SUB-COMMITTEE ON HUMAN ELEMENT, TRAINING AND WATCHKEEPING
1st session
Agenda item 3

HTW 1/3/2
22 November 2013
Original: ENGLISH

VALIDATION OF MODEL TRAINING COURSES

Model Course – Basic Training for Liquefied Gas Tanker Cargo Operations

Note by the Secretariat

SUMMARY

Executive summary:	This document provides the draft of a revised model course on Basic Training for Liquefied Gas Tanker Cargo Operations
Strategic direction:	5.2
High-level action:	5.2.2
Planned output:	5.2.2.5
Action to be taken:	Paragraph 3
Related documents:	STW 40/14 and STW 44/3/8

1 Attached in the annex is a revised draft model course on Basic Training for Liquefied Gas Tanker Cargo Operations.

2 As instructed by the Sub-Committee at its forty-fourth session, this model course was referred to the course coordinators for further revision, to reflect closely the requirements of the 2010 Manila Amendments.

Action requested of the Sub-Committee

3 The Sub-Committee is invited to consider the above information and take action, as appropriate.

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ANNEX

DRAFT IMO MODEL COURSE ON BASIC TRAINING FOR LIQUEFIED GAS TANKER CARGO OPERATIONS

MODEL COURSE

1.04

BASIC TRAINING FOR LIQUEFIED GAS TANKER CARGO OPERATIONS

ACKNOWLEDGEMENTS

This course for Basic Training for Liquefied Gas Tanker Cargo Operations is based on material developed by Anglo Eastern Maritime Training Centre, Mumbai for IMO.

IMO wishes to express its sincere appreciation to the Government of India for its provision of expert assistance, valuable cooperation in support of this work.

Contents

Introduction

■ Purpose of the model courses

The purpose of the IMO model courses is to assist maritime training institutes and their teaching staff in organizing and introducing new training courses, or in enhancing, updating or supplementing existing training material where the quality and effectiveness of the training courses may thereby be improved. The purpose is also to enhance the capabilities of shipboard personnel who sail on specialized carriers such as liquefied gas tankers. It is not the intention of the course to compartmentalize the trainee's way of thinking in terms of tanker operation. The idea is to make him/her aware of the specialization of operations specific to a liquefied gas tanker and, sensitize him/her towards the responsibilities that s/he will face on such a vessel.

It is not the intention of the model course programme to present instructors with a rigid "teaching package" which they are expected to "follow blindly". Nor is it the intention to substitute audio-visual or "programmed" material for the instructor's presence. Rather, this document should be used as a guide with the course duration given as indicative of the expected time required to cover the required outcomes. The parties may modify this course to suit their respective training schemes.

As in all training endeavors, the knowledge, skills and dedication of the instructors are the key components in the transfer of knowledge and skills to those being trained through IMO model course material.

Because educational systems and the cultural backgrounds of trainees in maritime subjects vary considerably from country to country, the model course material has been designed to identify the basic entry requirements and trainee target group for each course in universally applicable terms, and to specify clearly the technical content and levels of knowledge and skills necessary to meet the technical intent of IMO conventions and related recommendations.

This basic course is for all personnel serving on board liquefied gas tankers in the support and operational level for the cargo handling in port and care in transit. By successfully completing this course, the aforementioned shipboard personnel will fulfill the mandatory minimum requirements of Regulation V/1-2 para. 2 of STCW 1978, as amended. The coverage of the model course is wide in scope and includes liquefied gas tanker safety, fire safety measures and firefighting systems, prevention and control of pollution, safe operational practices and obligations under applicable laws and regulations.

In order to keep the training programme up to date in future, it is essential that users provide feedback. New information will provide better training in safety at sea and protection of the marine environment. Information, comments and suggestions should be sent to the Head of the STCW and Human Element Section at IMO, London.

■ Use of the model course

The instructor should review the course plan and detailed syllabus, taking into account the information provided under the entry standards specified in the course framework. The actual level of knowledge and skills and the prior technical education of the trainees should be kept in mind during the review, and any areas within the detailed syllabus which may cause difficulties because of differences between the actual trainee entry level and that assumed by the course designers should be identified. To compensate for such differences, the instructor is expected to delete from the course, or to reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. S/he should also identify any academic knowledge, skills or technical training which they may not have acquired.

The instructor, using his/her professional judgment, can analyze the detailed syllabus and the academic knowledge required to allow training in the technical area to proceed. The instructor can then design the appropriate pre-entry course or alternatively, insert the elements of academic knowledge required to support the technical training elements concerned at appropriate points within the course.

Adjustment of the course objective, scope and content may also be necessary if in a country's maritime industry the trainees completing the course are to undertake duties which differ from the course objective specified in the model course.

Within the course plan the course designers have indicated assessment of the time which should be allotted to each area of learning. However, it must be appreciated that these allocations are arbitrary and assume that the trainees have fully met all entry requirements of the course. The instructor should therefore review these assessments and may need to reallocate the time required to achieve each specific learning objective or training outcome.

■ Aims

This course provides training to candidates to be duly qualified under section A-V/1-2 of the STCW code with specific duties and responsibilities related to cargo or cargo equipment on liquefied gas tankers. It comprises a basic training programme appropriate to their duties, including basic training for liquefied gas tanker safety, fire safety measures, pollution prevention, operational practice and obligations under applicable law and regulations. The course covers the competence requirements as given in the table A-V/1-2-1 of the STCW Code adopted by the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 as amended.

Any of this training may be given on board or ashore. It could be either by practical instruction on board or in a suitable shore-based installation.

During the course, there will be:

- Familiarization with the equipment and instrumentation used for cargo handling on a liquefied gas tanker
- A greater awareness of the need of proper planning, the use of checklists involved in the various cargo handling operations
- An enhanced awareness to follow and safe procedures at all times when carrying out the various operations on board a liquefied gas tanker
- Follow procedures and instructions to promote safety and protect the marine environment
- To coordinate during emergencies

■ Lesson plans

After adjusting the course content, if so required, to suit the trainee intake and any revision of the course objectives, the instructor can then draw up lesson plans based on the detailed syllabus. The detailed syllabus contains specific references to the textbooks or teaching material proposed to be used in the course. Where no adjustment has been found necessary in the acquisition of knowledge and proficiency of the detailed syllabus, the lesson plans may simply consist of the detailed syllabus with keywords or other reminders added to assist the instructor in making his/her presentation of the material.

■ Presentation

The presentation of concepts and methodologies must be repeated in various ways by assessing and evaluating the trainee's performance and achievements until it satisfies the instructor, that the trainee has attained the required proficiency under each specific learning objective or training objective. The syllabus is laid out in the form of acquiring knowledge, understanding and proficiency format and each objective specifies that the trainee must be able to do as the learning or training outcome. Holistically, these objectives aim to meet the knowledge, understanding and proficiency specified in the appropriate tables of the STCW Code.

