Piping isolation prevents the temperature of the hull from falling below the design temperature of the hull material. This can be achieved by adding insulation around the pipe and/or raising the piping above the cargo deck.

- Hull protection is present in areas where low temperature piping can be regularly dismantled or where leakage is anticipated.
  - Typically located at the cargo manifold where cargo lines are connected to shore lines and at the cargo pump seals. LNG carriers commonly fitted with water curtains where LPG vessels normally have drip trays.

NOTE:

Per reference (e), IGC Code 1993 Edition, where liquid piping is dismantled regularly (cargo manifold), or where liquid leakage may be anticipated, such as at shore connections and at pump seals, protection for the hull beneath should be provided. Examples of this protection are water curtains and/or drip trays.

If the marine loading arms (MLAs) are connected and the water curtain is not activated, determine if a valid reason exists for that condition. Activation period may be stated in the Cargo Operations Manual or on the Declaration of Inspection (DOI).

CAUTION:

Per reference (o), Liquefied Gas Handing Principles On Ships and In Terminals, SIGTTO, Fourth Edition 2016, manifold drip trays for LNG transfers should be as dry as reasonably practical. Crew should not deliberately introduce water or allow water to accumulate in the rain.

- Gasketed pipe joints are electronically bonded. Ensure bonding arrangements have metal to metal contact and are intact (no breaks, loose connections, or excessive corrosion). See Figure 11-10.

WARNING:

Per reference (e), when liquid is being moved through conducting material, static electricity may build up depending on how much friction the liquid is causing. If two pipes are connected with a gasket there is a small space in between the pipes. If the pipes are not electrically bonded and the charge is great enough, a spark may occur which can cause an explosion/fire. To prevent this spark, the pipes are joined by conducting material. This may be in the form of wire or thin plate. For additional information about static electricity and electrical continuity, see Chapter 5: Fundamentals of Static Electricity of reference (ii), National Fire Protection Association (NFPA) 77: Recommended Practice on Static Electricity, 2019 Edition.

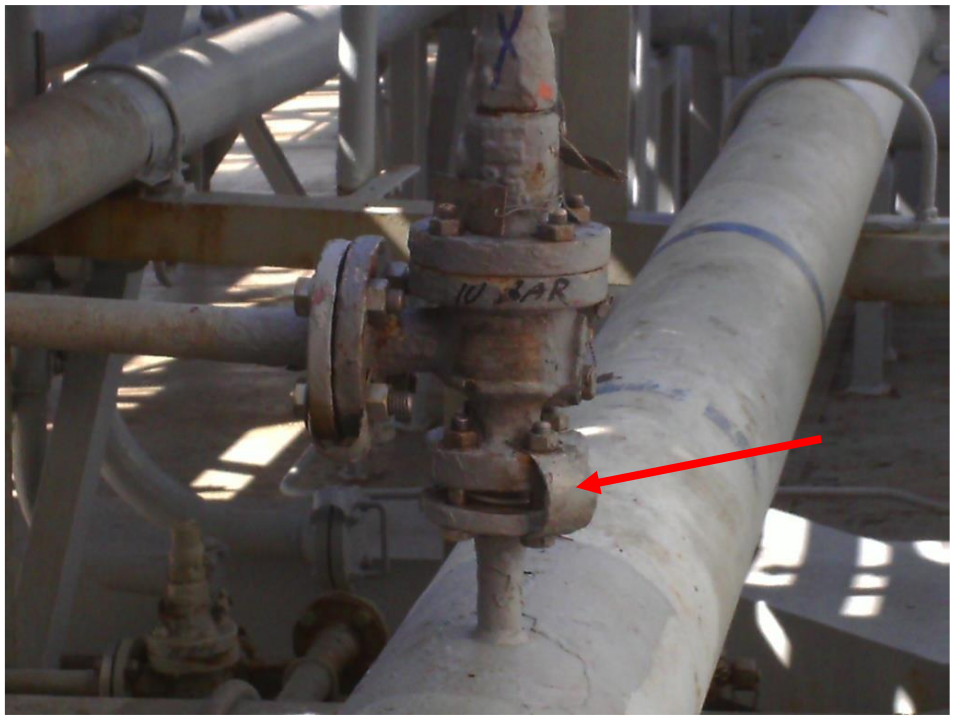

Figure 11-10 Electrically bonded relief valve

- Cargo piping which may be isolated in a liquid full condition is provided with relief valves.

NOTE: **The relief valve is normally external. However, some vessels have butterfly valves installed with internal relief valves. If you are unsure, check with the chief mate and/or cargo officer.**

- Cargo piping is in good condition free of cracks or excess of corrosion.

CAUTION: **If liquefied gas is trapped in a section of piping, the pressure from boil off could cause extensive damage. To mitigate the excessive pressures, a relief is installed in the piping. In most cases, this line leads back to the cargo tank.**

Section D: Cargo System Shutoff Valves

D.1. Overview

Per reference (e), IGC Code 1993 Edition, and reference (d), GC Code, cargo system shutoff valves are provided on cargo tanks liquid and vapor connections as close to the tank as practicable (except on safety relief valves and liquid level gauging devices). These valves are ball, globe, gate or butterfly valves and are usually fitted with pneumatic or hydraulic actuators. All pipe connections to the cargo tanks must be taken through the cargo tank domes which penetrate the main deck.

D.2. Conducting Examination

Verify the following:

- On cargo tanks with MARVS not exceeding 0.7 BARG, the presence of shut off valves on liquid lines and vapor lines that are capable of manual operation. See Figure 11-11.

NOTE: **These valves may be remotely controlled, but must be capable of manual operation per reference (e), and reference (d).**

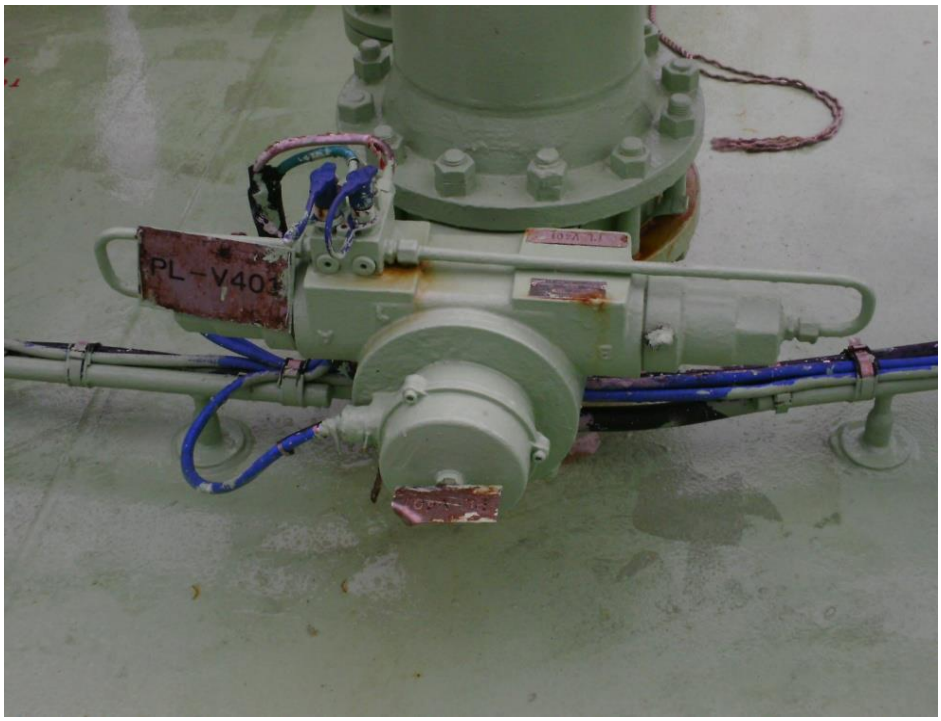

Figure 11-11 Hydraulically actuated fill line shutoff valve on an LPG gas carrier

- On cargo tanks with MARVS exceeding 0.7 bar gauge (BARG), the presence of a manually operated stop valve and a remotely controlled emergency shutdown valve on liquid and vapor lines.

NOTE: **MARVS are indicated on the COF and SOE.**

NOTE:

A single valve may be substituted for the two separate valves provided the valve complies with:

- **Reference (e), IGC Code 1993 Edition.**
- **Reference (d), GC Code.**
- **Is capable of local manual operation, and provides full closure of the line.**

NOTE:

Per reference (e), reference (d), and reference (c), Safety Standards for Self Propelled Vessels Carrying Bulk Liquefied Gases, 46 CFR Part 154, MARVS for tank types "A" and "B", may not exceed 0.7 BARG.

Per reference (c), MARVS for "membrane" may not exceed 0.25 BARG without Commandant approval.

NOTE: **Per reference (j), MSM Vol. II, missing or defective quick closing valves is grounds for detention.**

Section E: Cargo Machinery Space Equipment Examination

E.1. Overview

When conducting the cargo machinery room exam, equipment may or may not be in operation depending on if it's an LNG or LPG vessel. The primary purpose of examining the cargo machinery room equipment is not to test equipment, but to view its overall condition.

Determine that the cargo machinery room equipment is in good working order. We are primarily focused on verifying that the equipment is able to maintain cargo tank temperatures/pressures without venting to the atmosphere and operated to not pose a safety hazard. For example, no gas leaks, properly installed and maintained intrinsically safe electrical equipment, no leaking shaft seals, room is clean and not used as a storage space, etc.

NOTE: **The terminology may differ depending on the type of gas carrier that you are on. On LNG carriers, the space containing their cargo equipment is commonly referred to as a cargo machinery space, while on LPG carriers, the space room is called a cargo compressor room.**

NOTE: **The term "good standard of maintenance" is very subjective, and depends on your background and experience. If the equipment is fully functional, and not leaking, etc., it might be hard to articulate clear grounds for expanding the exam. But if you can, the SMS maintenance schedule is a good place to start the expansion.**

WARNING: ***USCG issued safety gear is not designed to protect you from exposure to cargo liquids or vapors. Be familiar with reference (l), COMDT COGARD WASHINGTON DC 191819Z MAR 10/ALSAFETY, Cargo Compressor Room Entries During Port State Control Exams and Law Enforcement Boardings of Liquefied Petroleum Gas (LPG) Carriers (Appendix D: Confined Space Safety Alert 2010), and conduct the required risk assessment before entering the cargo compressor room.***

WARNING:

Understanding the risks associated with hazardous cargoes is paramount to the safety of personnel while inspecting a gas carrier. Field personnel must be familiar with the most recent confined and enclosed space entry policies as well as perform a thorough risk assessment in accordance with reference (m), Risk Management (RM), COMDTINST 3500.3 (series), and reference (i), MSM Vol. I, before entry in such spaces.

The cargo machinery room aboard a liquefied gas carrier is a gas dangerous space located in the cargo area. It houses equipment such as:

- Cargo compressors.

NOTE:

The cargo compressors are usually powered by a motor located in an adjacent gas safe space with a shaft passing through the bulkhead by way of a gas or oil-tight seal. In some instances, the cargo compressors and motors will be located in the same space. If so, verify that the electric motors are certified safe.

- Cargo condensers.
- Cargo vaporizers.

NOTE:

When in doubt about the condition of this equipment, consider writing a requirement under reference (e), IGC Code 1993 Edition, and reference (d), GC Code.

NOTE:

Per reference (j), MSM Vol. II, a bulkhead between the motor room and compressor room that is not gastight is grounds for detention.

E.2. Conducting Examination

The exam consists of five parts as follows:

- Cargo compressors.
- Cargo vaporizers.
- Gas tight seals on compressor shafts if the shaft passes through a gas tight bulkhead.
- Reliquefaction system equipment.
- Electrical installation (refer to Chapter 8: Electrical Systems (ES) Examination for more information).

E.2.a. Cargo Compressors Overview

Except for fully pressurized cargo tanks, LNG carriers will be provided with a means to control cargo vapor pressures in the cargo tanks during cargo operations and during their voyage. During cool-down and cargo loading operations, LNG carriers typically return the vapors to shore for reliquefaction through a vapor line. They do this by using their high duty (HD) electric motors driven centrifugal compressors. While underway, LNG carrier use their low duty (LD) compressors to send boil-off gas through a heater. After heating, it is then sent to the engine room to be used as fuel in the propulsion system, or sent to a dedicated thermal oxidizer [gas combustion unit (GCU)] to maintain their cargo tank pressures.

NOTE:

Per reference (jj), COMDT (CG-5P) Port State Control Information for February 2016, Command Email of 26 Feb 16 (refer to the CG-CVC-2 website), *"Liquefied Gas Carriers are designed to be able to manage vapor pressure created due to boil-off gas IAW IGC Code 7.1 without venting to the atmosphere. IAW 46 CFR 154.1836, when the vessel is on the navigable waters of the United States, the master shall ensure that the cargo pressure and temperature control system under 46 CFR 154-701 through 154.709 is operating and that venting of cargo is unnecessary to maintain cargo temperature and pressure control, except under emergency conditions. In the event of an emergency or abnormal situation, venting to the facility is a preferred and safer option rather than venting to the atmosphere. Units may allow a foreign gas carrier to hook up their vapor hose prior to the completion of the Certificate of Compliance exam once all risk factors have been considered such as any conditions/concerns noted from the Marine Safety Center's plan review, initial impressions of the ship and prior inspection and compliance history."*

LNG gas carriers also have two LD compressors. They are provided for handling the cargo boil-off and passing it through a heater en-route to the engine room to be used as fuel or burned in the GCU. Under normal conditions only one of the LD compressors is in use at any one time.

NOTE:

While they are known as HD and LD compressors, they are essentially vapor blowers.

With the exception of fully pressurized gas carriers, LPG carriers usually control their boil-off gas by way of a reliquefaction plant onboard. This reliquefaction plant, also known as cargo compressors, is designed to maintain cargo temperatures and pressures within prescribed limits while at sea by liquefying the vapors generated by flash evaporation, liquid displacement and natural occurring boil-off. LPG gas carriers will have anywhere from a single stage, up to four stage reciprocating and screw type compressors. Most LPG vessels have anywhere between two and six liquefaction systems, or compressors, onboard for boil-off gas management. See Figure 11-12.

Figure 11-12 Three-stage cargo compressor on an LPG gas carrier

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E.2.a.(1). Conducting Examination

Verify that cargo compressors are free of leaks and are in good order. Evidence of a leak includes:

- Wet/frozen towels.
- Hissing.
- Ice in the bilge.
- Leaking shaft seals.

NOTE:

If there is evidence of a cargo leak or a cargo leak is suspected, use your best judgment, based on the hazards of the cargo carried, before entering the space. Consider having a marine chemist certify the space before entry.

E.2.b. Cargo Vaporizers Overview

Cargo vaporizers are heat exchangers that convert liquefied gas into a vapor. LNG vaporizers (see Figure 11-13) are used to maintain cargo tank pressures during discharge if shore is unable to supply a vapor return. A forcing vaporizer converts LNG to vapor to provide additional fuel gas for burning in the engine room to supplement the natural boil-off. The typical heating medium is steam.

Figure 11-13 LNG vaporizer on an LNG gas carrier

There is a difference between a cargo heater and a cargo vaporizer. The main purpose of a cargo heater is to warm the liquid cargo before it can be transferred into pressurized storage systems, to avoid low temperature embrittlement of cargo tanks and pipelines. Heating the cargo takes place whether when loading a cold cargo into a pressurized ship or when discharging a refrigerated cargo into pressurized tanks ashore. In many cases, booster pumps are used in tandem with the cargo heater when pumping ashore because the standard cargo tanks are not able to provide enough discharge pressure to send the cargo to the facility's pressurized storage tanks.

There are two different type of cargo heaters: direct and indirect. Direct heaters are conventional shell and tube type exchangers using seawater. Indirect heaters use an intermediate circuit between the cargo and heat source. They traditionally use steam-heated glycol. Sometimes indirect heaters use refrigerant gases or the cargo itself as an intermediate fluid.

A cargo vaporizer is often used on gas carriers as a means of producing vapors from the liquid cargo. This vapor is used to gas-up cargo tanks after they have been gas-freed or to maintain cargo tank pressure during discharge if there is no vapor return line provide from the facility. On LNG carriers there is also a requirement to occasionally produce vapor to supplement BOG to provide sufficient vapors by consumers in the ship's propulsion system. LPG carriers usually only have a single vaporizer while it is common practice on LNG carriers to have two vaporizers (high duty and low duty).

Cargo vaporizers are usually shell and tube heat exchangers using either steam or seawater as the heating source. They are similar in construction to cargo vaporizers. The main difference is that the heater simply warms the liquid cargo while the vaporizer is intended to change the cargo from a liquid to a vapor.

E.2.b.(1). Conducting Examination

Verify that cargo vaporizers are free of leaks and are in good order. Evidence of a leak includes:

- Wet/frozen towels.
- Hissing.
- Ice in the bilge.
- Cracked deck.

E.2.c. Gas Tight Seals on Compressor Shafts Overview

Per reference (e), IGC Code 1993 Edition, where pumps or compressors are driven by shafts that pass through a bulkhead or deck, gas tight seals (with efficient lubrication or other means of ensuring the permanence of the gas seal) should be fitted in the bulkhead. See Figure 11-14.

Figure 11-14 Lubricated bulkhead shaft seal passing through the gas tight bulkhead on an LNG gas carrier

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E.2.c.(1). Conducting Examination

Verify the following:

- Gas tight seals on compressor shafts passing through decks and/or bulkheads are well lubricated and in good working order (no gaps, no excessive vibration or misalignment of shaft, and no oil leaks).

- Oil head tank in good material condition (free of leaks, no excessive rust, oil appears clean in site glass, etc.)
- No excessive oil leaking from the gas tight seal.
- Entire gas tight bulkhead is intact (no improperly sealed penetrations).

E.2.d. Reliquefaction System Equipment Overview

On LPG gas carriers the typical two-stage direct reliquefaction system with inter-stage cooling equipment includes: multiple stage compressor, intercooler, heat exchanger (sea water or refrigerant), liquid receiver and thermal expansion valve (TXV). Single-stage direct reliquefaction systems and cascade-direct reliquefaction systems (see Figure 11-15) might also be encountered.

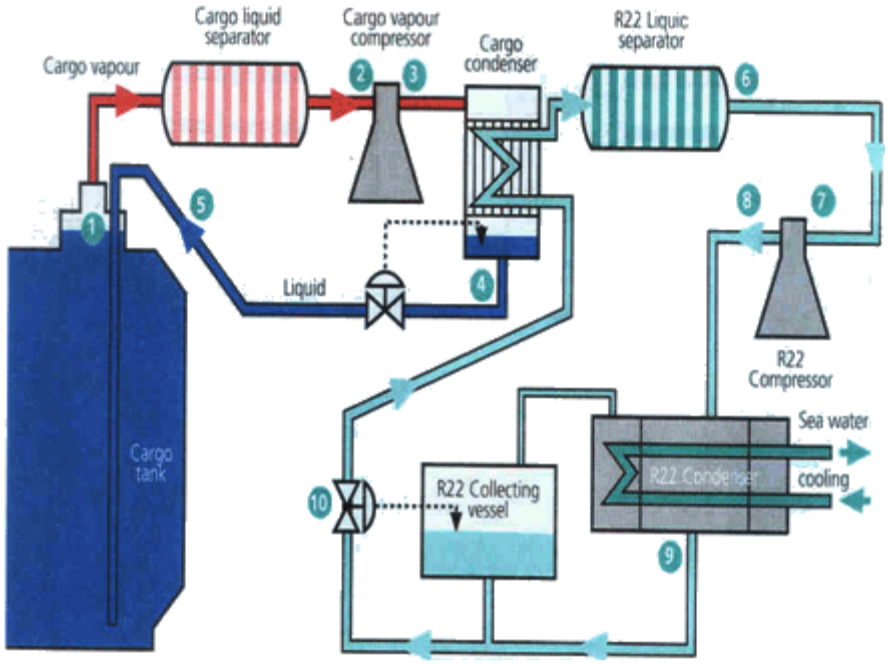

Figure 11-15 Cascade-direct reliquefaction system

LNG gas carriers that have slow speed diesel engine main propulsion may have a reliquefaction system aboard. On the BOG side, this system consists of a two stage compressor and heat exchanger. The cooling medium in the heat exchanger is N_2. Refrigeration is provided by N_2 compression, pre-cooling, and expansion. This is achieved with the N_2 compander unit, which consists of a three-stage compressor and a single-stage expander.

E.2.d.(1). Conducting Examination

Verify that the reliquefaction system equipment is free of leaks and is in good material condition (minimal carbon dust, no oil or cargo leaks, no damaged wires, no damaged instrumentation).

Chapter 12:
Cargo Environmental Control (CE) Examination

Introduction This chapter discusses requirements and procedures for conducting a cargo environmental control (CE) examination.

In This Chapter This chapter contains the following sections:

Section A: Inert Gas Systems (IGS)

A.1. Overview

Crude oil and product carriers are required to use an inert gas system to inert their cargo tanks because their vapor spaces have the potential of containing oxygen that could create a flammable atmosphere. However, a loaded gas carrier's vapor space will always be 100 percent by volume the vapor of the liquid cargo being carried due to the continuous boil-off gas being created. Because of this, gas carriers are not required to inert their cargo tanks or have an inert gas system as required by reference (y), International Fire Safety Systems (FSS Code), International Maritime Organization (IMO), 2015 Edition.

Inert gas systems (IGS) installed on liquefied gas carriers are used to inert Type A cargo tank hold spaces, before gassing up, changing grades of cargo and during the gas freeing process before going to shipyard for cargo tank inspections and maintenance. IGSs installed aboard liquefied gas carriers are ONLY required to comply with reference (e), IGC Code 1993 Edition, and not the IGS requirements in reference (y).

The IGSs might also be equipped by driers. Driers are used to decrease the dew point to prevent the freezing of CO_2 (freezing point -55 degrees Celsius) and water, which is present in inert gas after combustion (see Figure 12-1).

Figure 12-1 IGS on a gas carrier

The drier systems can come in the form of a refrigerator and/or adsorption drier. In the refrigerator, the inert gas is cooled to 5 degrees Celsius, condensing most of the water vapors present in the gas. The adsorption drier uses vessels filled with activated alumina or silica gel to adsorb the excess moisture dropping the dew point to manageable levels.

A.2. Conducting Examination

When conducting an examination of the IGS, verify the following:

- System has an operational O_2 content meter.
- System has an operational alarm that indicates if the O_2 content of the inert gas reaches a level higher than 5 percent.
- A means to prevent the backflow of cargo gas is provided.

NOTE:

It is not necessary to have the ship turn on the IGS in order to verify that both the O_2 content meter and alarm function are operational. Expect crew to demonstrate that they work without the IGS in full operation.

Section B: N_2 Gas Generating System

B.1. Overview

N_2 is an abundant gas that makes up 79 percent of the volume of atmospheric air. It is colorless, odorless, and has a relatively low boiling point which makes it an ideal gas for cryogenic cargoes. It can be used for the following purpose:

- Inerting interbarrier spaces.
- Inerting the cargo tank insulation.
- Inerting hold spaces.
- Purging cargo pipelines.
- Purging cargo related machinery.
- Gas tight bulkhead seals in-between gas safe and gas dangerous spaces.
- Cargo tank vent mast fire extinguishing.

There are two types of N_2 generators; membrane separation (see Figure 12-2) and pressure swing adsorption (see Figure 12-3). The two generators each have a unique way of taking advantage of the molecular size of N_2. Both systems are examined the same way.

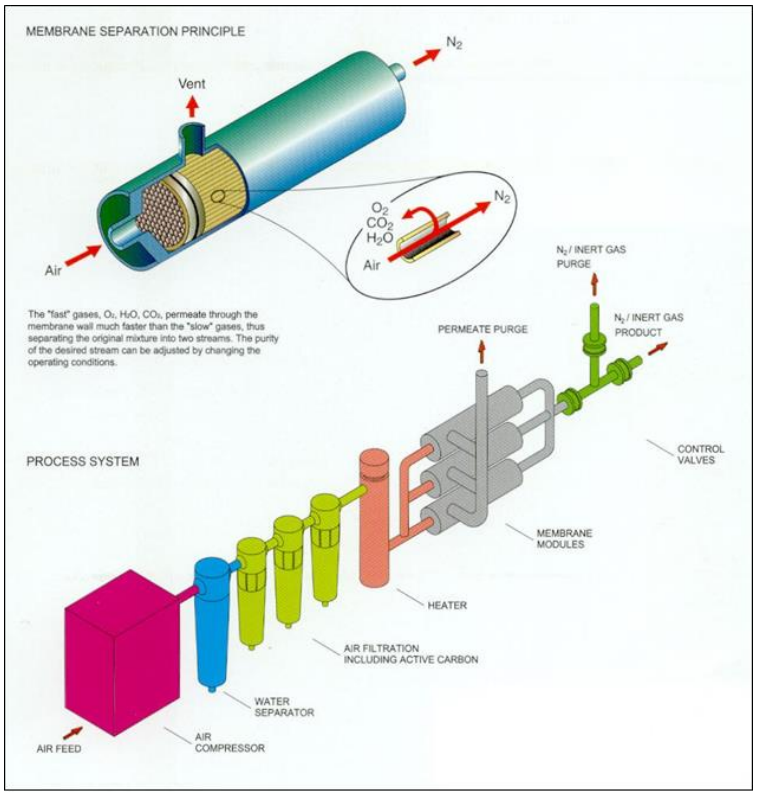

Figure 12-2 Gas separation membrane

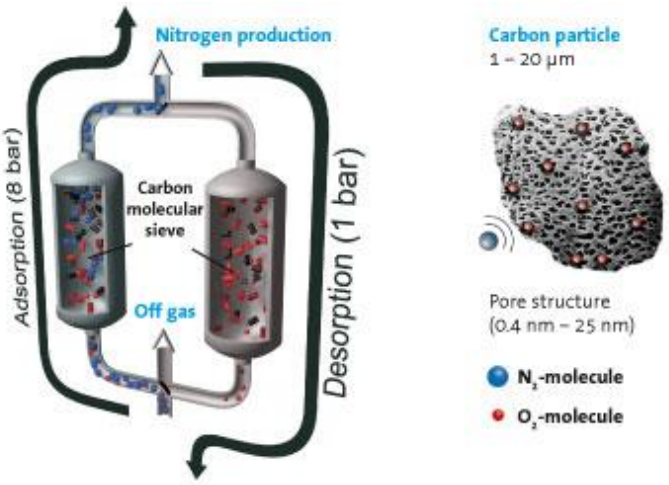

Figure 12-3 Pressure swing adsorption

B.1.a. Membrane Separation Overview

Compressed air is forced through a tube with hundreds of hollow nitrogen fiber membranes. These membranes use the principle of selective permeation to separate the gases. The rate of permeation of each gas is determined by its solubility in the nitrogen membrane material.

Gases that are highly soluble in the nitrogen membranes, and the gases that are small in molecular size, permeate faster than larger less soluble gases. These are often referred to as "fast gases" (O_2, CO_2, H_2O) and "slow gases" (N_2) with respect to their permeation rate. The larger and slower N_2 is collected after separation from the "fast gases" which pass through the nitrogen membrane.

B.1.b. Pressure Swing Adsorption Overview

This process uses a carbon molecular sieve that absorbs O_2 leaving mostly N_2 behind. There are two carbon units working in tandem to produce a continuous flow of N_2. While one unit is generating (separating gases from the N_2) the other unit is regenerating (releasing the non-N_2 gases). Once this is complete, the units switch roles.

B.2. Conducting Examination

Many liquefied gas carriers are capable of generating N_2 aboard. Since N_2 is an inert gas, the requirements for a N_2 generator are the same as the IGS and must align with reference (e), IGC Code 1993 Edition, and reference (d), GC Code, requirements.

When conducting an examination of the N_2 plant, verify the following:

- System has an operational O_2 content meter.
- System has an operational alarm that indicates if the O_2 content of the inert gas reaches a level higher than 5 percent.
- A means to prevent the backflow of cargo gas is provided.

Section C: Inert Gas/N_2 Storage Tanks

C.1. Overview

In the event that a liquefied gas carrier does not have the capability to generate N_2, it has the capability to store liquid N_2 aboard. Refer to reference (e), IGC Code 1993 Edition, and reference (d), GC Code, for storage requirements. Per reference (e), vessels using stored inert gas for interbarrier and hold spaces must have sufficient amount for normal consumption for at least 30 days. It is not common to come across storage tanks but some older ships still have them and you need to know how to examine them and calculate the required storage capacity.

C.2. Conducting Examination

Verify the following:

- Storage is sufficient for normal consumption of at least 30 days. Compare the normal amount of consumption for a 30 day period, with the aboard capacity.
  - To determine how much is needed, calculate the amount used per day for normal consumption. The vessel has an inert gas or N_2 usage log that notes daily, weekly, and/or monthly usage. Next, multiply the aboard volume by 696 (expansion ratio for N_2 696:1) and divide that number by the daily amount.
  - Using the numbers above, the vessel uses 550 m^3 of N_2 gas per day and has 30 m^3 of liquid N_2 storage. If the expansion ratio of N_2 (696) is multiplied by the liquid storage (30 m^3), that equals 20,880 total N_2 gas capacity. Divide the total N_2 gas capacity (20,880 m^3) by the daily usage (550 m^3) to equal 37.9 days. This system meets reference (e), requirements. See Figure 12-4.

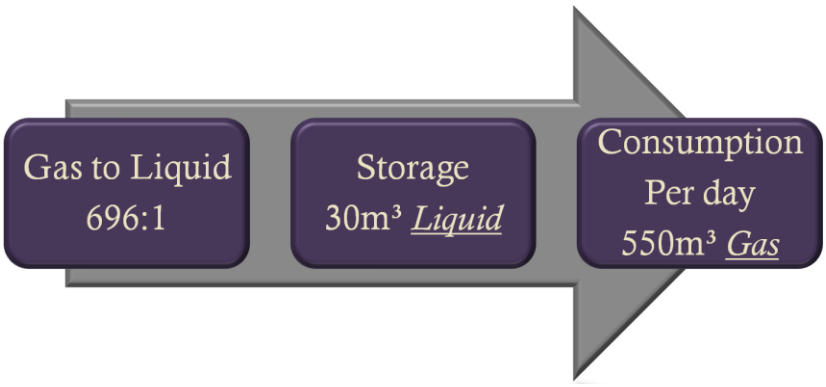

Figure 12-4 Liquid N_2 storage

- Inert gas stored for cargo related services is not used for firefighting.

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Chapter 13:
Cargo Area Ventilation (CV) Systems Examination

Introduction

This chapter discusses requirements and procedures for conducting the cargo area ventilation (CV) systems examination.

In This Chapter

This chapter contains the following sections:

Section A: Cargo Machinery Motor (Electric Motor) Room Ventilation System Examination

A.1. Introduction

The cargo machinery motor (electric motor) room is a gas safe space and, per reference (e), IGC Code 1993 Edition, must have positive ventilation. This helps the space maintain a pressure differential between it and the adjacent gas dangerous space. In the event of a leak in the cargo machinery room or on deck, the positive pressure prevents ingress of vapors. See Figure 13-1.

Figure 13-1 Machinery motor room supply

A.2. Conducting Examination

Verify the following:

- The ventilation system is controlled from outside the space.

NOTE: **The control location is typically just outside the space or in the cargo control room.**

- Positive ventilation is operational.
- Positive pressure is 30 air changes per hour.

NOTE: **Per reference (e), ventilation systems are designed to meet this requirement. It is very difficult on operating vessels to easily confirm that the system(s) is/are actually meeting the 30 changes per hour requirement.**

- Indications that the system is not functioning properly and an expanded exam is warranted include:
    - It is obvious when entering the space that the pressure in the space is weak. It should take a considerable effort to close a door against positive ventilation pressure.
    - One or more of the ventilation fans is damaged or is inoperable.
    - The fan(s) are blocked or inhibited from properly spinning.
    - The fan(s) cannot operated due to electrical or motor problems.
    - There is a component of the system that is "out of service" or not operating such that the system is no longer "as designed."

- Adjacent air locks have mechanical ventilation and are maintained at an overpressure compared to the on deck gas dangerous zone. Refer to Chapter 5: General Health (GH) and Safety Examination, Section E: Air Locks for more information.
- Equipment in spaces protected by air locks that are not certified safe, deenergize upon loss of overpressure in the space.
- Ventilation ducts have protective screens in place and are free from obstructions.
- A warning notice is posted outside of the space requiring ventilation before entering the space.

NOTE: **Ensure machinery motor room doors are closed on vessels without an airlock. Without proper door closure, the ventilation requirements for the space cannot be met.**

- Ensure ventilation distance requirements are met. Per reference (e), IGC Code 1993 Edition, ventilation discharge outlets from a gas dangerous space must be 10m horizontally from ventilation intakes and openings to accommodation spaces, service spaces and control stations, and other gas-safe spaces. See Figure 13-2.

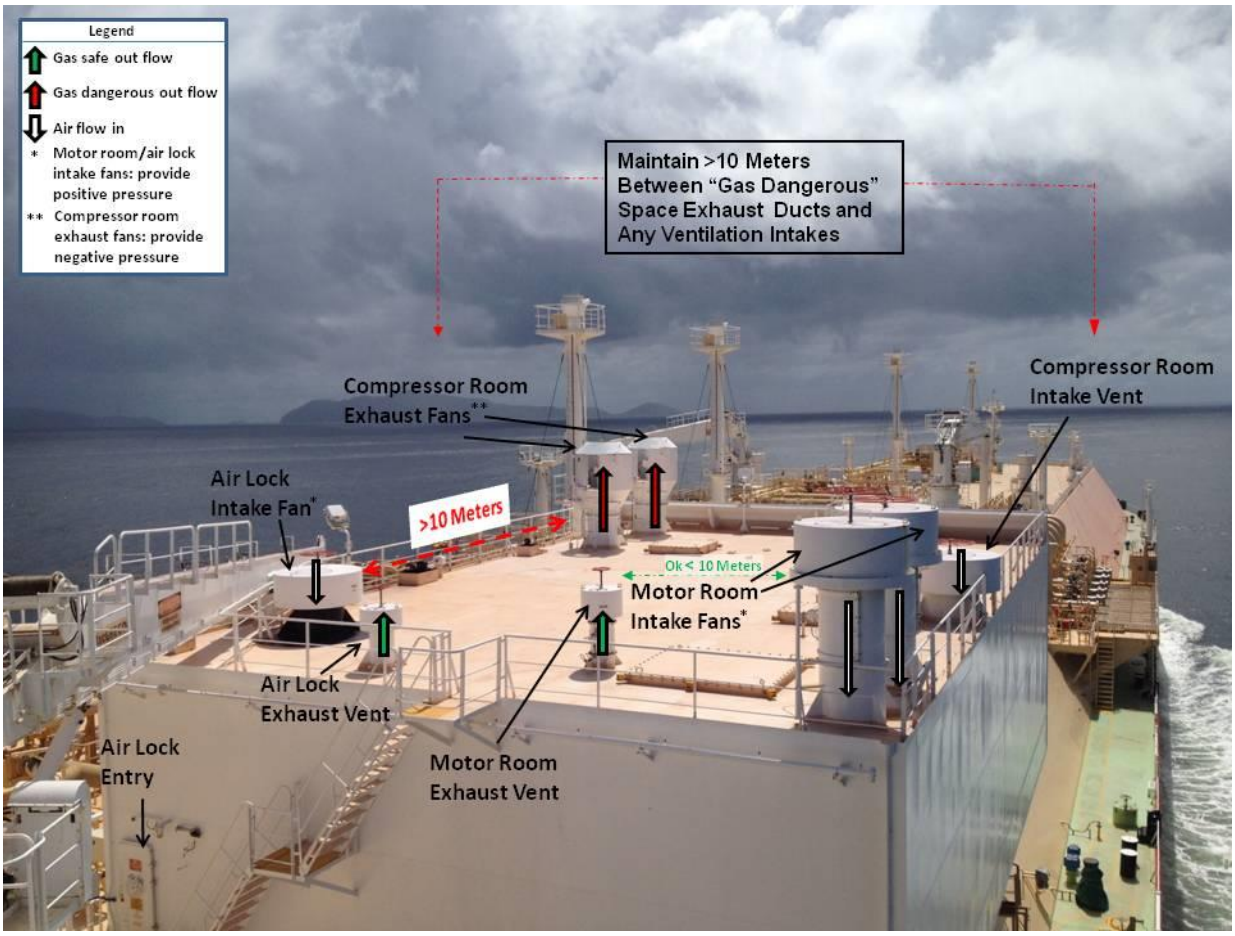

Figure 13-2 Ventilation

Section B: Cargo Machinery Space (Compressor Room)

B.1. Overview

The cargo machinery space (compressor room) is a gas dangerous space and per reference (e), IGC Code 1993 Edition, is required to have negative ventilation. This helps the space maintain a pressure differential between it and the adjacent gas safe space.