■ Implementation

For the course, to run smoothly and to be effective, considerable attention must be paid to the availability and use of:

- Properly qualified instructors
- Support staff
- Rooms and other spaces
- Equipment
- Textbooks, technical papers ,and
- Other reference material

Thorough preparation on part of the instructor is the key to successful implementation of the course. IMO has produced a booklet entitled "Guidance on the Implementation of IMO Model Courses", which deals with this aspect in greater detail and which is appended to this model course.

In certain cases, the requirements for some or all of the training in a subject are covered by another IMO model course. In these cases, the specific part of the STCW Code which applies is given and the user is referred to the other model course.

■ Guidance to course developers and instructors

The liquefied gas tanker safety section covers hazards involved in cargo operations, and constructional features of liquefied gas tankers to control the hazards.

Cargo operations include operational requirements for loading / unloading and ballasting, including the use of the inert gas systems.

Instructors should emphasize in their teaching the hazards involved in the operations on board liquefied gas tankers. They should explain, in as much detail as necessary to ensure these operations are undertaken safely, the systems, equipment and constructional features that exist to control those hazards.

Instructors should keep in mind that some of the topics in this model course are also included in the model course for the Officer in Charge of a Watch in the function controlling the Operation of the Ship and Care for the Persons on Board. These topics may therefore be treated as a revision of earlier learning.

Entrants should have completed an approved shore-based fire prevention and firefighting course (STCW chapter VI, section A-VI/1, para. 2.1.1.2), and hence firefighting principles in section 12.0 are an extension of the basic firefighting training carried out as per STCW Table A-VI/1-2.

■ Training and STCW 2010 Amendments

The standards of competence that have to be met by seafarers are defined in part A of the STCW Code in the standards of Training, Certification and Watchkeeping for Seafarers Convention, as amended in 2010. This IMO model course has been revised and updated to cover the STCW 2010 amendments. It sets out the education and training to achieve those standards.

Operational requirements for any candidate taking part in loading, unloading and care in transit or handling of cargo on liquefied gas tankers are detailed in Regulation V/1-2, para. 2 of the STCW Code. This model course aims to provide a basic training programme referred to in Table A-V / 1-2-1 of the STCW code, appropriate to these duties.

For ease of reference, the course is divided into separate sections.

Part A provides the framework for the course with its aims and objectives and notes on the suggested teaching facilities and equipment. A list of useful teaching aids, IMO references and textbooks is also included.

Part B provides an outline of lectures, demonstrations and exercises for the course, together with a suggested sequence and timetable. From the teaching and learning point of view, it is more important that the trainee achieves the minimum standard of competence defined in the STCW Code than that a strict timetable for each topic is followed. Depending on their experience and ability, some students will naturally take longer to become proficient in some topics than others.

Part C gives the Detailed Teaching Syllabus. This is based on the theoretical and practical knowledge specified in the STCW Code. It is presented in a logical sequence, starting with basic knowledge and information on physical properties, hazards and control safety and pollution prevention. Each subject area is covered by a series of required performances, in other words what the trainee is expected to be able to do as a result of the teaching and training. In this way the overall required performance of knowledge, understanding and proficiency is met. IMO references, textbook references and suggested teaching aids are included to assist the teacher in designing lessons.

Part D contains an Instructor Manual. Against each heading in the detailed teaching syllabus the teaching guidelines have been divided into:

- Key concepts to be delivered
- Lecture suggestions
- Simulation/Table-top exercises.

It is envisaged that such micro level division of each heading in the teaching syllabus will give the instructor, with varied backgrounds around the world, ample guidelines on developing his/her work plan, as well as the flexibility to adapt keeping in mind the level of the trainees. Furthermore, additional notes as well as simulator exercises for instructors who may have access to a liquid-cargo-handling simulator have also been provided.

The Convention defines the minimum standards to be maintained in part A of the STCW Code. Mandatory provisions concerning Training and Assessment are given in section A-I/6 of the STCW Code. These provisions cover: qualifications of instructors, supervisors and assessors. Assessment of competence and Training is assessed within an institution. A corresponding part B of the STCW Code contains non-mandatory guidance on training and assessment.

This course explains the use of various methods of demonstrating competence and criteria for evaluating competence as tabulated in the STCW Code and may be helpful in developing any necessary assessments that can include a form of a written examination. As a further aid to the instructor therefore, suggestions have been made on how to create specific objective type question paper for this course. In case a simulator is being used for training pertaining to this model course, then it is suggested that this form of assessment be independent of the assessment done on the simulator.

■ Responsibilities of Administration

Administrations should make sure that training courses delivered by approved training providers are such as to ensure officers and ratings completing training do meet the standards of competence required by STCW Regulation V/1-2 par 2.

■ Validation

The Sub-Committee on Standards of Training and Watchkeeping has validated the information contained in this document for use by technical advisors, consultants and experts for the training and certification of seafarers so that the minimum standards implemented may be as uniform as possible, "Validation", in the context of this document, means that the Sub Committee has found no grounds to object its content. The Sub-Committee has not granted its approval to the document, as it considers that this work must not be regarded as an official interpretation of the Convention.

In reaching a decision in this regard, the Sub-Committee was guided by the advice of a validation group comprised of representatives designated by IMO.

Part A: Course Framework

■ Scope

This course provides training for officers and ratings. It comprises a basic training programme appropriate to their duties for liquefied gas tanker safety, fire safety measures and cargo systems, pollution prevention, safe operational practices and obligations under applicable laws and regulations. The course takes full account of section A-V/1-2 of the STCW Code adopted by the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended.

This training may be given on board or ashore. It can be either by practical training on board or wherever possible on simulators in training institutions or in a suitable shore-based installation.

■ Objective

Provided they hold an appropriate certificate and are otherwise qualified in accordance with section A–VI/1 of STCW convention 78 as amended, those successfully completing the basic training for liquefied gas tanker cargo operations course should therefore be able to carry out specific duties during loading, unloading and care in transit or handling of cargo on liquefied gas tankers. They will make a safer and more effective contribution to the operation on a liquefied gas tanker, which will improve the ship safety and provide greater protection to the environment.

■ Entry standards

This course is principally intended for candidates for certification for basic training for liquefied gas tanker cargo operations as specified in section A-V/1-2 para. 1 of the STCW Code as amended.

■ Course certificate

All who are qualified in basic training for liquefied gas tanker cargo operations programme in accordance with regulation V/1-2 paragraphs 1 or 2 shall be issued with a certificate of proficiency.

■ Course intake limitations

The number of trainees should not exceed 20 and practical training should be undertaken in small groups of not more than eight.

■ Staff requirements

The instructor shall have appropriate training in instructional techniques and training methods (STCW Code A-I/6, para. 7). It is recommended that all training and instruction is given by qualified personnel experienced in the handling and characteristics of liquefied gas cargoes and the safety procedures involved. Staff may be recruited among deck and engineer officers of liquefied gas tankers, and/or fleet superintendents as appropriate.

■ Teaching facilities and equipment

Ordinary classroom facilities and an overhead projector are sufficient for most of the Course. However, dedicated CBT modules to be run on an ordinary PC as well as exercises on an operational, hands-on liquid cargo handling simulator, will greatly enhance the quality and result of the course. In such cases sufficient PCs for use by one or two trainees will be required. In addition, a video player will be required if using videos in the teaching program.

The following equipment should be available:

1. Resuscitator
2. Breathing apparatus
3. Portable oxygen meter
4. Portable combustible-gas detector
5. Portable tankscope/Multi point flammable gas (infra- red gas analyzer)
6. Portable toxic-gas detector and chemical absorption tubes
7. Portable multigas – detector
8. Personal multigas – detector
9. Tank evacuation equipment.

■ Use of Simulators

The revised STCW Convention sets standards regarding the performance and use of simulators for mandatory training, assessment or demonstration of competence. The general performance standards for simulators used in training and for simulators used in assessment of competence are given in section A-I/12. Simulator -based training and assessment is not a mandatory requirement for this Basic training for liquefied gas tanker course. However, it is widely recognized that well-designed lessons and exercises can improve the effectiveness of training.

If using simulator-based training, instructors should ensure that the aims and objective of these sessions are defined within the overall training program and that tasks are selected so as to relate as closely as possible to shipboard tasks and practices. part D included herein gives the sample exercises which can be performed to enhance the learning process. Instructors should refer to STCW, section A-I/12, part 1 and 2.

■ Fixed Dry Chemical Powder Firefighting System

To enable the trainees to undergo practical exercises and firefighting using fixed DCP systems, a firefighting mock-up will be needed to conduct realistic drills of extinguishing a LPG / LNG fire by activating the fixed extinguishing system and using the correct techniques in simulated shipboard conditions to extinguish the fire. A typical fixed DCP firefighting installation for carrying out such training is provided in annex 2.

■ Design

The core technical and academic knowledge, understanding and proficiency are set out in Table A-V/1-2-1 of the STCW as amended in 2010, adopted by IMO as part of the 2010 STCW Convention as shown below:

***Standard* of competence:**

1. Every candidate for certification in basic training for liquefied gas tanker cargo operations shall :

.1 demonstrate the competence to undertake the tasks, duties and responsibilities listed in column 1 of table A-V/1-2-1; and

.2 provide evidence of having achieved:

 .2.1 the minimum knowledge, understanding and proficiency listed in column 2 of table A-V/1-2-1, and

 .2.2 the required standard of competence in accordance with the methods for demonstrating competence and the criteria for evaluating competence tabulated in columns 3 and 4 of table A-V/1-2-1.

The content of the Model course is designed to suit the trainers teaching this course for optimum delivery, ensuring high degree of consistency and adherence to STCW 2010 standards leading to certification in basic training for liquefied gas tanker cargo operations.

The flow of topics mentioned in part C, is thus reflecting, how the trainer should design their course and delivery and is for guidance only.

To show consistency and adherence to STCW 2010, as given in table A-V/1-2-1, a mapping is provided below for easy reference from STCW's competences and training outcomes to the topics covered in this Model course.

Mapping - Topics in this course with STCW table A-V/1-2-1

STCW 2010 Table A-V/1-2-1 Mapping of IMO Model course 1.04topics

STCW 2010 Table A-V/1-2-1				IMO Model course 1.04		
S.No	**Competence**	**Knowledge, Understanding and Proficiency**		**S.No**	**Topic**	**Sub-topics**
1	**Contribute to the safe operation of a liquefied gas tanker**	**1.0 Basic knowledge of liquefied gas tankers:** .1 types of liquefied gas tankers .2 general arrangement and construction		1	**Basic knowledge of liquefied gas tankers**	1.1 Types of liquefied gas tankers 1.2 General arrangement and construction
		2.0 Basic knowledge of cargo operations: .1 piping systems and valves .2 cargo handling equipment .3 Loading, unloading and care in transit. .4 emergency shutdown ESD System .5 tank cleaning, purging, gas freeing and inerting		2	**Basic knowledge of cargo operations**	2.1 Piping systems and valves 2.2 Cargo handling equipment 2.3 Loading, unloading and care in transit. 2.4 Emergency shutdown ESD System 2.5 Tank cleaning, purging, gas freeing and inerting
		3.0 Basic knowledge of the physical properties of liquefied gases including: .1 properties and characteristics .2 pressure and temperature; Including vapour pressure/temperature relationship .3 types of electrostatic charge generation .4 chemical symbols		3	**Basic knowledge of the physical properties of liquefied gases**	3.1 Properties and characteristics 3.2 Pressure and temperature; Including vapour pressure/temperature relationship 3.3 Types of electrostatic charge generation 3.4 Chemical symbols

STCW 2010 Table A-V/1-2-1				IMO Model course 1.04		
S.No	**Competence**	**Knowledge, Understanding and Proficiency**		**S.No**	**Topic**	**Sub-topics**
		4.0 Knowledge and understanding of tanker safety culture and safety management		**4**	**Knowledge and understanding of tanker safety culture and safety management**	
2	**Take precautions to prevent hazards**	**5.0 Basic knowledge of the hazards associated with tanker operations, including:** .1 health hazards .2 environmental hazards .3 reactivity hazards .4 corrosion hazards .5 explosion and flammability hazards .6 sources of ignition, .7 electrostatic hazards .8 toxicity hazards .9 vapour leaks and clouds .10 extremely low temperatures .11 pressure hazards		**5**	**Basic knowledge of the hazards associated with tanker operations**	5.1 Health hazards 5.2 Environmental hazards 5.3 Reactivity hazards 5.4 Corrosion hazards 5.5 Explosion and flammability hazards 5.6 Sources of ignition, 5.7 Electrostatic hazards 5.8 Toxicity hazards 5.9 Vapour leaks and clouds 5.10 Extremely low temperatures 5.11 Pressure hazards
		6.0 Basic knowledge of hazard controls: .1 inerting, drying and monitoring techniques .2 anti-static measures .3 ventilation .4 segregation .5 cargo inhibition .6 importance of cargo compatibility .7 atmospheric control .8 gas testing		**6**	**Basic knowledge of hazard controls**	6.1 Inerting, drying and monitoring techniques 6.2 Anti-static measures 6.3 Ventilation 6.4 Segregation 6.5 Cargo inhibition 6.6 Importance of cargo compatibility 6.7 Atmospheric control 6.8 Gas testing