Air is pulled from different sections of the cargo machinery space (compressor room) to ensure gas pockets do not accumulate. Another factor that determines inlet location is the density of cargoes authorized for carriage. If a vessel is authorized to carry cargoes that are both lighter and heavier than air, then they will have an adjustable ventilation system with louvers to select one at a time.

B.2. Conducting Examination

Verify the following:

- The ventilation can be controlled from outside the space.

NOTE: **The control location is typically just outside the space or in the cargo control room.**

- Negative ventilation is operational when going through the entrance of this space (you should feel a slight pulling affect).

NOTE: **If checking the ventilation discharge which is typically located above the space, you should feel air escaping from the space.**

- Ventilation extraction points are relative to the cargoes density.
- Duct openings have protective screens in place and are free from obstructions.
- A warning notice is posted outside of the space requiring the use of ventilation prior to entering the space.

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Chapter 14:
Gas Fuel (GF) Supply System Examination

Introduction

Historically, CH_4 (LNG) is the only liquefied gas cargo whose vapor or (BOG) is used as fuel in Category A machinery spaces. However, other liquefied gases can be burned with the approval of the Administration. Per reference (e), IGC Code 1993 Edition, the use of BOG as fuel is an accepted method of controlling cargo tank pressure and temperature.

Such systems are designed to stop the flow of BOG fuel to the machinery space when fuel gas leaks create a risk of fire or explosion. This chapter discusses requirements and procedures for conducting the gas fuel (GF) supply system examination on liquefied gas carriers.

In This Chapter

This chapter contains the following sections:

Section A: Master Gas Valve

A.1. Overview Per reference (e), IGC Code 1993 Edition, the gas fuel system has a master gas valve (MGV) located in the cargo area. There must be a means to close the MGV within the machinery space. When the fuel gas supply needs to be shut off because of hazardous circumstances (e.g., fuel gas leak), the MGV must close automatically.

Before observing that the MGV can close automatically, discuss the fuel supply status, cargo tank vapor pressures, and possible consequences of MGV shutdown with the vessel master or chief officer.

WARNING: ***In heavy seas, the agitation of the cargo can increase tank pressures to unusually high levels during and immediately after voyages. If MGV closure could potentially elevate pressures to cause cargo tank safety relief valves to lift, carefully consider the need to perform test(s). Gas carrier specific fuel gas configurations are outlined in the vessel's Cargo Operations or Machinery Manual.***

WARNING: ***Failure of the MGV or other components of the fuel gas system, could result in loss of propulsion during maneuvering, or render the vessel unfit for service. Such failures represent clear grounds to expand the exam, such as reviewing relevant SMS maintenance and crew training records. Consider control actions if the safety of the vessel, crew, or the port is in doubt.***

Figure 14-1 depicts ventilated arrangement which moves BOG from the cargo tanks to the machinery space.

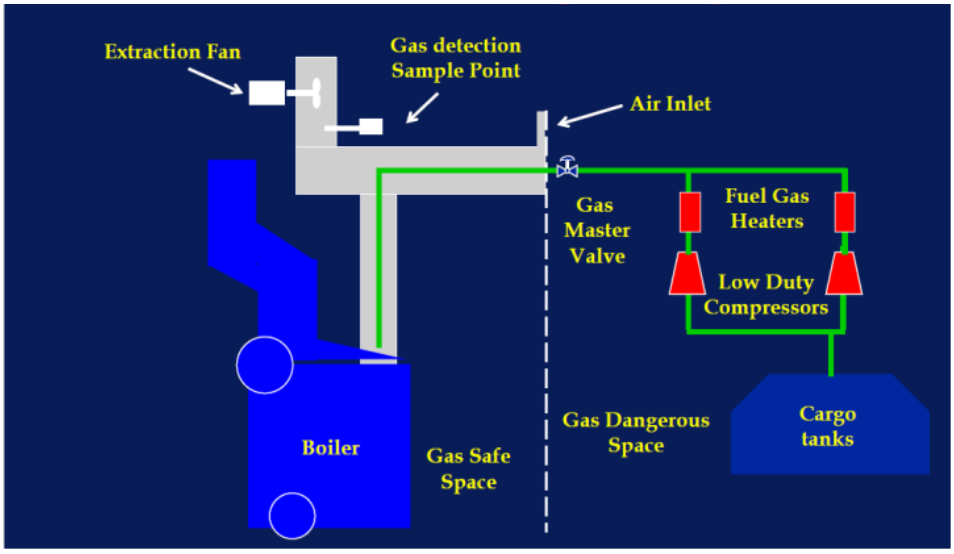

Figure 14-1 LNG gas carrier BOG fuel system ventilated duct or pipe arrangement

Figure 14-2 depicts inerted double-wall pipe arrangement which moves BOG from the cargo tanks to the machinery space.

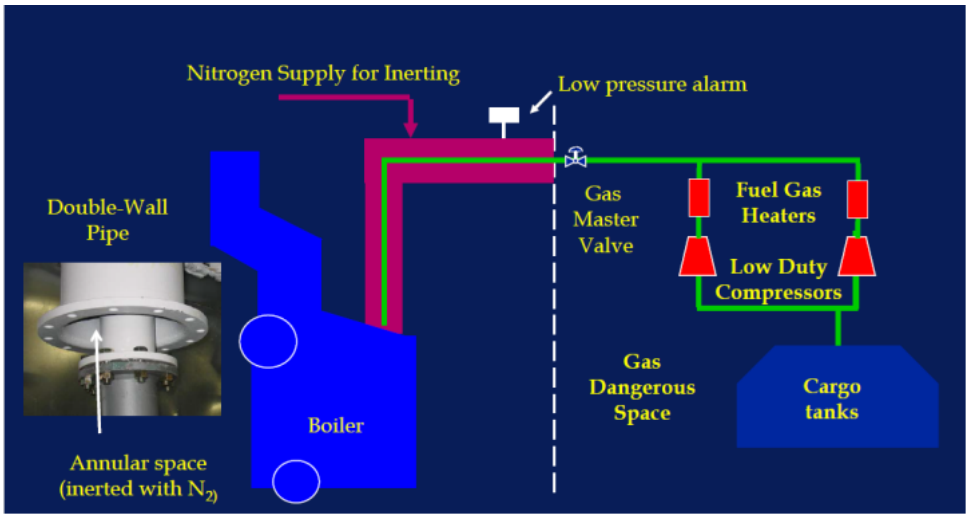

Figure 14-2 LNG gas carrier BOG fuel gas system inerted double-wall pipe arrangement

Figure 14-3 depicts ventilation and valve requirements for a boil-off gas fuel system.

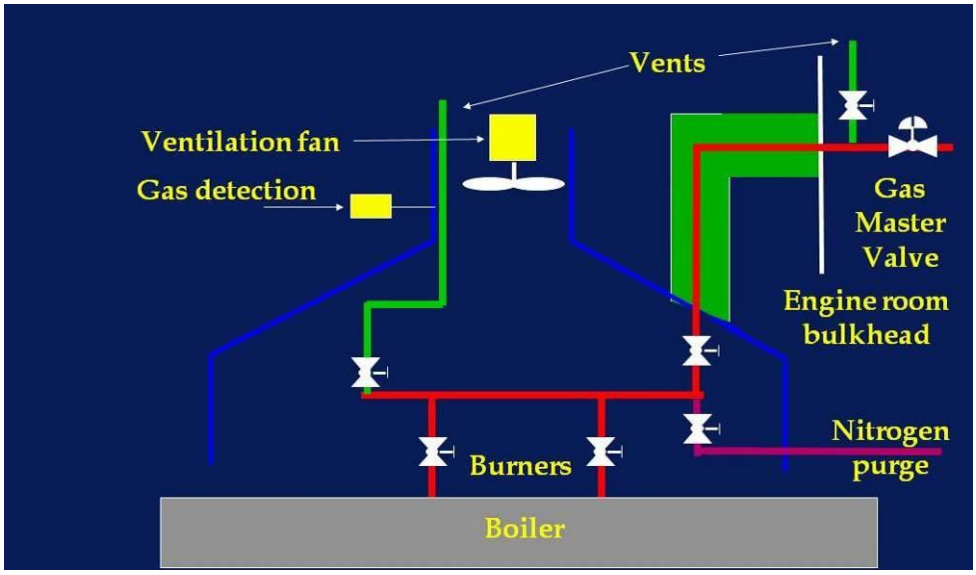

Figure 14-3 Typical LNG gas carrier BOG fuel system gas utilization unit ventilation and valve arrangements

A.2. Conducting Examination

This task requires two examiners; the team lead who is located at the actuation point (i.e., vent duct, ventilation/boiler hood, gas room) and another examiner located at the MGV. Exam procedures are the same for steam turbine (ST) and dual/tri fuel diesel electric propulsion except as indicated.

The team lead does the following:

- Discuss the gas carrier's fuel gas configuration and the status of cargo tank vapor pressures with the chief officer.
  - Determine if shutting down the MGV would pose an unacceptable risk and potentially cause cargo tank relief valves to open and vent BOG to the atmosphere.
  - Determine what the set points are for the fuel gas system gas detection alarm and shutdown in the machinery space.
  - Verify status of gas fuel and oil fuel burning:
    - ST propulsion: Per reference (kk), Methane (LNG) as Fuel, 46 CFR Part 154.1854(a), both main propulsion boilers must be operating in dual-fuel mode prior to MGV shutdown.

NOTE: **ST (boiler) propulsion uses an oil-fired pilot to ensure quick changeover to oil fuel burning mode in the event the gas fuel supply is cut off due to MGV closure. Dual and tri-fuel diesel engines always burn at least a small amount of fuel oil, even in gas mode, because BOG fuel will not ignite on its own from cylinder compression.**

- Duel fuel diesel electric (DFDE) propulsion: Needs to be operating in gas mode prior to MGV shutdown.

NOTE: **Alarm and shutdown set points are usually 30 percent LEL and 60 percent LEL CH_4. DFDE propulsion systems may have multiple MGVs serving engine rooms and GCU rooms. These arrangements often also have multiple alarm and shutdown set points, as prescribed in the Cargo Operations Manual or Machinery Manual. Allowances may be made for the prime movers in one engine room to continue gas burning, while those in the engine room, affected by the MGV shutdown, change over to oil fuel burning. Refer to the Cargo Operations Manual or Machinery Manual.**

- Discuss the precipitating event used to automatically close the MGV from the machinery space, and determine if any equipment will be affected in addition to the gas utilization unit (GUU) valves (e.g., MGV and fail-closed valves in series, fail-open vent valve and N_2 purging valves). One of the following methods is recommended:
  - Introduce gas with no more than 3 percent CH_4 by volume (60 percent LFL), with a balance air or N_2, into a continuous gas detection sensor installed in the vent duct, boiler hood/gas room (or gas valve unit (GVU) room for DFDE propulsion).
  - Shut off the ventilation in the vent duct, boiler hood/gas room (or GVU room for DFDE propulsion).
  - Simulate loss of pressurization in the double-wall gas fuel piping (i.e., inert gas pressure in the annual space falls below the gas fuel pressure in the inner pipe).
  - Simulate low gas fuel pressure in the gas fuel piping.
- At the vent duct, boiler hood/gas room or GVU room:
  - Examine the gas detection cabinet which may be located in, or near, the CCR or engine control room (ECR):

- Examine the interior of the cabinet for anomalies such as jumper wires or other evidence of tampering.

- Verify gas detection sensor calibration and/or witness a calibration check (i.e., bump test) per manufacturer's recommended maintenance or gas carrier's SMS.

➢ If gas detection is chosen to trigger MGV closure, verify that alarms and shutdown will activate at gas concentrations prescribed in the Cargo Operations Manual or Machinery Manual. The concentrations are 30 percent LFL and 60 percent LFL respectively, but may be lower, especially for gas carriers fitted with DFDE propulsion.

➢ If gas detection is chosen to trigger MGV closure, verify that ventilation remains on in duct, boiler hood/gas room or GVU room when the MGV closes.

➢ Verify that fail-closed and fail-open valves in the machinery space operate properly by observing the valves close/open or by observing valve status in the ECR.

➢ DFDE propulsion only: Verify that the shutoff valves on the gas fuel piping at the engines close when MGV closes.

➢ If loss of ventilation is chosen to trigger MGV closure, verify that gas burning cannot be restarted until ventilation is operating.

The other examiner at the MGV verifies the following:

- Each MGV can be closed manually (i.e., equipped with wheel for local closing).
- Each MGV fully closes. Upon closure, the valve indicator should be perpendicular to the fuel gas pipe.

A.2.a. Examples of GF Supply System

Examples of the GF supply system are shown in Figures 14-4, 14-5, 14-6, 14-7, and 14-8.

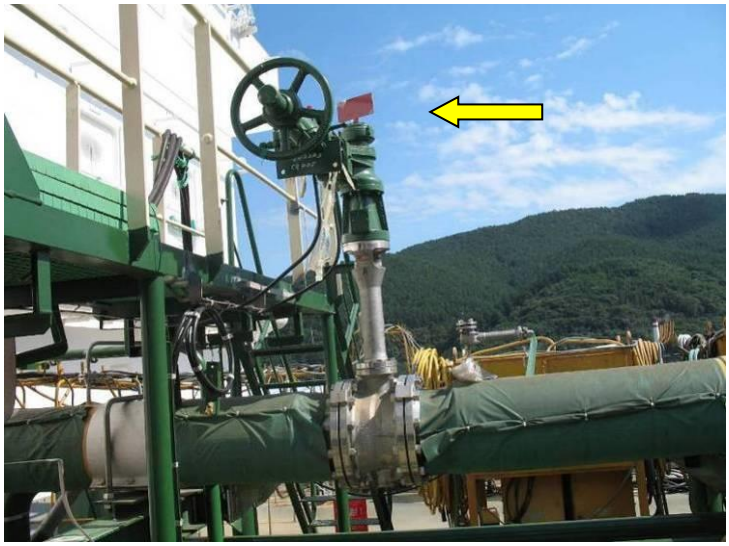

Figure 14-4 Red "flag" atop the valve stem aligned with the pipe indicates that the MGV is open

Figure 14-5 Example of second fail-closed shutoff valve installed in series with the MGV in the boiler hood or gas room

NOTE: **The second fail-closed shutoff valve should close automatically at the same time as the MGV. A fail-open vent valve is installed between this valve and the MGV. The vent valve automatically opens when the other two valves close to clear fuel gas from the pipe.**

Figure 14-6 Multiple valve arrangements

NOTE: **The function of the second fail-closed valve may be served by a multiple valve arrangement fitted after fuel gas piping splits.**

NOTE: **In Figure 14-6, three sets of double block and bleed valves are fitted on piping which direct fuel gas to each of the three burners in the port boiler. Per reference (e), IGC Code 1993 Edition, the starboard boiler also has 3 sets of valves, and when the shutdown is actuated all 6 sets must close.**

Figure 14-7 Fail-open vent valves

NOTE:

In Figure 14-7, fail-open vent valves for the port and starboard branches of the fuel gas piping are indicated by yellow arrows. The valves open when the shutdown is actuated. Vent piping is indicated by the blue arrows. N_2 purge valves are indicated by red arrows.

Depending on the design, the fail-open vent valves may be the last valves to open after the shutdown is actuated.

Figure 14-8 Twin MGVs

NOTE: **Figure 14-8 depicts twin master gas valves fitted on a liquefied gas carrier with a boil-off gas fuel system. It employs dual/tri-fuel electric propulsion and a GCU or thermal oxidizer to control cargo tank pressure.**

Section B: Ventilation within the Ventilation/Boiler Hood or Casing Examination

B.1. Overview

Per reference (e), IGC Code 1993 Edition, in case there is a natural gas leak and gas vapors must be extracted out of the space, ventilation is provided in the ventilation/boiler hood or casing.

NOTE: **The GUU room and GVU room are generally synonymous terms used to indicate the location of the GVU. Be aware that ships use different terminology for the same space.**

B.2. Conducting Examination

Verify the following:

- The extraction fan and the vent at the top of the space can sweep ventilation air across the GUUs.

NOTE: **You should feel the flow of air across the area protected by ventilation.**

- Ventilating air is exhausted at the top of the ventilation/boiler hood or casing.
- Ventilation remains on during MGV test (unless performing a ventilation shutdown).

Section C: Electrical Installations Within the Ventilation Hood/GUU Room

C.1. Overview

The definition of gas dangerous area in reference (e), IGC Code 1993 Edition, states that spaces with pipes for using BOG as fuel are excluded as being considered gas dangerous spaces. However, this is only if the piping is double wall ventilated or purged. Once in the ventilation hood/GUU room, the piping is now single wall piping and this space is now considered gas dangerous and must have electrical equipment certified for a gas dangerous space.

C.2. Conducting Examination

Verify the following:

- Electrical equipment is properly certified for a gas dangerous space.
- Electrical installations appear intact and in good material condition. This includes no:
  - Broken or exposed wires.
  - Broken bonding cables/straps.
  - Cracked light lenses.
  - Loose or missing bolts.
  - Paint or other foreign matter on flameproof fixtures that interferes with venting arrangements or flame paths or fixtures not fully enclosed/sealed as appropriate.
- Ensure power supply to electrical equipment is using appropriate cable glands and where cable glands are not used, a proper plug is used in its place.

Section D: Gas Detection System Used for the Protection of the Cargo Fuel System

D.1. Overview

The continuous monitoring gas detection system found in the fuel gas space (i.e., vent duct, ventilation/boiler hood, gas room) checks for flammable gases. Find the locations in the Machinery Manual or the Cargo Operations Manual. This is a different system than the cargo gas detection system.

D.2. Conducting Examination

Verify the following:

- Alarm should activate per the Cargo Operations Manual set points, generally 30 percent LFL.
- Closure of MGV at or before the gas concentration reaches 60 percent LFL. Set point may be much lower for DFDE propulsions systems (see Cargo Operations Manual or Machinery Manual).

NOTE: **Per the Cargo Operations Manual or the SMS, ship's personnel can use span gas or cargo sample to actuate alarm or shutdown from the gas detection sample point.**

Section E: Gas Utilization Unit(s) (GUU)

E.1. Overview

There are a number of automatic protective devices (valves) built into a system that uses LNG boil-off as fuel. Per reference (e), IGC Code 1993 Edition:

- Each GF supply system shall be fitted with a GUU.
- These protective devices (valves) are built into the system to ensure safe operation and they must be regularly inspected and maintained. Protective systems include automatic shut-down in the event of system malfunction or leak detection.

On ST (boiler) propulsion systems the GUU consists of a MGV located on the open deck, and fail-closed shutoff valve(s) and fail-open vent valves located in the machinery space. On DFDE propulsion systems, the GUU is comprised of the MGV, one or more GVU located in the GVU room(s), and fuel gas shutoff valves located at the engines.

The GUU typically has fail-closed shutoff valve(s), filters, flow meter, and a fuel gas control valve. The main functions of the GVU are pressure regulation, fuel shutoff in the event of a fuel gas leak or other anomalies, and inerting/venting fuel gas piping after shutdown. See Chapter 14: Gas Fuel (GF) Supply System Examination, Section A: Master Gas Valve for additional details.

E.2. Conducting Examination

Verify that each GUU has two valves, in series, located in the gas fuel pipe leading to the consuming unit. See Figure 14-9 and Figure 14-10.

NOTE:

One of the valves is typically the MGV and the other is located in the ventilation/boiler hood or gas room. These utilization valves are fail-closed.

Figure 14-9 Gas utilization room on LNG gas carrier

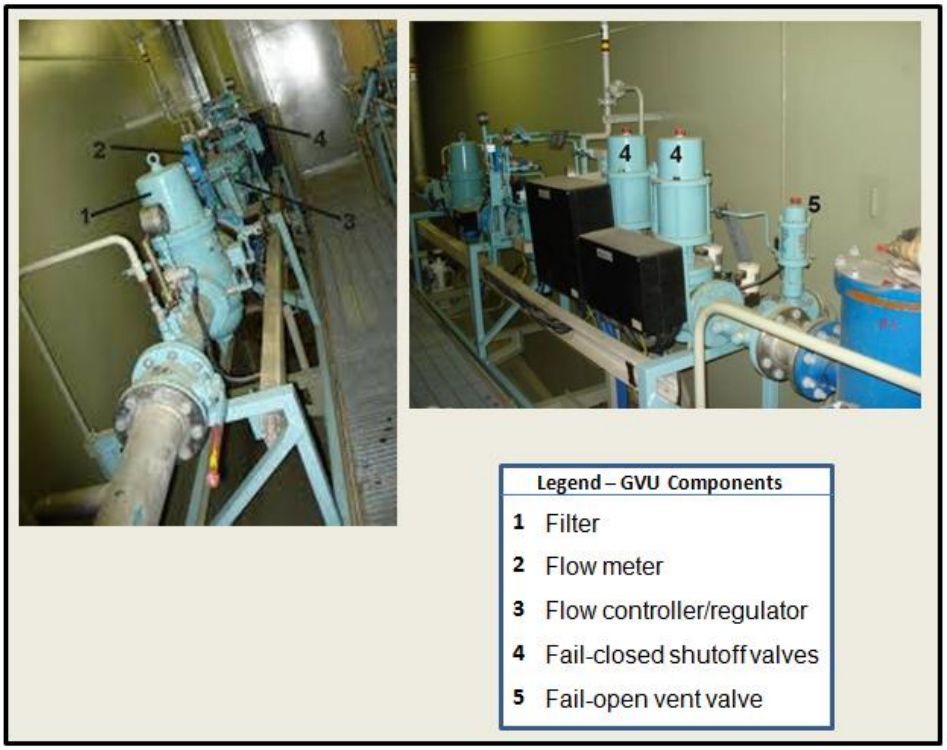

Figure 14-10 GVU is an integral part of the GUU on DFDE propulsion system

Section F: Gas Fuel Piping (Double Wall Piping System)

F.1. Overview

★★★Gas fuel (BOG) is provided to the engine room from the cargo machinery (compressor) room through either a double wall piping system or a ventilated pipe or duct system. This section discusses the double wall piping system.

The double wall piping system employs two concentric pipes. Fuel gas (vapor) flows through the inner pipe, while the annular space (see Figure 14-2) between the two pipes contains inert gas (typically N_2) at a higher pressure than the fuel gas. See vessel's Cargo Operations Manual or Machinery Manual for a detailed description and diagrams of the double wall pipe system.

F.2. Conducting Examination

Verify the following in the engine control room:

- Inert gas is at a pressure in the annular space that is greater than the gas fuel pressure in the inner pipe.
- Double wall piping system is fitted with an alarm that activates when inert gas pressure falls below the fuel gas pressure in the inner pipe.

NOTE:

Determine by comparing the fuel gas system piping and alarm details in the Cargo Operations Manual or Machinery Manual with the installation fitted on the vessel. The alarm can be tested in conjunction with the MGV test discussed in Section A.2.: Conducting Exam of this chapter.

Before observing that the MGV can close automatically, discuss the fuel supply status, cargo tank vapor pressures, and possible consequences of MGV shutdown with the vessel master or chief officer.

WARNING:

In heavy seas, the agitation of the cargo can increase tank pressures to unusually high levels during and immediately after voyages. If MGV closure could potentially elevate pressures to cause cargo tank safety relief valves to lift, carefully consider the need to perform test(s). Gas carrier specific fuel gas configurations are outlined in the vessel's Cargo Operations or Machinery Manual.

WARNING:

Failure of the MGV or other components of the fuel gas system, could result in loss of propulsion during maneuvering, or render the vessel unfit for service. Such failures represent clear grounds to expand the exam, such as reviewing relevant SMS maintenance and crew training records. Consider control actions if the safety of the vessel, crew, or the port is in doubt.

Section G: Gas Fuel Piping (Ventilated Pipe or Duct System)

G.1. Overview

Gas fuel (BOG) is provided to the engine room from the cargo machinery (compressor) room through either a double wall piping system or a ventilated pipe or duct system. This section discusses the ventilated pipe or duct system.

Ventilated pipe or duct systems employ a duct or concentric pipe around the fuel gas pipe. When fuel gas is flowing, negative ventilation is maintained in the annular space by an extraction fan at a rate of at least 30 air changes per hour. The fan is fitted near the upper end of the duct, and exhausts to a safe location (outside the engine room). This arrangement is designed to prevent the accumulation of flammable vapor in the duct in the event of a gas leak. If a gas leak is detected, or if ventilation is cut off, the MGV closes automatically.

G.2. Conducting Examination

Verify the following:

- Mechanical exhaust ventilation system is running while the vessel is operating in dual/tri-fuel mode.
- When in the ECR, there is continuous gas detection at the gas detection panel.

Section H: GCU

H.1. Overview

The GCU or thermal oxidizer is an authorized method for controlling cargo tank pressure and temperature. The GCU burns excess BOG that cannot be consumed by the propulsion system. The GCU fuel gas system is arranged in a similar manner as the propulsion system. The GCU may have valves (i.e., MGV) or sections of ducting/fuel gas piping that are common with a propulsion fuel gas system. On some gas carriers GCUs have completely independent fuel gas systems. Refer to the vessel's Cargo Operations Manual or Machinery Manual for system configuration.

The GCU should be sized to accommodate the maximum design boil off rate and should be totally independent of the reliquefaction system or dual fuel/gas burning diesel engines operation. If a foreign gas carrier is authorized to carry CH_4, it is required to comply with reference (ll), Foreign Flag Vessel: Certificate of Compliance Endorsement Application, 46 CFR § 154.22(a)(9)(i)(B). This can be verified on the COF.

NOTE: **The GCU is essentially a large capacity gas burner that sends most of the waste heat up the stack. See Figure 14-11.**

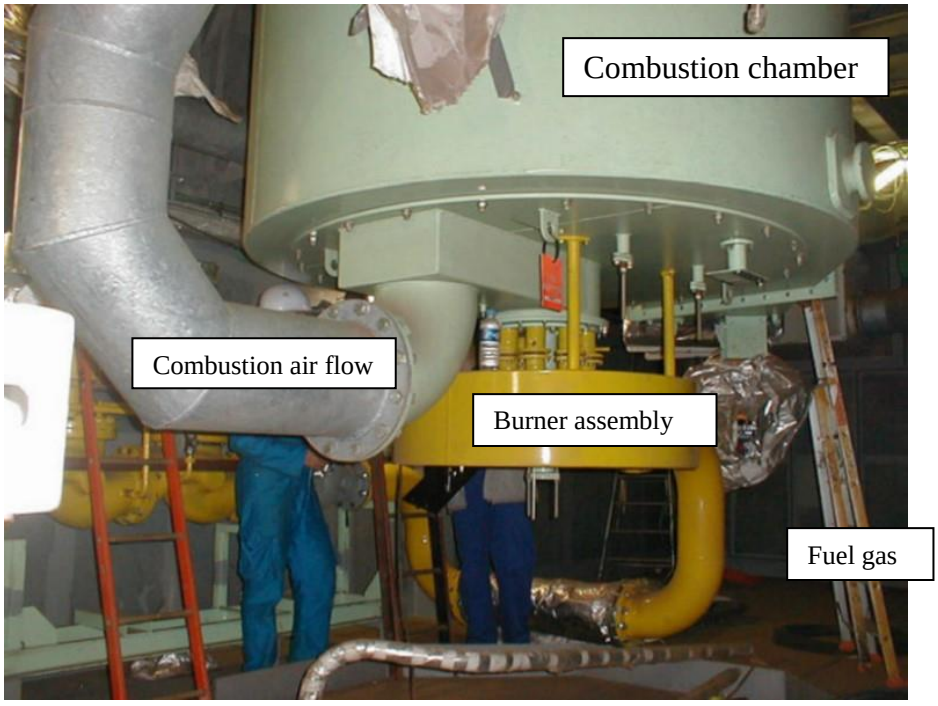

Figure 14-11 Typical GCU fitted on LNG gas carrier

H.2. Conducting Examination

The GCU fuel system is similar to the BOG fuel gas system for propulsion. Do the following:

- Verify the GCU is in operational condition.
- Verify automatic purge of gas fuel piping to burners by means of inert gas.
- Verify combustion chamber automatically purges prior to relighting after flame failure.
- Verify combustion chamber can be manually purged.
- Determine if the MGV shutdown will be tested. If so, follow procedures in Section A.2.: Conducting Exam of this chapter.

NOTE: **Enclosed space needs 30 air changes per hour and gas detection, including the GCU room.**

NOTE: **Per reference (e), IGC Code 1993 Edition, double wall pipe must be either:**

- **Inert to a pressure above the boil off gas pressure, or,**
- **Annuar space shall have ventilation with 30 air changes per hour and maintained at a pressure less than atmospheric.**

- Verify alarms are operational. Per the GCU operations manual, select two or three alarms to test. Typical alarms to choose from are:
  - Flame failure.
  - Flame scanner failure.
  - Combustion air fan failure.
  - Dilution air fan failure.
  - Main power supply failure.
  - Control power supply failure.
  - High flue gas outlet temperature.

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Chapter 15:
Follow Up (FU) Actions

Introduction

This chapter discusses follow up (FU) actions after all exams are completed. Refer to reference (mm), MSC Guidelines for Review of a Subchapter O Endorsement Application, Marine Safety Center (MSC), Procedure Number: C1-43.

In This Chapter

This chapter contains the following sections:

Section A: Issue Form CG-3585

A.1. Overview

Once examination is complete, fill out the remainder of Form CG-3585 (using guidance below, reference (j), MSM Vol. II, and reference (mm), MSC Guidelines for Review of a Subchapter O Endorsement Application, Marine Safety Center (MSC), Procedure Number: C1-43, and issue it to the ship's master.

A.2. Completing the Form CG-3585

Obtain Form CG-3585 form and do the following [refer to Appendix C: Sample Certificate of Compliance (COC), Form CG-3585]:

- Place an "X" in the following blocks under the "For Tank ships only" section:
  - The vessel is authorized to carry into or from United States ports.
  - The products listed on the COF for the carriage of liquefied gases in bulk subject to conditions noted on the attached USCG SOE.
  - The vessel is equipped with (check all that apply).
  - Segregated ballast tanks. (Place the vessel's deadweight tonnage in this section).
- Fill in the Date Issued section: Date of the exam.
- Fill in the Date of Expiration section: Two years from the date of the exam.
- Fill in the Annual Exam Due section: One year from the date of the exam.
- Complete the Examination Record on pages 2 or 3. This section is completed after initial, renewal and annual exams as follows:
  - Type of Examination section: Write in "COC-Gas Ren", "COC-Gas Ann" or "COC-Initial", as appropriate.
  - Remarks section: When deficiencies are found, list them along with corrective actions required or accomplished. Include requirements as to the type of repairs and time permitted for completion.

Section B: Form CG-3585 Common Mistakes

B.1. Common Mistakes to Avoid

When preparing a Form CG-3585, do not check the following blocks:

- *"Category Z Noxious Liquid Substances (NLS) as noted on the vessel's International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS Certificate)."*

NOTE: **The governing document for issuing a Form CG-3585 to a liquefied gas carrier is the COF, not the IPP NLS certificate. The IPP NLS never authorizes cargo carriage on a liquefied gas carrier without COF authorization. The block on Form CG-3585 regarding the carriage of category Z NLS cargoes will only be applicable to product carriers that are issued an IPP NLS certificate authorizing the carriage of category Z NLS cargoes.**

- *"This vessel meets the double-hull construction requirements as noted on the IOPP certificate and supplements."*

NOTE: **This information only applies to vessels carrying bulk oil, and is only found on the supplement to the International Oil Pollution Prevention (IOPP) certificate, Record of Construction, and Equipment for Oil Tankers.**

- *"The vessel's Vapor Collection System (VCS) meets the requirements of 46 CFR § 39."* (reference (bb), Vapor Control Systems, 46 CFR Part 39).

NOTE: **Even though liquefied gas carriers are designed to manage and transfer vapors, subsection 1001(b) of reference (bb), states "This part does not apply to the collection of vapors of liquefied flammable gasses as defined in 46 CFR 30.10-39."**

- *"This vessel is equipped with an Inert Gas System that complies with the requirements of SOLAS 74 (amended) II-2/4.5.5 and 46 CFR § 32."* (reference (h), SOLAS, and reference (nn), Special Equipment, Machinery, and Hull Requirements, 46 CFR Part 32).

NOTE:

The vessel may have an inert gas system that complies with the listed regulations, however, reference (nn), explicitly states that this subpart does not apply to vessels designed to carry liquefied gas cargo.

For inspection result sample deficiencies, refer to Appendix I: Deficiencies Example – Port State Control Report of Inspection - Form B, Form CG-5437B.

Section C: Complete MISLE Activity

C.1. Complete MISLE Activity

Upon completion of the COC examination the lead FGCE ensures that a MISLE activity is created and completed via the MISLE website on CGPortal. In addition to the requirements identified in the work instruction, the FGCE ensures the following:

- For initial and renewal exams, the status of the COC in MISLE is changed from "In Process" to "Valid."
- The dates of the COC in MISLE are updated to accurately reflect the date of issuance, next annual exam, and expiration date.
- For initial and renewal exams in which the SOE is initially issued, the status of the SOE in MISLE should remain "In Process" unless changed by MSC.
- A copy of the signed COC and SOE, is scanned and uploaded into MISLE as one document.

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Appendix A:
Glossary and Acronyms

ANOA	Advanced notice of arrival.
BARG	Bar gauge.
BOG	Boil-off gas.
BV	By volume.
CCR	Cargo control room.
CD	Certificates and documents.
CE	Cargo environmental control.
CGTTP	Coast Guard Tactics, Techniques, and Procedures.
CH_4	Methane.
C_2H_4	Ethylene.
C_2H_6	Ethane.
C_3H_6	Propylene.
C_3H_8	Propane.
C_4H_6	Butadiene.
C_4H_{10}	Butane.
C_2H_3Cl	Vinyl chloride monomer.
C_2H_4O	Ethylene oxide.

C_3H_6O	Propylene oxide.
CO_2	Carbon dioxide.
COC	Certificate of Compliance.
COF	Certificate of Fitness.
COMDT (CG-5P)	Coast Guard Assistant Commandant for Prevention Policy.
COMDT (CG-5P-TI)	Coast Guard Traveling Inspector Staff.
COMDT (CG-CVC-2)	Coast Guard Office of Commercial Vessel Compliance, Port State Control Division.
COMDT (CG-ENG)	Coast Guard Office of Design and Engineering Standards.
CS	Cargo systems.
CSR	Continuous Synopsis Record.
CSSC	Cargo Ship Safety Certificate.
CSSCC	Cargo Ship Safety Construction Certificate.
CV	Cargo area ventilation.
DFDE	Dual fuel diesel electric.
DHS	Department of Homeland Security.
DOI	Declaration of Inspection.
ECR	Engine control room.
EEBD	Emergency escape breathing devices.
EGC	Code for the Existing Ships Carrying Liquefied Gases in Bulk.

EPL	Equipment protection level.
ES	Electrical systems.
ESD	Emergency shutdown.
FC-T	FORCECOM Training Division.
FC-Tptc	FORCECOM Performance Technology Center, Performance Intervention Branch.
FF	Firefighting Systems.
FGCE	Foreign gas carrier examiner.
FORCECOM	Coast Guard Force Readiness Command.
FSS	Fire Safety Systems.
FU	Follow up.
GA	Annual survey.
GC Code	Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.
GCU	Gas combustion unit.
GF	Gas fuel.
GH	General health.
GI	Initial survey.
GIn	Intermediate survey.
GR	Renewal survey.
GUU	Gas utilization unit.

GVU	Gas valve unit.
HD	High duty.
HSSC	Harmonized System of Survey and Classification.
ICS	International Chamber of Shipping.
IAS	Integrated Automation System.
ICOF	International Certificate of Fitness.
IDHL	Immediate danger to life and health.
IE	Instrumentation.
IEC	International Electrotechnical Commission.
IGC Code	International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk.
IGS	Inert gas systems.
IMO	International Maritime Organization.
IOPP	International Oil Pollution Prevention.
IP	Ingress protection.
IPP NLS	International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk.
IMDG	International Maritime Dangerous Goods.
IR	Infrared.
LD	Low duty.