STCW 2010 Table A-V/1-2-1				IMO Model course 1.04		
S.No	**Competence**	**Knowledge, Understanding and Proficiency**		**S.No**	**Topic**	**Sub-topics**
		7.0 Understanding of information on a Material Safety Data Sheet (MSDS)		**7**	**Understanding of information on a Material Safety Data Sheet (MSDS)**	
3	**Apply occupational health and safety precautions and measures**	**8.0 Function and proper use of gas-measuring instruments and similar equipment**		**8**	**Function and proper use of gas-measuring instruments and similar equipment**	
		9.0 Proper use of safety equipment and protective devices, including: .1 breathing apparatus and tank-evacuating equipment .2 protective clothing and equipment .3 resuscitators .4 rescue and escape equipment		**9.0**	**Proper use of safety equipment and protective devices**	9.1 Breathing apparatus and tank-evacuating equipment 9.2 Protective clothing and equipment 9.3 Resuscitators 9.4 rescue and escape equipment
		10.0 Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers including: .1 precautions to be taken when entering enclosed spaces .2 precautions to be taken before and during repair and maintenance work .3 safety measures for hot and cold work .4 electrical safety .5 ship/shore safety checklist		**10.0**	**Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers**	10.1 Precautions to be taken when entering enclosed spaces 10.2 Precautions to be taken before and during repair and maintenance work 10.3 Safety measures for hot and cold work 10.4 Electrical safety 10.5 Ship/shore safety checklist

STCW 2010 Table A-V/1-2-1				IMO Model course 1.04		
S.No	**Competence**	**Knowledge, Understanding and Proficiency**		**S.No**	**Topic**	**Sub-topics**
		11.0 Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)		**11**	**Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)**	
4	**Carry out firefighting operations**	12.1 Tanker fire organization and action to be taken 12.2 Special hazards associated with cargo handling and transportation of liquefied gases in bulk 12.3 Firefighting agents used to extinguish gas fires 12.4 Fixed firefighting foam system operations 12.5 Portable firefighting foam operations 12.6 Fixed dry chemical system operations 12.7 Basic knowledge of spill containment in relation to firefighting operations		**12**	**Fire safety and firefighting operations**	12.1 Tanker fire organization and action to be taken 12.2 Special hazards associated with cargo handling and transportation of liquefied gases in bulk 12.3 Firefighting agents used 12.4 Fixed firefighting foam system operations 12.5 Portable firefighting foam operations 12.6 Fixed dry chemical system operations 12.7 Basic knowledge of Spill containment in relation to firefighting operations
5	**Respond to emergencies**	**13.0 Basic knowledge of emergency procedures including emergency shutdown**		**13**	**Basic knowledge of emergency procedures including**	**Basic knowledge of emergency procedures including emergency shutdown**

STCW 2010 Table A-V/1-2-1				IMO Model course 1.04		
S.No	**Competence**	**Knowledge, Understanding and Proficiency**		**S.No**	**Topic**	**Sub-topics**
					emergency shutdown	
6	**Take precautions to Prevent pollution of the environment from the release of liquefied gases**	**14.0 Basic knowledge of the effects of pollution on human and marine life**		**14**	**Basic knowledge of the effects of pollution on human and marine life**	**Basic knowledge of the effects of pollution on human and marine life**
		15.0 Basic knowledge of shipboard procedures to prevent pollution		**15**	**Basic knowledge of shipboard procedures to prevent pollution**	
		16.0 Basic knowledge of measures to be taken in the event of spillage, including the need to: .1 report relevant information to the responsible persons .2 assist in implementing shipboard spill-containment procedures .3 prevent brittle fracture		**16**	**Basic knowledge of measures to be taken in the event of spillage**	16.1 Report relevant information to the responsible persons 16.2 Assist in implementing shipboard spill-containment procedures 16.3 Prevent brittle fracture

■ Teaching aids (A)

Note: - Other equivalent teaching aids may be used as deemed fit by the instructor.

A1 Instructor's Manual (part D of this course)
A2 Overhead projector and diagrams in Appendix 1 to instructor manual
A3 CD Player for Videos
A4 Liquefied Gas Tanker Cargo and Ballast Water Handling Simulator

■ IMO references (R)

R1 SOLAS 1974, International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974) as amended
R2 STCW 78 as amended, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers,
R3 MARPOL 73/78, International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL 73/78) Consolidated Edition 2011
R4 IG Systems, Inert Gas Systems (IMO-860E)
R5 MFAG Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (IMO-251E)
R6 IGC Code, International Code for the Construction and Equipment of Ships Carrying liquefied gases in Bulk (IGC Code), as amended (IMO-100E)
R7 ISM Code, International Safety Management Code (ISM Code) (IMO-117E)
R8 IMO Model Course 1.20 Fire Prevention and Firefighting
R9 IMO Model Course 1.35 Liquefied Petroleum Gas (LPG) tanker cargo and ballast handling simulator.
R10 IMO Model Course 1.36 Liquefied Natural Gas (LNG) Tanker Cargo and Ballast Handling Simulator.

Details of distributors of IMO publications that maintain a permanent stock of all IMO publications may be found on the IMO website at http://www.imo.org

■ Text Book (T)

T1 SIGTTO, Liquefied Gas Handling Principles on Ships and in Terminals, 3rd ed. (London, Witherby and Company Ltd.)
T2. Basic Tanker Work for Oil, Chemicals, LPG and LNG, Ed.2013
Capt. K S D Mistree, MEHEREX Publication, 21, Royal Accord IV, Lokhandwala Road, Andheri (w), Mumbai - 400 053. India. Tel.: 91 9821369865

■ Bibliography (B)

B1 Tanker Safety Guide Liquefied Gas, International Chamber of Shipping, 2nd ed. 95.
B2 Ship to Ship Transfer Guide (Liquefied Gas), International Chamber of Shipping/Oil Companies International Marine Forum, (London, Witherby and Co. Ltd., 2005)

B3 Draeger-Tube Handbook, 11th ed. (Drager Sicherheitstechnik GmbH, Revalstrasse 1, D-23560 Lubeck, Germany, 1998) (ISBN 3-926762-06-3)

B4 Code of Safe Working Practices, PO Box 29, Norwich, NR3 1GNTelephone orders/General enquiries: 0870 600 5522 Fax orders: 0870 600 5533E-mail: customer.services@tso.co.uk Textphone 0870 240 3701

B5 Tanker Management Self-Assessment, Witherby Publications , 32/36 Aylesbury street London.. www.witherbys.com ISBN 10: 1905331231 ISBN 13: 9781905331239

B6 Liquefied Gas Carriers : Your Personal Safety Guide – SIGTTO, 2nd Edition – December 2012. ISBN No: 13:978-1-85609-572-3

B7 LNG operational practice Witherbys Publishing, Seamanship International I32/36 Aylesbury street London. www.witherbys.com ISBN 1856093212

B8 Tanker safety Training (Liquefied Gas) Specialized Level Witherbys Publishing, Seamanship International I32/36 Aylesbury street London. www.witherbys.com, ISBN-10:1856093417

B9 LPG Shipping Suggested Competency Standards, SIGTTO, Witherbys Seamanship International, Jan 2008 edition (www.witherbys.com)

B10 LNG Shipping Suggested Competency Standards, SIGTTO, Witherbys Seamanship International, 2nd edition, Dec 2008 (www.witherbys.com)

■ Videos (VG)