LEL	Lower explosive limit. LEL (U.S.) is synonymous with LFL (international).
LFL	Lower flammable limit.
LGC NCOE	Liquefied Gas Carrier National Center of Expertise.
LM	Logs and manuals.
LNG	Liquefied natural gas.
LPG	Liquefied petroleum gas.
LS	Lifesaving equipment.
LSA	Life-saving appliance.
M_3	Cubic meters.
MARPOL	International Convention for the Prevention of Pollution from Ships.
MARVS	Maximum allowable relief valve setting.
MFAG	Medical First Aid Guide.
MGV	Master gas valve.
MISLE	Marine Information for Safety and Law Enforcement.
MLA	Marine loading arm.
MI	Marine inspector.
MSC	Marine Safety Center.
MSM	Marine Safety Manual.
MSU	Marine safety unit.

N_2	Nitrogen.
NFPA	National Fire Protection Association.
NH_4	Ammonia.
NLS	Noxious liquid substances.
O_2	Oxygen.
Observe	To witness, watch carefully.
OCMI	Officer in charge, marine inspections.
OIC	Officer-in-charge.
P&A Manual	Procedures & Arrangements Manual.
PE	Pre-exam.
PFD	Personal flotation device.
PID	Photo ionization detectors.
PQS	Performance qualification standards.
PPE	Personnel protective equipment.
PPM	Parts per million.
PRG	Plan Review Guidelines.
PSC	Port state control.
PSCE	Port state control examiner.
PSCO	Port state control officer.

psi	Pounds per square inch.
RM	Risk management.
RO	Recognized Organization.
RO-RO	Roll on-roll off.
SCBA	Self-Contained Breathing Apparatus.
SDS	Safety data sheet.
SIGTTO	Society of International Gas Tanker and Terminal Operators Limited.
SMPEP	Shipboard Marine Pollution Emergency Plan.
SMS	Safety Management System.
SOE	Subchapter “O” Endorsement.
SOLAS	Safety of Life at Sea.
ST	Steam turbine.
STCW	Standards of Training, Certification and Watchkeeping.
TXV	Thermal expansion valve.
TTP	Tactics, techniques, and procedures.
VCM	Vinyl chloride monomer.
VCS	Vapor Collection System.
Verify	To confirm or establish the accuracy or truth of something.
USCG	United States Coast Guard.

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Appendix B:
IGC Code Equivalency Table

Use the tables in this appendix as a guide for finding the equivalent cites between the two versions of the IGC Code.

Cells filled with an "-" indicate that no equivalent regulation exists for the 1993 edition of the IGC Code.

Highlighted cells found in the tables indicate that there are changes to the section between the 1993 and the 2016 editions of the IGC Code.

Chapter 1					
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
1.1.1	1.1.1	1.2	1.1.10	1.5.4.4	1.4.4.4
1.1.2	1.1.2.1	1.2	1.1.11	1.5.5.1	1.4.5.1
-	1.1.2.2	-	1.1.12	1.5.6.1	1.4.6.1
-	1.1.2.3	1.3	1.2	1.5.6.2.1	1.4.6.2.1
1.1.3	1.1.3	1.4.1	1.3.1	1.5.6.2.2	1.4.6.2.2
1.1.4.1	1.1.4.1	1.4.2	1.3.2	1.5.6.2.3	1.4.6.2.3
1.1.4.2	1.1.4.2	1.5.1.1	1.4.1.1	1.5.6.3	1.4.6.3
1.1.4.3	1.1.4.3	-	1.4.1.2	1.5.6.4	1.4.6.4
1.1.4.4	1.1.4.4	1.5.1.2	1.4.1.3	1.5.6.5	1.4.6.5
1.1.5	1.1.5	1.5.1.3	1.4.1.4	1.5.6.6	1.4.6.6
1.1.6	1.1.6.1	1.5.1.4	1.4.1.5	1.5.6.7	1.4.6.7
-	1.1.6.2	1.5.2.1	1.4.2	1.5.6.8	1.4.6.8
-	1.1.6.3	1.5.3.1	1.4.3.1	1.5.6.9	1.4.6.9
-	1.1.6.4	1.5.3.2	1.4.3.2		
1.1.7.1	1.1.7.1	1.5.3.3	1.4.3.3		
1.1.7.2	1.1.7.2	1.5.4.1	1.4.4.1		
1.1.8	1.1.8	1.5.4.2	1.4.4.2		
-	1.1.9	1.5.4.3	1.4.4.3		

Chapter 2			
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
2.1.1	2.1.1	2.6.3	2.4.3
2.1.2	2.1.2	-	2.4.4
2.1.3	2.1.3	2.7.1	2.5.1
2.1.4	2.1.4	2.7.2	2.5.2
-	2.1.5	2.7.3	2.5.3
2.2.1	2.2.1	2.7.4	2.5.4
2.2.2	2.2.2	2.7.5	2.5.5
2.2.3	2.2.3	2.7.6	2.5.6
2.2.4	2.2.4	2.7.7	2.5.7
2.2.5	2.2.5	2.7.8	2.5.8
-	2.2.6	2.8.1	2.6.1
-	2.2.7	2.8.2	2.6.2
2.4	2.2.8	2.9	2.7
2.5.1	2.3	2.9.1	2.7.1
2.5.2.1	2.3.2.1	2.9.2	2.7.2
2.5.2.2	2.3.2.2		
2.6	2.4.1		
2.6.2	2.4.2		

Chapter 3							
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
3.1.1	3.1.1	3.3.1.2	3.3.2	-	3.5.6	-	3.8.4.3
3.1.2	3.1.2	3.3.1.3	3.3.3	3.6.1/2/5	3.6.1	3.8.4	3.8.4.4
3.1.3	3.1.3	3.3.2	3.3.4	-	3.6.2	3.8.5	3.8.5
-	3.1.4	3.3.3	3.3.5	3.6.3	3.6.3	3.8.7	3.8.6
-	3.1.5	3.3.3	3.3.6	3.6.4	3.6.4	3.8.8	3.8.7
3.1.4	3.1.6	-	3.3.7	3.6.4	3.6.5		
3.1.7	3.1.7	3.4.1	3.4.1	3.6.6	3.6.6		
3.2.1	3.2.1	3.4.2	3.4.2	3.6.7	3.6.7		
3.2.2	3.2.2	3.4.3	3.4.3	3.7.1.1	3.7.1		
3.2.3	3.2.3	3.5.1	3.5.1	3.7.1.2	3.7.2		
3.2.4	3.2.4.1	3.5.2	3.5.2	3.7.2.1	3.7.3		
3.2.4	3.2.4.2	3.5.3	3.5.3.1	3.7.2.2	3.7.4		
3.2.4	3.2.4.3	3.5.3	3.5.3.2	3.7.4	3.7.5		
-	3.2.4.4	-	3.5.3.3	3.8.1	3.8.1		
3.2.5	3.2.5	-	3.5.3.4	3.8.1.1	3.8.2		
3.2.6	3.2.6	-	3.5.3.5	3.8.2	3.8.3		
-	3.2.7	3.5.4	3.5.4	3.8.4	3.8.4.1		
3.3.1.1	3.3.1	-	3.5.5	3.8.4	3.8.4.2		

Chapter 4

1993 IGC Code	2016 IGC Code
-	4.1.1
4.2.6.1	4.1.2
4.2.7	4.1.3
4.2.4.1	4.1.4
4.2.2.1	4.1.5
4.2.1.1	4.1.6
4.2.3.1	4.1.7
4.1.2	4.1.8
-	4.2
-	4.3
4.6.4	4.3.4.3.1
4.6.7	4.3.4.3.3
-	4.4
4.7.3	4.5
4.7.2	4.6.1
4.7.4.1	4.6.2.1
-	4.6.2.2
-	4.6.2.3
-	4.6.2.4
-	4.6.2.5
4.7.5	4.6.2.6
-	4.7
4.7.6.1	4.7.2
4.6.1	4.8.1
4.6.7	4.8.2
4.6.2/4/5	4.8.3
-	4.9
-	4.10.
4.8.1	4.10.1
4.3.1.1	4.11
-	4.12
4.3.1.1	4.12.2
4.3.1.1	4.13.1
4.2.6.3	4.13.2.1
4.2.6.2	4.13.2.2
4.2.6.4	4.13.2.3
4.3.2.1	4.13.2.4
4.3.3	4.13.3

1993 IGC Code	2016 IGC Code
4.3.6.1	4.13.4.1
4.3.6.2	4.13.4.2
-	4.13.5
-	4.13.6
-	4.13.7
-	4.13.8
4.3.1.4	4.13.9
-	4.13.10
4.3.4.1	4.14.1.1
4.3.4.6	4.14.1.2
-	4.14.1.3
4.3.4.2	4.14.1.4
4.3.4.5	4.14.1.5
-	4.14.2
4.3.5.1	4.14.3.1
4.3.5.2	4.14.3.2
-	4.14.4
-	4.14.5
-	4.15
-	4.16
-	4.17.1
-	4.17.2.1
-	4.17.2.2
4.5.1.9	4.17.3
-	4.18.1.1
-	4.18.1.2
-	4.18.1.3
4.5.1.8	4.18.1.4
4.5.1.11	4.18.1.5
4.5.1.12	4.18.1.6
-	4.18.2.1
4.4.5.6	4.18.2.2
-	4.18.2.3
-	4.18.2.4
4.3.4.3	4.18.2.5
-	4.18.2.6.1
-	4.18.2.6.2
4.3.4.4	4.18.2.6.3

1993 IGC Code	2016 IGC Code
-	4.18.2.6.4
-	4.18.2.7
-	4.18.2.8
-	4.18.2.9
-	4.18.3
4.8	4.19
-	4.19.1.1
4.9.1	4.19.1.2
4.9.2	4.19.1.4
4.8.3/4	4.19.1.5
4.8.4	4.19.1.6
4.9.2/3	4.19.2.1
-	4.19.2.2
4.9.7.1	4.19.2.3
4.9.7.3	4.19.2.4
-	4.19.2.5
-	4.19.2.6
4.9.5	4.19.3.1
4.9.7.1	4.19.3.2
4.9.7.3	4.19.3.3
4.9.6	4.19.3.4
-	4.19.3.5
-	4.19.3.6
4.9.9	4.19.3.7
4.10.1.1	4.20.1.1
4.10.1.2	4.20.1.2
-	4.20.1.3
-	4.20.3.1
4.10.11	4.20.3.2
4.10.12	4.20.3.3
4.10.13	4.20.3.4
4.10.14	4.20.3.5
4.10.15	4.20.3.6
4.10.16	4.20.3.7

1993 IGC Code	2016 IGC Code
4.2.4.2	4.21.1.1
4.7.1	4.21.1.2
4.4.4.1	4.21.2.1
4.4.4.2	4.21.2.2
-	4.21.2.3
4.5.1.3	4.21.3.1
-	4.21.3.2
-	4.21.3.3
-	4.21.4.1
-	4.21.4.2
4.10.10.1	4.21.5
4.2.4.3	4.22.1.1
4.7.1	4.22.1.2
4.4.5.1	4.22.2.1
4.4.5.2	4.22.2.2
4.4.5.3	4.22.2.3
-	4.22.3.1
4.5.1.4	4.22.3.1.1
4.5.1.5	4.22.3.1.2
-	4.22.3.1.3
4.4.5.4	4.22.3.2
4.4.5.6	4.22.4.1
-	4.22.4.2
4.4.5.5	4.22.4.3
-	4.22.5.1
-	4.22.5.2
4.10.10.2	4.22.6
-	4.22.7
-	4.23.1.1
4.2.4.4	4.23.1.2
4.2.4.4	4.23.1.3
4.4.6.4	4.23.2.1.1
4.4.6.5	4.23.2.1.2
4.4.6.1.3	4.23.2.1.3

1993 IGC Code	2016 IGC Code
4.4.6.1.2	4.23.2.2
4.4.6.2	4.23.2.3
4.4.6.1	4.23.2.4
4.4.6.3	4.23.2.5
4.5.1.6	4.23.3.1
4.4.6.2.1	4.23.3.2
-	4.23.4
-	4.23.5
4.10.10.3.1	4.23.6.1
4.10.10.3.1	4.23.6.2
4.10.10.3.1	4.23.6.3
4.10.10.3.1	4.23.6.4
4.10.10.3.1	4.23.6.5
4.10.10.3.1	4.23.6.6
4.10.10.3.7	4.23.6.7
-	4.23.7
4.2.2.1	4.24.1.1
-	4.24.1.2
-	4.24.1.3
4.2.2.2	4.24.1.4
4.2.2.3	4.24.1.5
4.2.2.3	4.24.1.6
-	4.24.1.7
-	4.24.2
4.4.2.4	4.24.3
-	4.24.4.1
4.4.2.5	4.24.4.2
4.4.2.3	4.24.4.3
-	4.24.5.1
-	4.24.5.2
4.4.2.5	4.24.5.3
-	4.24.6
-	4.24.7

1993 IGC Code	2016 IGC Code
4.4.2.2	4.24.8.1
-	4.24.8.2
4.10.7	4.24.9
4.2.1.2	4.25.1.1
4.2.1.3	4.25.1.2
-	4.25.1.3
4.4.1	4.25.2
4.4.1	4.25.3.1
-	4.25.3.2
-	4.25.4
4.10.6	4.25.5
4.2.3.1	4.26.1.1
4.2.3.2	4.26.1.2
4.10.4	4.26.1.3
-	4.26.1.4
-	4.27
4.3.2.1	4.28.1.1
4.3.2.2	4.28.1.2
-	4.28.1.3
4.12	4.28.2.1
4.13	4.28.3
-	4.28.3.1
4.13.1	4.28.3.2
4.13.1	4.28.3.3
4.13.1	4.28.3.4
4.13.1	4.28.3.5
4.13.1	4.28.3.6
4.13.1	4.28.3.7
4.13.7	4.28.3.8
4.13.8	4.28.3.9

Chapter 5

1993 IGC Code	2016 IGC Code
5.2.1.1	5.1.1
5.1.2	5.1.2
-	5.1.3
-	5.2.1
3.1.5	5.2.2.1
5.2.1.5	5.2.2.2
-	5.2.2.3
5.2.1.7	5.2.2.4
3.1.6	5.3.1
3.8.1	5.3.2.1
3.8.3	5.3.2.2
-	5.3.3
-	5.3.4
5.2.3.1	5.4.1
5.2.3.3	5.4.2
5.2.3.2	5.4.3
-	5.4.4
-	5.5.1.1
-	5.5.1.2
-	5.5.2.1
5.6.1	5.5.2.2
5.6.1.2	5.5.3.1
5.6.3	5.5.3.2
5.6.1.2 5.6.6	5.5.4

1993 IGC Code	2016 IGC Code
5.6.2	5.5.5
5.2.1.6	5.5.6
-	5.5.7
5.8.1	5.6.1
5.8.2	5.6.2
5.9	5.6.3
-	5.6.4
-	5.6.5.1
-	5.6.5.2
-	5.6.5.3
-	5.6.5.4
-	5.6.5.5
-	5.6.5.6
-	5.6.6
5.2.1.2	5.7.1
5.2.1.3	5.7.2
-	5.7.3
5.2.1.4	5.7.4
5.4.1	5.8.1
5.4.2	5.8.2
5.4.3.1	5.8.3.1
5.4.3.2	5.8.3.2
5.4.5	5.8.4
5.4.4	5.8.5

1993 IGC Code	2016 IGC Code
5.4.6.1	5.9.1
5.4.6.2	5.9.2
5.4.6.3	5.9.3
3.8.3	5.10.1
-	5.10.2
-	5.10.3
-	5.11.1
-	5.11.2.1
5.2.2.1	5.11.2.2
5.2.4.2	5.11.2.3
5.2.4.3	5.11.2.4
5.2.4.1	5.11.3
-	5.11.4
5.2.5	5.11.5
5.2.4.4	5.11.6.1
5.2.4.5	5.11.6.2
-	5.11.6.3
-	5.11.6.4
5.7.1	5.11.7.1
5.7.2	5.11.7.2
5.7.3	5.11.7.3
5.2.6.1	5.12.1
5.2.6.2	5.12.2
-	5.12.3.1

1993 IGC Code	2016 IGC Code
-	5.12.3.2
-	5.12.4
5.3.2.1	5.13.1.1
5.3.2.2	5.13.1.2
5.5.1	5.13.2.1
5.5.2	5.13.2.2
5.5.3	5.13.2.3
-	5.13.2.4
5.5.4	5.13.2.5
-	5.13.3

Chapter 6

1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
6.1.9	6.1.1	6.1.4.1	6.3.2.3	6.3.4.2	6.5.3.5.2 6.5.3.5.3	-	6.5.6.6
-	6.1.2	6.1.4.2	6.3.2.4	-	6.5.3.6	6.3.7.5	6.5.6.7
-	6.1.3	6.1.6	6.3.3.1	6.3.5	6.5.4	6.3.7.6	6.5.6.8
-	6.1.4	-	6.3.3.2	6.3.6.1	6.5.5.1	-	6.6.1.1
-	6.1.5	-	6.3.4	6.3.6.2.1	6.5.5.2	-	6.6.2.1
-	6.1.6	6.2	6.4.1.1	6.3.6.3	6.5.5.3	4.11.1	6.6.2.2
6.1.2	6.2.1	6.3.1	6.5.1.1	-	6.5.5.4	4.11.2	6.6.2.3
6.1.3	6.2.2	6.3.2	6.5.2.1	6.3.6.4	6.5.5.5	-	6.6.3
6.1.8	6.2.3	6.3.3.1	6.5.3.1	6.3.7.1.3	6.5.6.1	4.10.4	6.6.4
-	6.3.1.1	6.3.3.1	6.5.3.2	6.3.7.1	6.5.6.2	4.10.3	6.6.5
6.1.5	6.3.1.2	6.3.3.1	6.5.3.3	6.3.7.1.1	6.5.6.3	-	6.7.1
6.1.4.1	6.3.2.1	6.3.3.2	6.5.3.4	6.3.7.1.2	6.5.6.4		
6.1.4.2	6.3.2.2	6.3.4.1	6.5.3.5.1	4.10.9.2.1 4.10.9.2.2	6.5.6.5		

Chapter 7

1993 IGC Code	2016 IGC Code
7.1.1	7.1.1
7.1.3	7.1.2
7.1.1.5	7.1.3
7.1.2	7.2
7.2.4	7.3.1
7.2.5	7.3.2
-	7.4
-	7.5
-	7.6
7.2.2.1	7.7
-	7.8.1
7.2.1	7.8.2
7.2.1	7.8.3
-	7.8.4