VG1. An introduction to Liquefied Gas Carriers (Catalogue code 103)
VG2. Cargo firefighting on Liquefied Gas Carriers. (Catalogue code 254)
VG3. Permit to Work (Catalogue code 621)
VG4. Portable Gas detectors. (Catalogue code 650)
VG5.The chemistry of liquefied gases.
VG6.The physics of liquefied gases

Available from: Videotel Marine International

84 Newman Street, London W1T 3EU, UK
Tel: +44(0) 20 72991800
Fax: +44(0) 207299 1818
e-mail: mail@videotelmail.com
URL: www.videotel.co.uk

VG7.Firefighting, basic and advanced (DVD# 2036)
VG8 Static electricity on board Tankers (DVD# 3203).
VG9 Enclosed space entry-Hazard awareness (DVD# 3025).
VG10 Enclosed space entry- Safe entry procedures (DVD# 3026)
VG11 Enclosed space entry- Rescue drill procedures (DVD# 3027)
VG12 Low temperature insulation on gas carriers (CBT#0099)
VG13 Gas measurement (CBT#0048)

Available from:

Seagull AS
Gamleveien 36
P.O. Box 1062
N-3194 Horten, Norway
Phone: +47 33 03 09 10
Fax: +47 33 04 62 79
Email: **seagull@sgull.com**

VG14 Medical emergencies at sea.
VG15 Enclosed space entry- Rescue drill procedures

Available from:

Maritime Training Services
1900 West Nickerson Street Suite 205
Seattle, WA 98119, **USA**
Phone: +1-206-467-8458
info@maritimetraining.com

Part B: Course Outline and Timetable

■ Lectures

As far as possible, lectures should be presented within a familiar context and should make use of practical examples. They should be well illustrated with diagrams, photographs and charts where appropriate, and be related to matter learned during seagoing time.

An effective manner of presentation is to develop a technique of giving information and then reinforcing it. For example, first tell the trainees briefly what you are going to present to them; then cover the topic in detail; and, finally, summarize what you have told them. The use of an overhead projector and the distribution of copies of the transparencies as trainees handouts contribute to the learning process. The areas where the Instructors can use various instructional methods while delivering the course are broadly recognized as:

- **Classroom (Lecturing and explaining)**

  Explanation of topics encompassed within part C – Detailed teaching syllabus of this model course is the most used instructional method. This type of method is often referred to as "the lecture method", "presentation" or "chalk and talk", although nowadays the blackboards are mostly replaced by whiteboards and the chalks by whiteboard markers. In some institutions which have embraced technology, "interactive whiteboards" have replaced traditional whiteboards taking full advantage of what these boards offer. The software supplied with the interactive whiteboard usually allows the Instructors to keep notes and annotations as an electronic file for later distribution either on paper or through a number of electronic formats. Although the chalks gets replaced by using a pen, finger, stylus or other device, the expression "chalk and talk" remains the same.

- **Laboratory/Classroom/Simulator (Demonstration/Exercises)**

  The topics identified to be taken up as practical's in the course outline that follows, can be taught by demonstration method. Like explanation method mentioned above, this method is always linked in some way to other instructional strategies. The Instructor would need to identify very clearly what is the activity, and then would need to perhaps break it down in various steps. In case the trainees are allowed to practice, then proper supervision for assessment would be required, which will require the whole class to be divided into various groups, with every group being supervised by Instructors, qualified to conduct this course.

  Traditional methods of instruction have been largely adopted for maritime training courses, however with the advancement of technology and reducing costs, the industry is witnessing the increasing introduction of technology into the classrooms, including the use of simulation technology.

  The use of simulators provides a learning platform where all three elements of learning; knowledge, skill and attitude can be integrated into a valuable learning experience.

  The Manila Amendments to the STCW Convention have also embraced the use of simulators for training, evaluation and assessment of competence. It is therefore important that the potential for utilizing this valuable training tool is realized to the maximum.

It is suggested that relevant topics of cargo operation which are marked with an Asterisk (*) in the course outline that follows, should be taught on a simulator. When the simulator sessions are used to cover the topics mentioned in this course, then the method of assessment that can be used is also provided in the Part E of this Model course and is for guidance only.

When simulators are used for training and assessing competence, the Instructors are guided to the STCW 2010 requirements with relation to simulators and to the training and assessment. The Simulator should conform to the requirements of STCW 2010 Regulation I/12 (use of simulators), section A-I/12, parts 1 and 2, Performance Standards for the simulator and simulator training objectives and sections B I/12, (guidance regarding the use of simulators). The training and assessment should conform to the requirements of STCW 2010 Regulation I/6 (training and assessment), section A-I/6, training and assessment (mandatory) 4.3.1, 4.3.2 and 6.5 and section B-I/6 (guidance regarding training and assessment).

In case simulators cannot be used owing to unavailability of such facility within the training institute, table top exercises could be conducted using screenshots of some topics have been appended in Part D - Instructor's Manual for assisting the training. These screen shots can be incorporated in power point presentations or projected on board, to elucidate understanding and thus assist effective teaching and learning to take place.

- **Classroom (Case studies)**

Case studies which form supporting instructional methods can be incorporated within the core methods mentioned above or used as the major method for developing certain types of learning in a session covering certain topic. Group work, questioning, discussion and role-play are also some of the examples of supporting instructional methods, which the Instructors can incorporate and use in a lesson.

Case studies, appended in part D of this model course is a capture of a real life situation. Instructors are requested to carefully select the case-studies that will form a part of training of this model course. Cases should typically provide information outlining a problem based scenario, where decisions involving value judgments are involved. Although the information actually provided within cases can vary considerably with some containing very detailed and comprehensive information, whereas others simply documenting the key elements of a situation, the latter is preferred.

The Instructors should ensure that whichever case studies they incorporate within their lesson plan, it should be interesting and appropriate for the level of trainees attending the course.

- **Firefighting Mock-up**

Existing installations for firefighting training as part of the basic safety training for all seafarers (as per STCW Reg VI/1 and section A-VI/1-2) may be used for gas firefighting practical exercises. However the installations may need to be enhanced with the fitting of Fixed Dry Chemical Powder Firefighting System as well as the construction of a fire pit with piped LPG gas leading to it.

The gas may be leaked in a controlled manner and ignited to create a gas flame which can then be extinguished by the trainees on activating the fixed dry chemical powder system.

As a guidance, a typical fixed DCP firefighting installation for carrying out such training detailed in section 12.6 is provided in annex 2.

- **Course Outline**

The tables that follow, list the competencies and areas of knowledge, understanding and proficiency, together with the estimated total hours required for lectures and practical exercises. Teaching staff should note that timings are suggestions only and should be adapted to suit individual groups of trainees depending on their experience, ability, equipment and staff available for training.

COURSE OUTLINE

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for exercises
	Competence 1 : Contribute to the safe operation of a liquefied gas tanker		
1.0	**Basic knowledge of liquefied gas tankers**		
1.1	Types of liquefied gas tankers	1.5	
1.2	General arrangement and construction (*)	1.5	
2.0	**Basic knowledge of cargo operations**		
2.1	Piping systems and valves (*)	1.5	
2.2	Cargo handling equipment (*)	1.5	
2.3	Loading, unloading and care in transit (*)	3.0	
2.4	Emergency shutdown(ESD) system (*)	0.5	
2.5	Tank cleaning, purging, gas freeing and inerting (*)	1.0	
3.0	**Basic knowledge of the physical properties of liquefied gases**		
3.1	Properties and characteristics (**)	0.25	
3.2	Pressure and temperature; including vapour pressure / temperature relationship	0.50	
3.3	Types of electrostatic charge generation	0.50	
3.4	Chemical symbols	0.25	
4.0	**Knowledge and understanding of tanker safety culture and safety management**	1.5	
	Competence 2 : Take precautions to prevent hazards		
5.0	**Basic knowledge of the hazards associated with tanker operations**		
5.1	Health hazards	0.30	
5.2	Environmental hazards	0.10	
5.3	Reactivity hazards	0.10	
5.4	Corrosion hazards	0.10	
5.5	Explosion and flammability hazards	0.30	
5.6	Sources of ignition	0.10	
5.7	Electrostatic hazards	0.10	
5.8	Toxicity hazards	0.10	
5.9	Vapour leaks and clouds	0.10	
5.10	Extremely low temperatures	0.10	
5.11	Pressure hazards	0.10	

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for exercises
6.0	**Basic knowledge of hazard controls**		
6.1	Inerting, drying and monitoring techniques	0.25	
6.2	Anti-static measures	0.25	
6.3	Ventilation	0.125	
6.4	Segregation	0.125	
6.5	Cargo inhibition	0.125	
6.6	Importance of cargo compatibility	0.125	
6.7	Atmospheric control	0.25	
6.8	Gas testing	0.25	
7.0	**Understanding of information on a Material Safety Data Sheet (MSDS)**	1.5	
	Competence 3: Apply occupational health and safety precautions and measures		
8.0	**Function and proper use of gas-measuring instruments and similar equipment**	0.5	
9.0	**Proper use of safety equipment and protective devices**		
9.1	Breathing apparatus and tank-evacuating equipment(#)/(**)		0.25
9.2	Protective clothing and equipment(#)/(**)		0.25
9.3	Resuscitators(#)/(**)		0.25
9.4	Rescue and escape equipment(#)/(**)		0.25
10.0	**Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers**		
10.1	Precautions to be taken when entering enclosed spaces(#)/(**)	0.5	
10.2	Precautions to be taken before and during repair and maintenance work	0.25	
10.3	Safety measures for hot and cold work	0.5	
10.4	electrical safety	0.25	
10.5	Ship/shore safety checklist(#)/(**)	1.5	
11.0	**Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)**	1.5	
	Competence 4 : Carry out fire – fighting operations		
12.0	**Fire safety and firefighting operations**		
12.1	Tanker fire organization and action to be taken(#)/(**)	0.25	

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for exercises
	12.2 Special hazards associated with cargo handling and transportation of liquefied gases in bulk	0.25	
	12.3 Firefighting agents used to extinguish gas fires(#)/(**)	0.25	
	12.4 Fixed firefighting foam system operations	0.25	
	12.5Portable firefighting foam operations (#)/(**)/(##)	0.25	1.0
	12.6 Fixed dry chemical system operations(#)/(**)/(##)	0.25	2.0
	12.7Basic knowledge of spill containment in relation to firefighting operations	0.50	
	Competence 5 : Respond to emergencies		
13.0	**Basic knowledge of emergency procedures including emergency shutdown**	0.50	
	Competence 6 : Take precautions to prevent pollution of the environment from the release of liquefied gases		
14.0	**Basic knowledge of the effects of pollution on human and marine life**	0.25	
15.0	**Basic knowledge of shipboard procedures to prevent pollution**	0.25	
16.0	**Basic knowledge of measures to be taken in the event of spillage.**		
	16.1 Report relevant information to the responsible persons	0.20	
	16.2 Assist in implementing shipboard spill-containment procedures	0.20	
	16.3 Prevent brittle fracture	0.10	
17.0	**Case Study**	1.0	
17.1	**Assessment**	1.5	
	Subtotals	29.0	4.0
	Total for the course (Includes Gas firefighting exercise)	**33.0**	

Notes

It is suggested that relevant topics which are marked with an Asterisk (*) may be taught on a simulator.

It is suggested that relevant topics which are marked with a Hash (#) may be conducted separately in any facility which can conduct practical exercises and instruction under approved and truly realistic training conditions (e.g., simulated shipboard conditions).

It is suggested that relevant topics which are marked with a double Asterisk (**) may be demonstrated practically or relevant videos to be shown for same.

The items marked with double hash (##) could be be part of a specific firefighing module or other appropriate practical firefighting training as determined by the administration. The practical exercise (3 hours) corresponding to this competence may not be carried out if the candidates have already undertaken an approved Fire prevention and Firefighting course with Gas firefighting training.

Teaching staff should note that the hours for lectures and exercises are suggestions only as regards sequence and length of time allocated to each objective. These factors may be adapted by lecturers to suit individual groups of trainees depending on their experience, ability, equipment and staff available for teaching.

Part B: Course Timetable

Teaching staff should note that timetables are suggestions only as regards to sequence and length of time allocated to each objective. Lecturers to adapt these factors to suit the needs of individual group of trainees depending upon their experience, ability and on the equipment and staff available for training: An example of the sequence for the flow in topics in the timetable is appended below:

	1st Period (1.5 Hours) **(0900 - 1030 hrs)**	**2nd Period** (1.5 Hours) **(1100 - 1230 hrs)**		**3rd Period** (1.5 Hours) **(1330 - 1500 hrs)**	**4th Period** (1.5 Hours) **(1530 - 1700 hrs)**
Day 1	1.0 Basic knowledge of liquefied gas tankers 1.1 Types of liquefied gas tankers	1.2 General arrangement and construction (*)	**MEAL BREAK (1200 – 1300 hrs)**	2.0 Basic knowledge of cargo operations: 2.1 Piping systems and valves (*)	2.2 Cargo handling equipment(*)
Day 2	3.0 Basic knowledge of the physical properties of liquefied gases 3.1 Properties and characteristics(**) 3.2 Pressure and temperature, including vapour pressure / temperature relationship 3.3 Types of electrostatic charge generation 3.4 Chemical symbols	5.0 Basic knowledge of the hazards associated with tanker operations 5.1 Health hazards 5.2 environmental hazards 5.3 Reactivity hazards 5.4 Corrosion hazards 5.5 Explosion and flammability hazards 5.6 Sources of ignition 5.7 Electrostatic hazards 5.8 Toxicity hazards 5.9 Vapour leaks and clouds 5.10 Extremely low temperatures 5.11 Pressure hazards		6.0 Basic knowledge of hazard controls 6.1 Inerting, drying and monitoring techniques 6.2 Anti-Static measures 6.3 Ventilation 6.4 Segregation 6.5 Cargo inhibition 6.6 Importance of cargo compatibility 6.7 Hydrate control 6.8 Cargo tank atmosphere monitoring	7.0 Understanding of information on a Material Safety Data Sheet (MSDS)