Chapter 8

1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
8.1	8.1	8.2.10	8.2.11.2	-	8.4.1.2
8.2.1	8.2.1	8.2.11	8.2.12	-	8.4.1.3
8.2.2	8.2.2	8.2.12	8.2.13	8.2.16	8.4.2
8.2.3	8.2.3	8.2.13	8.2.14	8.2.16	8.4.3.1
8.2.4	8.2.4	8.2.14	8.2.15	-	8.4.3.2
-	8.2.5.1	8.2.15	8.2.16	-	8.4.3.3
8.2.5	8.2.5.2	8.2.17	8.2.17	-	8.4.4.1
8.2.5	8.2.6	8.2.18	8.2.18	8.2.16	8.4.4.2
8.2.6	8.2.7	8.4.2	8.3.1	-	8.4.5
8.2.7	8.2.8	8.4.3	8.3.2		
-	8.2.9	8.4.4	8.3.3		
8.2.9	8.2.10	8.5	8.4.1		
8.2.10	8.2.11.1	8.5.1	8.4.1.1		

Chapter 9

1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
9.1.1	9.1.1	9.4.5	9.4.5
9.1.3	9.1.2	-	9.4.6
9.1.4	9.1.3	9.5.1	9.5.1
9.1.2	9.1.4	9.5.2	9.5.2
9.1.5	9.1.5	9.5.3	9.5.3
9.2.1/9.2.2.1	9.2.1	9.5.4	9.5.4
9.2.2.2	9.2.2		
9.2.3	9.2.3		
9.3	9.3		
9.4.1	9.4.1		
9.4.2	9.4.2		
9.4.3	9.4.3		
9.4.4	9.4.4		

Chapter 10	
1993 IGC Code	2016 IGC Code
-	10.1
10.1.2	10.2.1
10.1.3	10.2.2
10.1.4	10.2.3
10.1.5	10.2.4
-	10.2.5
-	10.2.6
10.2.4.1 10.2.5.2.1 10.2.3.2.2	10.2.7
10.2.3.2.3	10.2.8
10.2.2	10.2.9

Chapter 11						Chapter 12	
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
11.1.1	11.1.1	-	11.3.4	11.5.1	11.5.1	12.1.1	12.1.1
11.1.2	11.1.2	11.3.4	11.3.5	11.5.2	11.5.2	12.2.2	12.1.2
11.1.3	11.1.3	11.3.5	11.3.6	-	11.5.3	-	12.1.3
11.1.4	11.1.4	11.3.6	11.3.7	11.6.1	11.6.1	-	12.1.4
11.2.1	11.2.1	-	11.3.8	11.6.2	11.6.2	-	12.1.5
11.2.2	11.2.2	11.4.1	11.4.1	11.6.3	11.6.3	12.1.8	12.1.6
11.2.3	11.2.3	11.4.2	11.4.2			12.1.9	12.1.7
11.2.4	11.2.4	11.4.3	11.4.3			12.1.10	12.1.8
-	11.2.5	11.4.5	11.4.4			12.1.11	12.1.9
11.3.1	11.3.1	11.4.6	11.4.5			-	12.1.10
11.3.2	11.3.2.1	11.4.7	11.4.6			12.2	12.2.1
11.3.2	11.3.2.2	-	11.4.7			12.2	12.2.2
11.3.3	11.3.3	-	11.4.8			-	12.2.3

Chapter 13					
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
13.1.1	13.1.1	13.4.4	13.4.6	13.6.2	13.6.12
13.1.3	13.1.2	-	13.4.7	-	13.6.13
13.1.4	13.1.3	13.5.1	13.5.1	13.6.11	13.6.14
13.2.1	13.2.1	13.5.4	13.5.2	13.6.11	13.6.15
13.2.1	13.2.2	-	13.5.3	-	13.6.16
13.2.2	13.2.3	-	13.6.1	13.6.10	13.6.17
13.3.1	13.3.1	13.6.7	13.6.2	13.6.6	13.6.18
13.3.1	13.3.2	13.6.1	13.6.3	13.6.13	13.6.19
13.3.1	13.3.3	-	13.6.4	13.6.14	13.6.20
13.3.2	13.3.4	13.6.9/12	13.6.5	13.1.2	13.7.1
-	13.3.5	13.6.12	13.6.6	-	13.7.2.1
13.3.3	13.3.6	-	13.6.7	13.5.2	13.7.2.2
-	13.3.7	13.6.8	13.6.8.1	13.5.3.1	13.7.2.3
13.4.1	13.4.1	-	13.6.8.2	-	13.7.2.4
13.4.1	13.4.2	-	13.6.8.3	-	13.8
13.4.1	13.4.3	-	13.6.9	-	13.9
13.4.2	13.4.4	-	13.6.10		
13.4.3	13.4.5	-	13.6.11		

Chapter 14	
1993 IGC Code	2016 IGC Code
14.1	14.1.1
14.2.5	14.1.2
14.2.6	14.1.3
14.3.1	14.2.1
14.3.2	14.2.2
14.2.1	14.3.1
14.2.2	14.3.2
14.2.3.1	14.3.3
14.4.1	14.4.1
14.4.2	14.4.2
14.4.3	14.4.3
-	14.4.4

Chapter 15	
1993 IGC Code	2016 IGC Code
-	15.1.1
15.1.2	15.1.2
15.1.4	15.1.3
7.1.2	15.1.4
-	15.2
15.1.1	15.3
15.1.3	15.4.1
-	15.4.2
15.1.2	15.5.1
15.1.5	15.5.2
15.2	15.6.1
15.2	15.6.2
15.2	15.6.3

Chapter 16			
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
16.1.1	16.1	16.4.3	16.5.3
-	16.2.1	16.4.4	16.5.4
-	16.2.2	16.5.1	16.6.1.1
16.2.1	16.3.1	16.5.2	16.6.1.2
16.2.2	16.3.2	16.5.3	16.6.1.3
16.2.3	16.3.3	16.5.4	16.6.2.1
-	16.3.4	-	16.6.2.2
16.3.1	16.4.1.1	16.5.4	16.6.2.3
16.3.9	16.4.1.2	16.5.4	16.6.2.4
16.3.1.2	16.4.2	16.5.6	16.6.3.1
16.3.1	16.4.3	16.5.6	16.6.3.2
-	16.4.4	16.5.4	16.6.3.3
16.3.6	16.4.5	16.5.5	16.6.3.4
16.3.7	16.4.6	16.5.6	16.6.3.5
16.3.8	16.4.7	16.5.6	16.6.3.6
16.3.10	16.4.8	-	16.7
16.4.1	16.5.1	-	16.8
16.4.2	16.5.2		

Chapter 17							
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
17.1	17.1	17.13.5	17.12.5	17.16.5	17.14.5	17.20.5.1	17.18.13
17.2	17.2	17.13.6	17.12.6	17.16.6	17.14.6	17.20.5.2	17.18.14
17.3.1	17.3.1	17.13.7	17.12.7	17.16.7	17.14.7	17.20.5.3	17.18.15
17.3.2	17.3.2	17.13.8	17.12.8	17.16.8	17.14.8	17.20.6	17.18.16
17.4.1	17.4.1	17.14.1.1	17.13.1.1	17.16.9	17.14.9	17.20.7	17.18.17
17.4.2	17.4.2	17.14.1.2	17.13.1.2	17.16.10	17.14.10	17.20.8	17.18.18
17.4.3	17.4.3	17.14.1.3	17.13.1.3	17.16.11	17.14.11	17.20.9	17.18.19
17.5	17.5.1	17.14.1.4	17.13.1.4	17.17	17.15	17.20.10	17.18.20
17.9.1	17.5.2	17.14.1.5	17.13.1.5	17.18.1	17.16.1	17.20.11	17.18.21
17.9.2	17.5.3	17.14.1.6	17.13.1.6	17.18.2	17.16.2	17.20.12	17.18.22
14.4.6	17.5.4	17.14.2.1	17.13.2.1	17.18.3	17.16.3	17.20.13.1	17.18.23
14.4.5	17.5.5	17.14.2.2	17.13.2.2	17.18.4	17.16.4	17.20.13.2	17.18.24
-	17.5.6	17.14.2.3	17.13.2.3	17.18.5	17.16.5	17.20.13.3	17.18.25
-	17.5.7	17.14.3.1	17.13.3.1	17.19	17.17	17.20.14	17.18.26
17.6	17.6	17.14.3.2	17.13.3.2	17.20.1	17.18.1	17.20.15	17.18.27
17.7	17.7	17.14.4.1	17.13.4.1	17.20.2.1	17.18.2	17.20.16	17.18.28
17.8	17.8	17.14.4.2	17.13.4.2	17.20.2.2	17.18.3	17.20.17	17.18.29
17.1	17.9	17.14.4.3	17.13.4.3	17.20.2.3	17.18.4	17.20.17	17.18.30
17.11	17.1	17.14.4.4	17.13.4.4	17.20.2.4	17.18.5	17.20.17	17.18.31
17.12	17.11.1	17.14.5	17.13.5	17.20.2.5	17.18.6	17.21	17.19
17.15.1	17.11.2	17.14.6.1	17.13.6.1	17.20.2.6	17.18.7	-	17.2
17.15.2	17.11.3	17.14.6.2	17.13.6.2	17.20.3.1	17.18.8	-	17.21
17.13.1	17.12.1	17.16.1	17.14.1	17.20.3.2	17.18.9	-	17.22
17.13.2	17.12.2	17.16.2	17.14.2	17.20.3.3	17.18.10		
17.13.3	17.12.3	17.16.3	17.14.3	17.20.3.4	17.18.11		
17.13.4	17.12.4	17.16.4	17.14.4	17.20.4	17.18.12		

Chapter 18					
1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code	1993 IGC Code	2016 IGC Code
-	18.1.1	18.3.2	18.7.1.1	18.8.2	18.10.2.1.4
18.1.3	18.1.2	18.3.3	18.7.1.2	-	18.10.2.2
-	18.2.1	18.4.1	18.8.1	-	18.10.2.3
-	18.2.2	-	18.8.2	-	18.10.3.1
18.1.1	18.3.1	18.4.2	18.8.3	5.6.4	18.10.3.2
-	18.3.2	-	18.9.1	-	18.10.3.3
-	18.3.3	-	18.9.2	-	18.10.3.4
18.2.1	18.4.1	-	18.9.3	-	18.10.4
18.2.2	18.4.2	-	18.9.4	-	18.10.5
18.1.2	18.4.3	-	18.9.5	-	18.11
18.5.1	18.5	-	18.10.1	18.9	18.12
18.8.1	18.6.1	-	18.10.2.1.1		
18.8.7	18.6.2	5.6.4	18.10.2.1.2		
18.3.1	18.7.1	5.6.4	18.10.2.1.3		

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Appendix C:
Certificate of Compliance (COC), Form CG-3585

FOR TRAINING PURPOSES ONLY

DEPARTMENT OF HOMELAND SECURITY
U.S. Coast Guard
OMB No: 1625-0037

CERTIFICATE OF COMPLIANCE

Name of Vessel:	IMO Number:	Flag of Vessel:
LNG CARRIER	1234567	COUNTRY

Owner:	Operator Manager:
GAS OWNER 1234 GAS WAY SOMEWHERE, COUNTRY (IMO# 7777777)	GAS OPERATOR 4567 GAS STREET SOMEWHERE, COUNTRY (IMO# 8888888)
Gross Tonnage: 66666	**Keel Laid Date:** 01 July 2000

Type of Vessel: ☐ Passenger ☐ Oil Tanker ☐ Chemical Tanker ☒ Gas Carrier ☐ Mobile Offshore Drilling Unit (MODU) ☐ Floating Installation (FI)

For Passenger Vessels only:

☐ The maximum number of passengers is _____. The maximum allowable total persons on board is: _____.

For Tank Vessels: Deadweight Tonnage: 77777

☒ The vessel is authorized to carry into or from United States ports *(mark all that apply)*:

- ☐ the products listed on the Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk
- ☒ the products listed on the Certificate of Fitness for the Carriage of Liquefied Gases in Bulk subject to conditions noted on the attached USCG Subchapter O Endorsement (SOE)
- ☐ crude oil ☐ other petroleum products
- ☐ Category Z Noxious Liquid Substances (NLS) as noted on the vessel's International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS Certificate). DO NOT CHECK THIS BLOCK

☐ This vessel meets the double-hull construction requirements as noted on the IOPP certificate and supplements. DO NOT CHECK THIS BLOCK

☐ On N/A, this vessel must meet the U.S. double-hull design standard of 33 CFR 157.10d.

☐ This vessel's vapor collection system (VCS) has been certified as meeting the requirements of Title 46, Code of Federal Regulations, Part 39 and Title 33, Code of Federal Regulations, Section 155.750(d) by _____, under the authority of Title 46, Code of Federal Regulations, Section 39.10-13(d), for the collection of cargo vapors listed in the certification dated _____, and is therefore accepted for the collection of these vapors in the navigable waters of the United States. DO NOT CHECK THIS BLOCK

☒ This vessel is equipped with *(mark all that apply)*: ☒ segregated ballast tanks ☐ dedicated clean ballast tanks ☐ crude oil washing system.

☐ This vessel is equipped with an inert gas system that complies with the requirements of SOLAS 74 (amended) II-2/4.5.5 and 46 CFR 32. NOT CHECKED

For Floating Installations (FI): (ex. Floating Production, Storage and Offloading (FPSO) Units/Floating Production Systems (FPS)) *(see instructions)*

☐ Maximum allowable number of persons on board is _____ and the minimum number of lifeboatmen required is _____.

For MODU's only:

☐ This vessel has been examined in accordance with *(mark one)*: ☐ 33 CFR 143.207(a) ☐ 33 CFR 143.207(b) ☐ 33 CFR 143.207(c) per _____ (YR) MODU code

☐ The maximum allowable number of persons on board is _____ and the minimum number of lifeboatmen required is _____.

☐ This vessel is *(mark all that apply)*: ☐ Propelled by mechanical means ☐ Not propelled by mechanical means ☐ Equipped with Dynamic Positioning (DP)

THIS IS TO CERTIFY:

That the vessel has been examined and found to be in compliance with all applicable U.S. and international marine safety and environmental protection standards.

		Tank Vessels, Floating Installations and MODU's Annual Exam Date	Passenger Vessels Periodic Exams Due
I.M. CHARGE, CAPT Officer in Charge, Marine Inspection	01 Sep 2015 Date Issued	09/01/2016	1. _____ 2. _____ 3. _____
SECTOR ANYWHERE, USA Zone	01 SEP 2017 Date of Expiration		

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FOR TRAINING PURPOSES ONLY

EXAMINATION RECORD

(see instructions on Certificate of Compliance)

Type of Examination	Remarks	Place, Date and Port State Control Officer
COC-GAS-ANN	Vessel Examined for Issuance of COC - no deficiencies , COC issued based on SOE issued by the Marine Safety Center on 01AUG2015.	Place of examination Unit Anywhere, USA Date 01 Sep 2015 Port State Control Officer's Signature I.M. PSCO, LT, USCG
		Place of examination Unit Date Port State Control Officer's Signature
		Place of examination Unit Date Port State Control Officer's Signature
		Place of examination Unit Date Port State Control Officer's Signature
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		Place of examination Unit Date Port State Control Officer's Signature

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DEFICIENCY REPORT

(see instructions on Certificate of Compliance)

Complete only for COC exams occurring outside 12 NM (overseas, lightering zones, MODU's and Floating Installations)

1. Date of Inspection	2. OCMI Zone	3. Vessel Type
4. Vessel Name	5. IMO #	6. Inspection Type

7. COC Issued: ☐ Yes ☐ No

8. For MODU's only: ☐ NPV ☐ Priority ☐ Random

9. Drills Conducted: ☐ No ☐ Fire ☐ Abandon Vessel

10. Nature of Deficiency [1]:

No.	Description	Cite/Action Taken [2]

Vessel Representative: (print) | Signature:

USCG Inspector: (print) | Signature:

Issuing Unit Name and Address: | Unit Phone and E-mail Address:

1. This inspection was not a full survey and deficiencies listed may not be exhaustive.

2. Codes for action taken, see below: (Note: code numbers are derived from International harmonization; U.S. uses similar codes and those are reflected below)

10 Deficiency Rectified	40 Rectify within 7 days	20 Vessel expelled
15 Rectify Deficiency by next port	50 Rectify within 30 days	25 Vessel denied entry
16 Rectify within 14 days	60 Rectify def prior to movement	a To the satisfaction of Class/RO
17 Rectify Def prior to departure	66 Rectify defs prior to drilling operations	b To the satisfaction of the Administration
30 Vessel Detained	67 Rectify defs prior to continued drilling operations	c To the satisfaction of the Coast Guard
34 Operations Restricted	70 Rectify defs prior to next U.S. port after sailing foreign	

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Appendix D:
Confined Space Safety Alert 2010

R 191819Z MAR 10 ZUI ASN-ACC078001708 PSN 083185I25 FM COMDT COGARD WASHINGTON DC//CG-543// TO AIG 4901 BT UNCLAS //N05100//

SUBJ: SAFETY ALERT - CARGO COMPRESSOR ROOM ENTRIES DURING PORT STATE CONTROL EXAMS AND LAW ENFORCEMENT BOARDINGS OF LIQUEFIED PETROLEUM GAS (LPG) CARRIERS.

A. SAFETY AND ENVIRONMENTAL HEALTH MANUAL, COMDTINST M5100.47

B. OPERATIONAL RISK MANAGEMENT, COMDTINST 3500.3

C. MARINE SAFETY MANUAL VOL I CH 10, COMDTINST M16000.6 (SERIES)

D. MARITIME LAW ENFORCEMENT MANUAL M16247.1D

E. TITLE 46 CODE OF FEDERAL REGULATIONS PART 154

F. INTERNATIONAL CODE FOR THE CONSTRUCTION AND EQUIPMENT OF SHIPS CARRYING LIQUEFIED GASES IN BULK (IGC) CODE.

1. THE PURPOSE OF THIS SAFETY ALERT IS TO REMIND PERSONNEL OF THE POTENTIAL ATMOSPHERIC HAZARDS THAT MAY BE PRESENT DURING LPG CARRIER SAFETY AND SECURITY EXAMS AND BOARDINGS. THE IMPORTANCE OF UNDERSTANDING RISKS ASSOCIATED WITH HAZARDOUS CARGOS CANNOT BE OVERSTATED. STRONGLY RECOMMEND REVIEWING THIS MESSAGE AS WELL AS CG CONFINED SPACE ENTRY POLICY WITH PREVENTION AND RESPONSE PERSONNEL DURING THEIR NEXT SCHEDULED TRAINING SESSION . FIELD PERSONNEL SHOULD ALSO REVIEW REFS A - D AS THEY PROVIDE GOOD GUIDANCE ON USING RISK ASSESSMENTS AND SAFE WORK PRACTICES WHILE PERFORMING OPERATIONAL ACTIVITIES ON VESSELS WHERE HAZARDOUS ATMOSPHERES MAY BE PRESENT .