	1st Period (1.5 Hours) **(0900 - 1030 hrs)**	**2nd Period** (1.5 Hours) **(1100 - 1230 hrs)**		**3rd Period** (1.5 Hours) **(1330 - 1500 hrs)**	**4th Period** (1.5 Hours) **(1530 - 1700 hrs)**
Day 3	11.0 Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)	10.0 Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers 10.1 Precautions to be taken when entering enclosed spaces(#)/(**) 10.2 Precautions to be taken before and during repair and maintenance work 10.3 Safety measures for hot and cold work 10.4 Electrical safety		10.5 Ship/shore safety checklist (#)/(**)	8.0 Function and proper use of gas-measuring instruments and similar equipment 9.0 Proper use of safety equipment and protective devices 9.1 Breathing apparatus and tank evacuating equipment (#)/(**) 9.2 Protective clothing and equipment(#)/(**) 9.3 Resuscitators(#)/(**) 9.4 Rescue and escape equipment(#)/(**)
Day 4	2.4 Emergency shut Down system (ESD) (*) 2.3 Loading, unloading and care in transit (*)	2.3 Loading, unloading and care in transit (contd) (*)		2.3 Loading, unloading and care in transit(*) 2.5 Tank cleaning, purging, gas-freeing and inerting(*)	4.0 Knowledge and understanding of tanker safety culture and safety management

	1st Period (1.5 Hours) **(0900 - 1030 hrs)**	**2nd Period** (1.5 Hours) **(1100 - 1230 hrs)**		**3rd Period** (1.5 Hours) **(1330 - 1500 hrs)**	**4th Period** (1.5 Hours) **(1530 - 1700 hrs)**
Day 5	12.0 Fire safety and firefighting operations 12.1 Tanker fire organization and action to be taken(#)/(**) 12.2 Special hazards associated with cargo handling and transportation of liquefied gases in bulk 12.3 Firefighting agents used to extinguish gas fires(#)/(**) 12.4 Fixed firefighting foam system operations(**) 12.5 Portable firefighting foam operations(#)/(**)/(##) 12.6 Fixed dry chemical system operations (#)/(**)/(##)	12.7 Basic knowledge of spill containment in relation to firefighting operations 13.0 Basic knowledge of Emergency procedures, including emergency shutdown 14.0 Basic knowledge of the effects of pollution on human and marine life 15.0 Basic knowledge of Shipboard procedures to prevent pollution	**MEAL BREAK (1200 – 1300 hrs)**	16.0 Basic knowledge of measures to be taken in the event of spillage 16.1 report relevant information to the responsible persons 16.2 assist in implementing shipboard spill-containment procedures 16.3 prevent brittle fracture 17.0 Case studies	Test and Discussions

Tea Breaks: 1030-1100 / 1500-1530
Note:
It is suggested that relevant topics which are marked with an Asterisk (*) may be taught on a simulator.

It is suggested that relevant topics which are marked with a Hash (#) may be conducted separately in any facility which can conduct practical exercises and instruction under approved and truly realistic training conditions (e.g., simulated shipboard conditions).

It is suggested that relevant topics which are marked with a double Asterisk (**) may be demonstrated practically or relevant videos to be shown for same.

The items marked with double hash (##) could be be part of a specific firefighing module or other appropriate practical firefighting training as determined by the administration. The practical exercise corresponding to this competence may not be carried out if the candidates have already undertaken an approved Fire prevention and Firefighting course with Gas firefighting training.

The 3 hours of practical exercises in the mock-up are not accounted in the above timetable.

Part C: Detailed Teaching Syllabus

COMPETENCE 1 Contribute to the safe operation of a liquefied gas tanker

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

1. **Liquefied gas tankers:**
   .1 types of liquefied gas tankers
   .2 general arrangement and construction

2. **Cargo operations:**
   .1 piping systems and valves
   .2 cargo handling equipment
   .3 loading, unloading and care in transit.
   .4 emergency shutdown ESD System
   .5 tank cleaning, purging, gas freeing and inerting

3. **Physical properties of liquefied gases:**
   .1 properties and characteristics
   .2 pressure and temperature; Including vapour Pressure/temperature relationship
   .3 types of electrostatic charge generation
   .4 chemical symbols

4. **Tanker safety culture and safety management**

TOPIC 1	LIQUEFIED GAS TANKERS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
1.0	**Basic knowledge of liquefied gas tankers**	**R1,R2, R6**	**T1, T2, B7, B8, B1, B9, B10**	**A1, A2**
1.1	**Types of liquefied gas tankers**	**R1,R2, R6**	**T1, T2, B1**	**A1, A2 A3, VG12**
1.1.1	States that liquefied gas tankers are categorized as per the cargoes carried, as follows: - LPG ships - LEG ships - LNG ships - Chlorine ships - LPG / Chemical ships			
1.1.2	States that there are three types of gas tankers according to the carriage condition, such as: - Fully pressurized ships - Semi-pressurized ships - Fully refrigerated ships			
1.1.3	Describes generally LPG ships			
1.1.4	Describes generally LEG ships			
1.1.5	Describes generally LNG ships			
1.1.6	Describes generally chlorine ships			
1.1.7	Describes LPG/Chemical ships			
1.1.8	Describes briefly the tank containment systems of a liquefied gas tanker			
1.2	**General arrangement and construction**	**R1,R2,R6**	**T1,T2,B7,B8,B1**	**A1,A2, A3,A4**
1.2.1	States that the cargo area of a gas tanker which is not equipped in an approved manner to ensure that its atmosphere is at all times maintained in a safe manner is a gas dangerous space or zone and is segregated from other parts of the ship			**VG1**
1.2.2	States that a gas-safe space is a space other than a gas-dangerous space			
1.2.3	States that air intakes for accommodation and engine-room have to be at a minimum safe distance from ventilation outlets from gas-dangerous spaces			
1.2.4	States that access to accommodation or engine-room has to be at a minimum safe distance from the forward division of the accommodation			
1.2.5	States that access from a gas-dangerous zone on the open weather deck to a gas-safe space is arranged through an airlock			

TOPIC 1	**LIQUEFIED GAS TANKERS**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
1.2.6	States that the airlock doors should be self-closing and that there must not be any hook or other device by which they could be held open			
1.2.7	States that an audible and visual alarm system gives a warning on both sides of the airlock when more than one door is moved from the closed position.			
1.2.8	States that gas-safe and airlock spaces within the cargo area have positive-pressure ventilation			
1.2.8.1	States that when this over-pressure is lost, all electrical equipment that is not of a certified safe type should be de-energized			
1.2.8.2	States that use of segregation, separation and airlocks are fundamental to the safety of a gas tanker			