2. DURING A RECENT CERTIFICATE OF COMPLIANCE EXAM ON A LPG CARRIER TRANSPORTING BUTADIENE A MARINE CHEMIST DETECTED A CONCENTRATION OF BUTADIENE IN THE CARGO COMPRESSOR ROOM THAT WAS WELL ABOVE THE ESTABLISHED TIME WEIGHTED AVERAGE (TWA) AND SHORT TERM EXPOSURE LIMIT (STEL). THE CAUSE WAS CONTRIBUTED TO A CARGO LEAK THAT WAS SAFELY REPAIR ED BY THE VESSEL'S CREW. THE ATMOSPHERE WAS RECHECKED AND CERTIFIED SAFE BY THE MARINE CHEMIST BEFORE COAST GUARD PORT STATE CONTROL OFFICERS (PSCOS) ENTERED.

3. COAST GUARD POLICY DOES NOT REQUIRE MARINE CHEMIST CERTIFICATES PRIOR TO ENTERING CARGO COMPRESSOR ROOMS AS THEY ARE NORMALLY LOCATED ON OR ABOVE THE MAIN DECK, ARE WELL VENTILATED AND ARE ROUTINELY ENTERED BY THE VESSEL'S CREW. CARGO COMPRESSOR ROOMS ARE CONSIDERED ENCLOSED SPACES AND ARE DEFINED AS GAS DANGEROUS SPACES IN REFS E AND F AS THEY MAY CONTAIN OXYGEN DEFICIENT, FLAMMABLE AND/OR OXIC ATMOSPHERIC HAZARDS DUE TO CARGO LEAKS. A THOROUGH RISK ASSESSMENT SHOULD BE COMPLETED WITH APPROPRIATE COUNTERMEASURES EMPLOYED TO ENSURE A SAFE ATMOSPHERE BEFORE ENTERING. ALTHOUGH CARGO COMPRESSOR ROOMS HAVE FIXED FLAMMABLE GAS DETECTION SYSTEMS INSTALLED, THESE SYSTEMS SHOULD NOT BE RELIED ON FOR ENTRY DECISIONS. PORTABLE EQUIPMENT SPECIFICALLY DESIGNED FOR TESTING ATMOSPHERES SHOULD BE USED TO DETERMINE IF A CARGO COMPRESSOR ROOM IS SAFE TO ENTER.

4. AT A MINIMUM THE RISK ASSESSMENT AND COUNTERMEASURES SHOULD INCLUDE THE FOLLOWING:

A. REVIEW THE MATERIAL SAFETY DATA SHEETS (MSDS) FOR THE CARGO CARRIED AND UNDERSTAND THE POTENTIAL HAZARDS.

B. VERIFY THAT THE INSTALLED FIXED DETECTION SYSTEM IS PROPER LY CALIBRATED, OPERATING AS DESIGNED WITH NO CURRENT ALARMS INDICATED.

C. VERIFY THE CARGO COMPRESSORS ARE OFF.

D. VERIFY THE CARGO COMPRESSOR ROOM VENTILATION SYSTEM IS IN GOOD CONDITION AND OPE RATING PROPERLY FOR AT LEAST 30 MINUTES AFTER THE COMPRESSORS ARE OFF.

E. REVIEW AND FOLLOW THE VESSEL'S SHIPBOARD OCCUPATIONAL HEALTH AND SAFETY PROGRAM FOR COMPANY MANDATED PROCEDURES TO BE FOLLOWED PRIOR TO ENTERING THE CARGO COMPRESSOR ROOM AND/OR ENCLOSED SPACES.

F. VERIFY THE VESSEL'S OFFICER DESIGNATED TO CONDUCT ATMOSPHERIC TESTING (NORMALLY THE CHIEF OFFICER) HAS ADEQUATE TRAINING AND MAINTAINS GOOD TESTING EQUIPMENT CALIBRATION RECORDS . HAVE THE MAINTAINS GOOD TESTING EQUIPMENT CALIBRATION RECORDS . HAVE THE DESIGNATED OFFICER DEMONSTRATE HIS/HER ABILITY TO CONDUCT CALIBRATION TESTS. ENSURE TEST EQUIPMENT IS NOT EXPIRED (E.G., 02 SENSOR, DRAEGER TUBES).

G. FROM OUTSIDE THE SPACE, WITNESS CARGO COMPRESSOR ROOM ATMOSPHERIC TESTING BY THE DESIGNATED OFFICER IN ACCORDANCE WITH THE SHIPBOARD PROCEDURES. VERIFY ATMOSPHERIC LEVELS ARE WITHIN ACCEPTABLE RANGES AND IF THE VESSEL HAS TOXIC CARGO ONBOARD VERIFY THAT NO TOXIC LEVELS ARE DETECTED.

5. ONCE SATISFIED WITH THE ABOVE ITEMS THE CARGO COMPRESSOR ROOM CAN BE ENTERED WITH REQUIRED PPE IN ACCORDANCE WITH EXISTING POLICY GUIDELINES (EEBA CARRIED, 4 GAS METER ON EACH PERSON ENTERING). ENSURE THE VENTILATION IS ON AND THE COMPRESSORS ARE OFF. THE DESIGNATED OFFICER SHALL ENTER BEFORE CG PERSONNEL. CREW SAFETY/RESCUE PERSONNEL AND VESSEL'S EMERGENCY/RESCUE EQUIPMENT SHALL REMAIN AVAILABLE OUTSIDE THE SPACE. MINIMIZE THE NUMBER OF CG PERSONNEL ENTERING AND LENGTH OF TIME IN THE COMPRESSOR ROOM. IMMEDIATELY EVACUATE THE SPACE SHOULD ANY CONDITIONS CHANGE (E.G., VENTILATION SECURED OR COMPRESSOR STARTED).

6. SHOULD THE PSCO OR BOARDING OFFICER DETERMINE A MARINE CHEMIST IS NEEDED AS A RESULT OF THE. ASSESSMENT AND/OR INABILITY TO EMPLOY COUNTERMEASURES (E.G., CREW NOT ADEQUATELY TRAINED, TOXIC GAS DETECTED AT ANY LEVEL, EQUIPMENT NOT CALIBRATED , INADEQUATE VENTILATION) THE SPACE SHOULD NOT BE ENTERED BY CG PERSONNEL UNTIL A MARINE CHEMIST OR (IF AT SEA) A GAS FREE ENGINEER VERIFIES THE CARGO COMPRESSOR ROOM IS SAFE FOR ENTRY AND PARAGRAPHS 4.A THRU 4.E HAVE BEEN SATISFIED .

7. NOTE: BUTADIENE IS A TOXIC AND HAZARDOUS SUBSTANCE THAT IS PRODUCED THROUGH THE PROCESSING OF PETROLEUM AND IS MAINLY USED IN PRODUCTION OF SYNTHETIC RUBBER BUT IS ALSO FOUND IN SMALLER AMOUNTS PRODUCTION OF SYNTHETIC RUBBER BUT IS ALSO FOUND IN SMALLER AMOUNTS IN PLASTICS AND FUELS. IN 1996 THE EXPOSURE LIMITS FOR BUTADIENE WERE REDUCED FROM A TWA OF 1000 PPM TO 1 PPM. THE COAST GUARD WILL WORK TO ENSURE REFS E AND F ARE UPDATED ACCORDINGLY.

8. FOR ADDITIONAL INFORMATION CONTACT THE OFFICE OF VESSEL ACTIVITIES (CG- 5432), LCDR DAN GAINOR (202)372-1236 OR THE OFFICE OF ENVIRONMENTAL HEALTH (CG-1132), CDR LAURA WEEMS (202)475-5216.

9. INTERNET RELEASE IS AUTHORIZED.

10. CAPT ERIC CHRISTENSEN, CHIEF, OFFICE OF VESSEL ACTIVITIES, SENDS. BT

NNNN

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Appendix E:
Example Subchapter O Endorsement (SOE)

MSC Project: P0#####
Serial: C1-#######
Month DD, YYYY

CERTIFICATE OF COMPLIANCE ENDORSEMENT
(SUBCHAPTER O ENDORSEMENT)
for

_____ , IMO No. 5555555

1. VALIDITY

This Subchapter O Endorsement is valid only when attached to the vessel's valid Certificate of Compliance and only when accompanied by a valid IMO International Gas Code (Resolution MSC.5(48)) Certificate of Fitness.

2. CERTIFICATION

a. The subject vessel's current IMO International Gas Code (Resolution MSC.5(48)) Certificate of Fitness is the basis for this Subchapter O Endorsement. A valid copy of the certificate is required on board the vessel at all times to maintain the validity of the Certificate of Compliance and Subchapter O Endorsement. If the certificate has been updated, a copy of the updated certificate shall be presented to the cognizant Coast Guard Officer in Charge, Marine Inspection (OCMI) at the vessel's next U.S. port of call.

b. The requirements to notify the Marine Safety Center are detailed in paragraph 8 below. If any changes to the cargo containment system, list of authorized cargoes on the IMO Certificate of Fitness, or deficiencies exist with the cargo containment system, notify the Marine Safety Center immediately at the postal address, e-mail address, or fax below:

Commanding Officer (MSC-3)
U.S. Coast Guard Marine Safety Center
2703 Martin Luther King Jr. Ave SE
Washington, DC 20593-7430
Or
E-mail to: msc@uscg.mil

c. Only the cargoes listed in the paragraph 4 below entitled "Cargoes Authorized" may be carried in U.S. waters. Adjustment to this list may be made only by forwarding an updated IMO Certificate of Fitness that reflects the desired cargoes to the Marine Safety Center.

d. Evidence must be available on board the vessel that the periodic surveys required by section 1.5.2 of the International Gas Code have been completed.

3. CARGO CONTAINMENT SYSTEM

The cargo containment system is acceptable subject to the following restrictions:

a. Maximum allowable relief valve settings (MARVS):

Main Tanks: #1-4, Independent Type A / B (Moss-Rosenberg, MHI Hull Nos. 2283, 2286) / C, Membrane (GTT Mk.III, GTT No.96, GTT CS1): 0.25 bar gauge (25 kPa gauge, 3.63 psig)
0.25 bar gauge (25 kPa gauge, 3.63 psig) at sea
0.45 bar gauge (45 kPa gauge, 6.53 psig) in harbour

Deck Tanks: Independent Type C: 18 bar gauge (1800 kPa gauge, 261 psig)

b. Minimum temperature: -50 °C (-58 °F)

c. Certification from the classification society must be onboard the vessel attesting to the set pressure of the cargo tank relief valves and the date verified.

4. CARGOES AUTHORIZED

Unless specifically prohibited by a paragraph of this endorsement entitled "Special Restrictions," the cargoes listed below are authorized for carriage in U.S. waters. These cargoes must be carried in accordance with any additional restrictions contained in this Endorsement.

a. Acetaldehyde
b. Ammonia, anhydrous
c. Butadiene
d. Butane
e. Butane/propane mixtures
f. Butylenes
g. C-4 mixtures
h. Carbon dioxide
i. Diethyl ether
j. Dimethylamine
k. Dimethyl ether
l. Ethane
m. Ethylamine
n. Ethyl chloride
o. Ethylene
p. Ethylene oxide
q. Ethylene oxide/propylene oxide mixtures (containing a maximum of 30% ethylene oxide)
r. Isoprene
s. Isopropylamine
t. Methane (LNG)
u. Methyl acetylene- propadiene mixture
v. Methyl bromide
w. Methyl chloride
x. Monoethylamine
y. Nitrogen
z. Pentanes (all isomers)
aa. Pentenes (all isomers)
bb. Propane
cc. Propane, commercial
dd. Propylene
ee. Propylene oxide
ff. Refrigerant
gg. Sulfur dioxide
hh. Vinyl chloride
ii. Vinyl ethyl ether
jj. Vinylidene chloride

5. CARGOES NOT LISTED

Cargoes for which a Subchapter O Endorsement is required are indicated in Table 1 of 46 CFR 153 and in Table 4 of 46 CFR 154. Cargoes for which a Subchapter O Endorsement is not required are listed in Table 2 of 46 CFR 153. Cargoes not authorized by this Subchapter O Endorsement nor listed in Table 2 of 46 CFR 153 must be specifically authorized by the Marine Safety Center (MSC-3) before carriage is permitted in U.S. waters.

6. GENERAL CARRIAGE REQUIREMENTS

The carriage of all cargoes listed in the vessel's IMO Certificate shall be in accordance with the requirements of the International Gas Code, Resolution MSC.5(48) as amended, the Certificate of Fitness, and all Coast Guard requirements.

7. CARGO COMPATIBILITY

Incompatible cargoes shall be stowed in accordance with paragraph 18.2 of the International Gas Code. Title 46, Code of Federal Regulations, Part 150, Subpart A-Compatibility of Cargoes, shall be consulted to determine cargo compatibility.

8. REPORTS TO THE MARINE SAFETY CENTER (MSC-3)

a. Any alterations, damage, or system failure of the cargo containment system of the vessel must be promptly reported to the Marine Safety Center (MSC-3) prior to the next U.S. port of call. A report describing any damages or system failures must also specify any corrective action taken. Examples of reportable occurrences include, but are not limited to, involvement in a significant marine casualty that affects the vessel's hull or cargo containment system, cargo piping, tank damage or leaks, failure of fire protection equipment, failure of leak detection equipment, failure of the nitrogen inerting system including cargo inter-barrier nitrogen pressure regulators, failure of cargo handling equipment, and/or failure of the main propulsion equipment for LNG carriers.
b. Remit an updated IMO Certificate of Fitness to make any changes to the list of cargoes reflected in paragraph 4 above titled "Cargoes Authorized." The vessel must obtain an updated Subchapter O Endorsement from the Marine Safety Center prior to carriage of any new cargoes.

9. SUBCHAPTER O ENDORSEMENT INVALIDATION

The Subchapter O Endorsement (SOE) will become invalid under the following conditions:

a. The subject vessel's IMO Certificate of Fitness is invalidated as a result of a marine casualty affecting the vessel's cargo containment system; or
b. The subject vessel cannot show proof of a valid IMO Certificate of Fitness prior to calling or returning to a U.S. port; or
c. A Coast Guard representative considers the vessel unsuitable for carriage of the authorized cargoes and invalidates the SOE and/or the Certificate of Compliance (COC). Examples of unsuitable conditions include, but are not limited to involvement in a significant marine casualty that affects the vessel's hull or cargo containment system, cargo piping, tank damage or leaks, failure of fire protection equipment, failure of leak detection equipment, failure of the nitrogen inerting system including cargo inter-barrier nitrogen pressure regulators, and failure of cargo handling equipment.

10. REISSUANCE OF SOE AND COC

Upon normal expiration of the Certificate of Compliance, contact the Officer in Charge Marine Inspection (OCMI) at the nearest U.S. Coast Guard Marine Inspection or Marine Safety Office to arrange for a vessel examination. To avoid any vessel delays when an examination is required, at least seven days advance notice must be provided to the OCMI. If the SOE becomes invalid due to the conditions in paragraph 9.a or 9.b above, contact the Marine Safety Center (MSC-3) well in advance of any planned port arrival. If the conditions in paragraph 9.c apply, contact the Marine Safety Center (MSC-3) otherwise the OCMI has the authority to invalidate the Certificate of Compliance.

11. CERTIFICATION OF INHIBITION

For those cargoes stabilized to prevent decomposition or inhibited against self-reaction, the certification required by paragraph 17.8 of the International Gas Code must be available for presentation to Coast Guard personnel prior to loading.

12. SPECIAL RESTRICTIONS

a. Ethylene oxide is authorized for carriage subject to the following special restrictions:
   (1) Classification society certification that the required cargo piping separation has been achieved must be on board the vessel and available to Coast Guard boarding personnel.
   (2) All gaskets which may contact ethylene oxide liquid or vapor must be constructed from spirally wound stainless steel with a filler of Teflon or similar fluorinated polymer.
   (3) Neoprene, natural rubber, asbestos mixed with other materials, and materials containing oxides of magnesium (such as mineral wools) may not be used for packing, insulation and similar items in the ethylene oxide containment system and piping.

b. The following requirements apply to the carriage of ethylene oxide/propylene oxide mixtures (containing a maximum of 30% ethylene oxide):
   (1) The requirements for propylene oxide in certification item 2.a. and paragraph 12.a. above must be followed.
   (2) When this cargo is carried without refrigeration the cargo tank relief valve setting shall not be less than 120 kPa gauge (17 psig).

c. The following requirements apply to the cargo C-4 mixture:
   (1) The weight percent of acetylene may not exceed 5.0 percent.
   (2) The weight percent of propadiene may not exceed 0.5 percent.
   (3) If the weight percent of butadiene exceeds 50 percent, the C-4 Mixture must be inhibited to prevent self-reaction in accordance with paragraph 11 above.
   (4) A manufacturer's certificate specifying the composition of the cargo must be on board the vessel and available to Coast Guard boarding personnel.

d. Methyl acetylene propadiene mixtures (MAPP gas) shall be carried only in one of the two compositions specified in section 17.12.2 of the IMO Gas Code (Resolution A.328(IX)).

e. The person in charge of the transfer of vinyl chloride shall ensure that:
   (1) Fixed or portable instruments shall be used to continuously monitor for vinyl chloride vapor leaks during vinyl chloride transfer operations. The method of monitoring and measurement shall have an accuracy (with a confidence level of 95 percent) of not less than ± 50 % from 0.25 through 0.5 ppm, ± 35% from over 0.5 ppm through 1.0 ppm, and ± 25% over 1.0 ppm;
   (2) Cargo transfer operation is discontinued or corrective action is initiated by the person in charge to minimize exposure to personnel whenever a vinyl chloride vapor concentration in

excess of 1 ppm is detected. If the vinyl chloride vapor concentration exceeds 5 ppm for over 15 minutes, action to reduce the leak can be continued only if the respiratory protection requirements of 29 CFR 1910.1017 are met by all personnel in the area of the leak;

(3) Those portions of cargo lines which will be open to the atmosphere after piping is disconnected are free of vinyl chloride liquid and the vinyl chloride vapor concentration in the area of the cargo piping disconnect points is not greater than 5 ppm;

(4) Any restricted gauge fitted on a tank containing vinyl chloride is locked or sealed so that it cannot be used and a restricted gauge is not used as a check on the required closed gauge, nor as a means of sampling;

(5) The words "CANCER-SUSPECT AGENT" are added to the warning signs required by 46 CFR 154.1830, and signs bearing the legend: "CANCER-SUSPECT AGENT IN THIS AREA, PROTECTIVE EQUIPMENT REQUIRED, AUTHORIZED PERSONNEL ONLY" are posted whenever hazardous operations, such as tank cleaning, are in progress;

(6) A vessel undergoing cargo transfer operations must be designated a "regulated area" having access limited to authorized persons and requiring a daily roster of authorized persons who may board, and;

(7) Employees engaged in hazardous operations, such as tank cleaning, shall be required to wear and use respiratory protection in accordance with the provisions of 29 CFR 1910.1017 and protective garments, provided clean and dry for each use, to prevent skin contact with liquid vinyl chloride.

f. Based on the ambient design temperatures listed in the vessel's IMO Certificate of Fitness, the cargoes authorized for carriage in Paragraph 4 may not be carried in Alaskan waters.

g. Discharge of a Moss-Rosenberg model Independent Type B cargo tank by over-pressurization is only authorized with the approval of the cognizant Captain of the Port. Otherwise, the "In Harbour" MARVS listed on the vessel's IMO Certificate of Fitness are not permitted in US waters.

h. The following cargoes, listed on the IMO Certificate of Fitness, may not be carried in US waters because their vapor pressure at 45 °C (113 °F) exceeds the MARVS listed in paragraph 3:

Butane/propane mixtures (in excess of XX% propane)
Propane
Propylene

i. The following cargoes are subject to the provisions of MARPOL 73/78 Annex II. Their carriage is contingent on the vessel having on board an approved Procedures & Arrangements Manual and a valid International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk which lists these cargoes:

Diethyl ether
Ethylene oxide/propylene oxide mixtures (containing a maximum of 30% ethylene oxide)
Isoprene
Isopropylamine
Monoethylamine
Pentanes (all isomers)
Pentenes (all isomers)
Propylene oxide
Vinyl ethyl ether
Vinylidene chloride

Issuing Officer

Issue Date

Expiration Date

Appendix F:
Survey Report Example

FOR TRAINING PURPOSES ONLY

SURVEY REPORT

Classification Society
Certificate No: 123456AP
Date of issue: 1-18-18

DECLARATION OF SET POINTS AND SEALING OF PRESSURE RELIEF VALVES FOR CARGO TANKS & PIPING SYSTEMS

Name of Ship	GELU LIQUIDUS
Port of Registry	Easton, MD
Signal Letter	8HA1234
IMO Number	1234567
Gross Tonnage	23,952
Builder	Smith Building Co., Ltd
Hull No.	S123
Date on which keel was laid	06-23-1998

This is to confirm that set point and sealing of pressure relief valves for cargo tanks and piping systems have been verified by _____as stated below:

SETTINGS OF SAFETY RELIEF VALVES ON CARGO TANKS

Cargo Tank	Valve No.	Set Pressure (bar)	Maker / Type	Dimension
No.1	32PSVI 001 32PSV I002	*0.25/0.45* *0.25/0.45*	Lewallen Co. (Pilot Operated)	8"x 10"
No.2	32PSV2001 32PSV2002	*0.25/0.45* *0.25/0.45*		8"x 10"
No.3	32PSV3001 32PSV3002	*0.25/0.45* *0.25/0.45*		8"x 10"
No.4	32PSV4001 32PSV4002	*0.25/0.45* *0.25/0.45*		8" x 10"

SETTINGS OF CARGO HOLD EMERGENCY RELIEF HATCHES

Cargo Hold	Maker / Type	Set Pressure (bar)
No. I	Hansen Tech Co. / KSRH-900	*0.25*
No.2		*0.25*
No.3		*0.25*
No.4		*0.25*

Form Code: DEC 901 Revision: 2018-10 Page 1 of 1

FOR TRAINING PURPOSES ONLY

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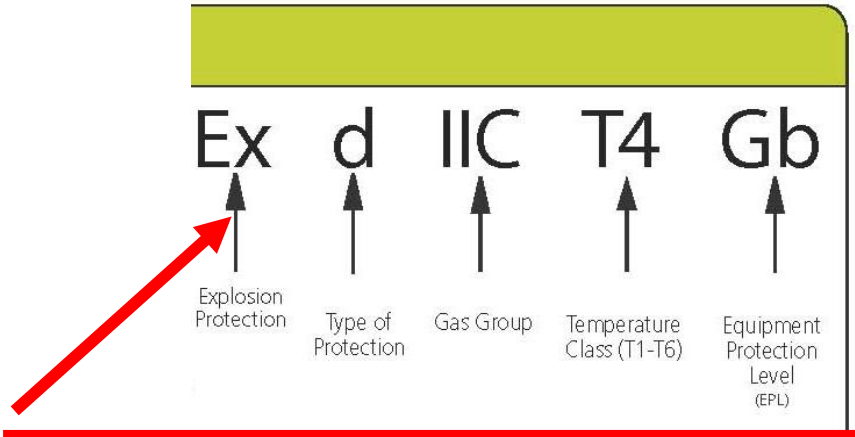
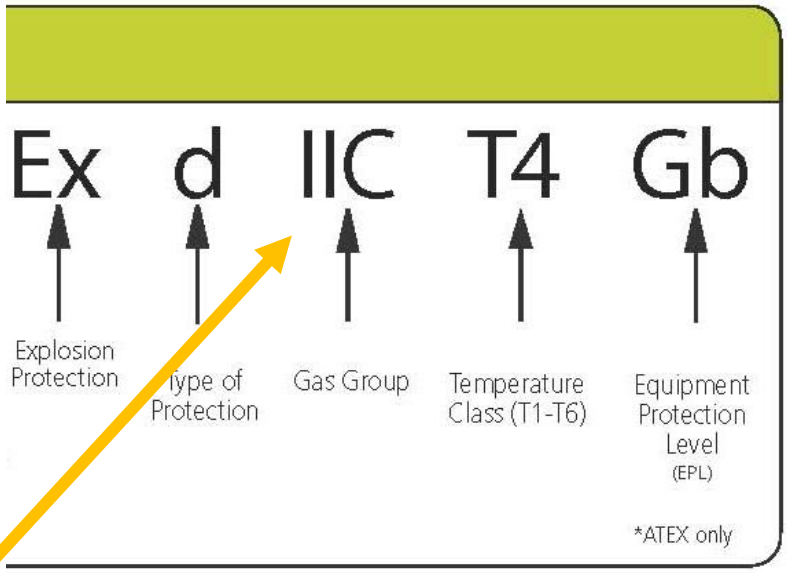
Appendix G:
Electrical Charts



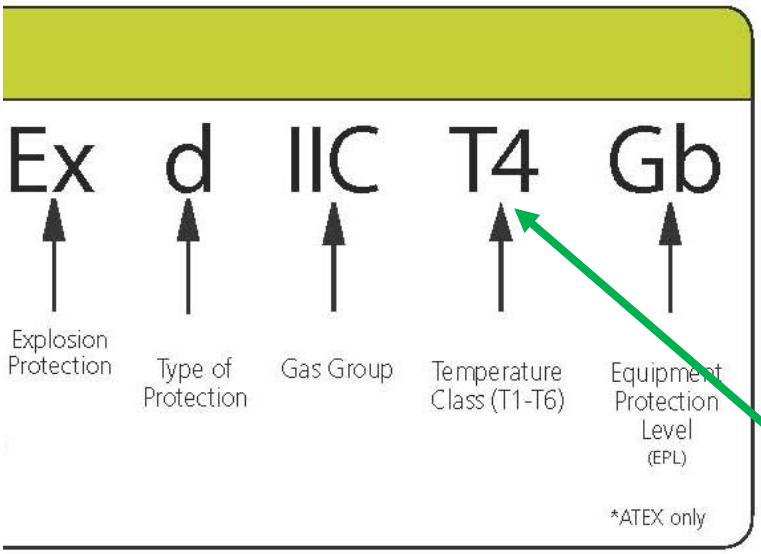
Protection Concepts [ATEX and IECEx]

Type of Protection	Symbol	Typical IEC EPL	Typical Zone(s)	IEC Standard	Basic Concept of Protection
Electrical Equipment for Gases, Vapors and Mists (G)					
General Requirements	-	-	0,1,2	IEC 60079-0	
Optical Radiation	Op pr Op sh Op is	Gb Ga Ga	1,2 0,1,2 0,1,2	IEC 60079-28 IEC 60079-28 IEC 60079-28	Inherently safe protected by shutdown
Increased Safety Type 'n' (Non-Sparking)	e nA	Gb Gc	1,2 2	IEC 60079-7 IEC 60079-15	No arcs, sparks or hot surfaces Enclosure IP54 or better
Flame-proof	d	Gb	1,2	IEC 60079-1	Contain the explosion, quench the flame
Type 'n' (Enclosed Break)	nC	Gc	2	IEC 60079-15	
Quartz/Sand Filled	q	Gb	1,2	IEC 60079-5	Quench the flame
Intrinsic Safety	ia ib ic	Ga Gb Gc	0,1,2 1,2 2	IEC 60079-11 IEC 60079-11 IEC 60079-11	Limit the energy of sparks and surface temperatures
Purged / Pressurized	px py pz	Gb Gb Gc	1,2 1,2 2	IEC 60079-2 IEC 60079-2 IEC 60079-2	Keep the flammable gas out
Type 'n' (Sealing & Hermetically Sealed)	nC	Gc	2	IEC 60079-15	
Type 'n' (Restricted Breathing)	nR	Gc	2	IEC 60079-15	
Encapsulation	ma mb mc	Ga Gb Gc	0,1,2 1,2 2	IEC 60079-18 IEC 60079-18 IEC 60079-18	
Oil Immersion	o	Gb	1,2	IEC 60079-6	



Atmosphere Groups [ATEX & IECEx]

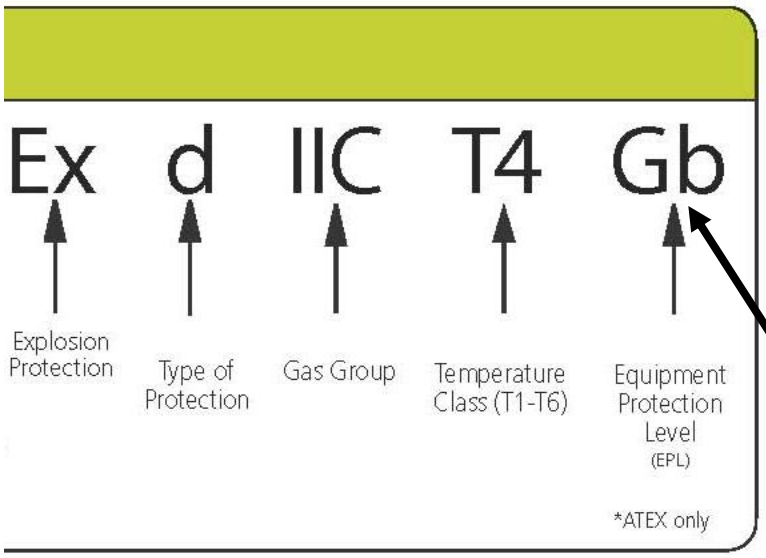
Group	Environment	Location	Typical Substance
I	Gases, Vapors and Mists	Coal Mining	Methane (Fire damp)
IIA		Surface and Other Locations	Methane, Propane, etc.
IIB			Ethylene
IIC			Hydrogen, Acetylene, etc.
IIIA	Combustible Dusts	Surface and Other Locations	Combustible flyings
IIIB			Non-conductive
IIIC			Conductive



Temperature Classification[7]

Max. Surface Temperature	NEC® 500 CEC®	NEC® 505 / IEC - Group II
450° C (842°F)	T1	T1
300° C (572°F)	T2	T2
280° C (536°F)	T2A	
260° C (500°F)	T2B	
230° C (446°F)	T2C	
215° C (419°F)	T2D	
200° C (392°F)	T3	T3
180° C (356°F)	T3A	
165° C (329°F)	T3B	
160° C (320°F)	T3C	
135° C (275°F)	T4	T4
120° C (248°F)	T4A	
100° C (212°F)	T5	T5
85° C (185°F)	T6	T6

Note 7: For Group I applications (ATEX and IECEx only), electrical apparatus has fixed temperature limits of 150°C (where layers of coal dust can form) and 450°C (where coal dust is not expected to form a layer).



Equipment Categories & Protection Levels[8]

ATEX Category	Equipment Protection Levels	Typical Equipment Zone Suitability
1 G	Ga	Suitable for Zones 0,1,2
1 D	Da	Suitable for Zones 20,21,22
2 G	Gb	Suitable for Zones 1,2
2 D	Db	Suitable for Zones 21,22
3 G	Gc	Suitable for Zone 2
3 D	Dc	Suitable for Zone 22

Ingress Protection Codes [IEC 60529]

First Number (protect from solid bodies)		Second Number (protect from water)	
0	No Protection	0	No protection
1	Objects > 50mm	1	Vertical drip
2	Objects > 12.5mm	2	Angled drip
3	Objects > 2.5mm	3	Spraying
4	Objects > 1.0mm	4	Splashing
5	Dust-Protected	5	Jetting
6	Dust-Tight	6	Powerful jetting
		7	Temporary immersion
		8	Continuous immersion
		9	High pressure and temperature water jet

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Appendix H:
COMDT (CG-5P) Port State Control Information for Nov - Dec 2015 Command Email of 18 Dec 15

Subject: Port State Control Information for NOV-DEC 2015

D. Certificate of Compliance Exams on Foreign Liquefied Gas Carriers.

It was brought to the attention of our office that there are inconsistencies in how units interpret the 30 second requirement for emergency shutdown (ESD) valves to fully close on Foreign Liquefied Gas Carriers. There are some units that interpret "actuation" to mean activation of the ESD button and others that interpret "actuation" to mean activation of the ESD valve(s). In accordance with The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases, Chapter 5, regulation 6.4; "Emergency shutdown valves in liquid piping should fully close under all service conditions with 30 s of actuation." While the term "actuation" is not defined by IMO, feedback from The Society of International Gas and Terminal Operators, interprets this requirement to mean when the ESD button is pushed. Ideally, during the cargo systems portion of the Certificate of Compliance exam, PSC personnel should observe the emergency shutdown valve(s) fully closing in 30 seconds from the time the ESD button is pushed. This time requirement provides a balance between prompt valve closing in the event of fire and still guarding against potential liquid hammer caused by excessively rapid valve closure. Note, if there is an undue delay between pushing the ESD button and the start of valve actuation, there may be a problem that should be corrected. The operating characteristics of the ESD system should be referenced in the vessel's Cargo Operations Manual and should be in line with this requirement.

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Appendix I:
Deficiencies Example – Port State Control Report of Inspection - Form B, Form CG-5437B

FOR TRAINING PURPOSES ONLY

DEPARTMENT OF HOMELAND SECURITY
U.S. Coast Guard
PORT STATE CONTROL REPORT OF INSPECTION - FORM B

MISLE Activity Number: 8675309
Exam Type: PSC/ISPS

In accordance with IMO Port State Control Procedures and the International Ship & Port Facility Security (ISPS) Code

1. Reporting Country: United States of America

2. Name of Ship: Ice Ice Gas Carrier | 3. IMO Number: 1234567

4. Date of Inspection: Today | 5. Place of Inspection: Any Port U.S.

6. Nature of Deficiency[1]:

No.	Code	Description	Cite (Convention)	(Action Taken)[2]
01	1138	A ventilation hood or casing should be provided for areas occupied by flanges, valves, etc., and for the gas fuel piping, at the gas fuel utilization units, such as boilers, diesel engines or gas turbines. The ventilation hood or casing should be installed or mounted to permit the ventilation air to sweep across the gas utilization unit and be exhausted at the top of the ventilation hood or casing. Port state control officers discovered the ventilation in the ventilation hood was of the positive type, preventing gas leaks from being swept outside of the space.	74 SOLAS 2014 con. VII IGC 1993/12.1.2/12.1.5	30AC
02	1138	Gas detection equipment acceptable to the administration and suitable for the gases to be carried should be provided in accordance with column f in the table of chapter 19. PSCOs observed 02 fixed gas sampling points in the lower compressor room were covered and modified from their original design.	74 SOLAS 2014 con. VII IGC 1993/17.8	30AC
03	1138	Cargo compressor and pump rooms and in cargo control rooms if considered gas dangerous, the ventilation should be of the negative type. The No.2 ventilation fan for the compressor room creates positive pressure. When both fans are running, it creates a neutral ventilation condition instead of the required negative ventilation.	74 SOLAS 2014 con. VII IGC 1993/12.1.2/12.1.5	30AC

Copy provided to: _____ *(Printed name of Master/Vessel representative)* Signature: _____

Name of PSCO: LT Methane Dan *(Printed name of duly authorized PSCO of reporting authority)* Signature: _____

Issuing Unit Name, Address, and e-Mail:

Copies forwarded to: *Check as appropriate*
☐ Agent ☐ Ship Management
☐ Flag State ☐ Recognized Organization
☐ Recognized Security Organization

Reviewed by Supervisor
Name: Date:
Signature:

[1] This inspection was not a full survey and deficiencies listed may not be exhaustive. In the event of a detention, it is recommended that a full survey is carried out and all deficiencies are rectified before an application for re-inspection is made.

[2] Codes for action taken, see below: *(Note: code numbers are derived from International harmonization; U.S. uses similar codes and those are reflected below.)*

10	Deficiency Rectified	17	Rectify deficiencies prior to departure	20	Ship expelled
15	Rectify deficiencies by next port	60	Rectify deficiencies prior to movement	25	Ship denied entry
16	Rectify deficiencies within 14 days	40	Rectify deficiencies prior to next US port after sailing foreign	a.	To the satisfaction of RO/RSO
50	Rectify deficiencies within 30 days	30	Ship detained	b.	To the satisfaction of the Administration
				c.	To the satisfaction of the Coast Guard

CG-5437B (09/17) Page ____ of ____

FOR TRAINING PURPOSES ONLY


UNITED STATES COAST GUARD
FORCE READINESS COMMAND