TOPIC 2	CARGO OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
2.0	**Basic knowledge of cargo operations**	**R2,R4,R6**	**T1,T2,B7,B8,B1**	**A1,A2, A3,A4**
2.1	**Piping systems and valves**	**R2,R4,R6, R9**	**T1,T2,B7,B8,B1**	**A1,A2, A4**
2.1.1	Describes generally the cargo piping arrangement			
2.1.2	States that the construction materials in tanks, piping and equipment containing cargo liquid and vapour should be resistant to the cargo			
2.1.3	States that the resistance to the cargo is dictated by the minimum service temperature and the compatibility with the cargo carried			
2.1.4	States that all penetrations and personnel access to a cargo tank have to be arranged through the cargo tank dome			
2.1.5	Lists commonly found fixed piping arrangements in a cargo tank, such as: - Sample tubes - Temperature probes - Vapour line - Condensate line - Stripping line/puddle heat line - Unloading line - Liquid line - Upper purge line/spray line - Ventilation line			
2.1.6	States that there are usually three each sample and temperature tubes at different levels in the cargo tank.			
2.1.7	States that the monitoring of tank atmosphere and vapour sampling can be done through the sample tubes.			
2.1.8	States that the main purpose of the vapour line is to lead the boil-off to the reliquefaction plant or to the shore via the crossover.			
2.1.9	States that the main purpose of the condensate line is to lead liquid from the reliquefaction plant to the cargo tank			
2.1.10	States that the stripping line is used for removal of remaining liquid cargo from the pump sump by means of using hot vapour.			

TOPIC 2	CARGO OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
2.1.11	States that the purpose of the puddle heat line is to lead heated cargo vapour from the cargo compressor to the pump sump for vaporizing the remnants of a liquefied gas cargo			
2.1.12	States that the main purpose of the unloading line is to lead the liquid cargo from the cargo tank to the crossover by means of the cargo pump			
2.1.13	States that the main purpose of the liquid line is to lead the liquid cargo from shore to the cargo tank via the cross over.			
2.1.14	States that the purpose of the upper purge line is to lead different types of ventilation gases (Nitrogen, IG, Air cargo vapours) into or out from the cargo tank.			
2.1.15	States that the main purpose of the spray line is to spray liquid cargo into the tank during cool-down of the cargo tank			
2.1.16	States that the main purpose of the ventilation line is to lead vapour relieved through the cargo tank safety relief valve to the vent outlet			
2.1.17	States that it is a requirement to have remotely operated emergency shutdown valves in the cargo piping system.			
2.2	**Cargo handling equipment**	**R2,R4,R6, R9**	**T1,T2,B7,B8,B1,B3**	**A1,A2, A4**
2.2.1	**Instrumentation**			
2.2.1.1	States that all electrical equipment installed or used in gas-dangerous spaces or zones should be approved for operation in a flammable atmosphere.			
2.2.1.2	States that each cargo tank is provided with means for indicating level, pressure and temperature of the cargo			
2.2.1.3	States that the liquid level in cargo tanks is commonly measured by means of float gauges			
2.2.1.4	Describes generally a float gauge			
2.2.1.5	States that each cargo tank is fitted with high-level alarms independent of the level gauging system			
2.2.1.6	States that the purpose of high-level alarms is to prevent overflow of cargo tanks			

TOPIC 2 CARGO OPERATIONS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
2.2.1.7	States that another sensor independent of the high level alarm is fitted to automatically actuate a shut off valve to prevent over pressure and overfilling			
2.2.1.8	States that the fixed gas-detection system's alarm is activated when the vapour concentration reaches 30% of the Lower Explosive Limit (LEL)			
2.2.1.9	States that gas sampling and analyzing from different parts of the ship is done continuously and sequentially			
2.2.1.10	States that a fixed gas-detection system detects gases from different compartments on a gas tanker as prescribed in the IGC Code			
2.2.2	**Pressure-relief and vacuum - protection system**			
2.2.2.1	States that all pipelines or components that may be isolated in liquid full condition should be provided with pressure-relief valves.			
2.2.2.2	States that all cargo tanks should be provided with a pressure-relief system			
2.2.2.3	States that each tank above 20m^3 is fitted with at least two relief valves			
2.2.2.4	States that some cargo tanks are provided with vacuum protection system			
2.2.2.5	States that the set pressures of Cargo tank relief valves are called Maximum allowable relief Valve settings (MARVS)			
2.2.2.6	States that tank relief valves are generally pilot operated and the relief valves on cargo lines and system are generally spring loaded			
2.2.2.7	States that the pressure-relief and vacuum-protection system gives an automatically controlled protection against too high or too low pressure within the cargo-handling system			

TOPIC 2 CARGO OPERATIONS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
2.2.3	**Cargo heaters and cargo vaporizers**			
2.2.3.1	States that Heater may be fitted in a cargo handling system of a liquefied gas tanker, for heating cargo liquid to increase the discharge temperature when unloading.			
2.2.3.2	States that vaporizers may be fitted in a cargo handling system of a liquefied gas tanker, for vaporizing liquids and ramping up the tank pressures when required during unloading.			
2.2.3.3	States that seawater is commonly used as a heating medium for the cargo heater when discharging to pressurized storage			
2.2.3.4	States that it is necessary to run the booster pump in series with the heater when discharging to a pressurized shore tank			
2.2.4	**Describes generally the unloading system**			
2.2.4.1	States that the main cargo pumps fitted aboard liquefied gas tankers are of the centrifugal type			
2.2.4.2	States that these cargo pumps are either submerged or deep well pumps			
2.2.4.3	States that in addition to the main unloading pumps there are arrangements for alternative unloading			
2.2.4.4	States that alternative unloading can be done by means of vapour pressure, replaceable pump or eductor or by using pump of adjacent side tank, through a gate valve fitted on centre line bulkhead.			
2.2.5	**Reliquefaction systems and control of boil-off**			
	States that Cargo Conditioning is an important process during transit			
2.2.5.1	States that the temperature of the cargo will increase as long as the cargo is relatively cooler than the environment			
2.2.5.2	States that when the temperature of the cargo increases, the pressure in the cargo tank increases			

TOPIC 2 CARGO OPERATIONS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
2.2.5.3	Lists the methods of controlling vapour pressure in cargo tanks such as: - Leading the cargo boil-off to the ship's boiler, gas turbine or main engine to be used as fuel - Leading the cargo boil-off to the ship's reliquefaction plant, where the vapour is liquefied and returned to the tank - Cooling the liquid cargo - Cooling the shell of the cargo tank and thereby the cargo -			
2.2.5.4	States vapour-handling system for LNG tankers is by leading the cargo boil-off to the boilers in E/R			
2.2.5.5	Explains a simplified single-stage direct reliquefaction cycle for LPG			
2.2.5.6	States reliquefaction of LPG is done to control boil off and maintaining tank pressure at safe level and cargo in liquid state.			
2.2.6	**Cargo compressors**			
2.2.6.1	States that liquefied gas tankers generally have reciprocating compressors			
2.2.6.2	States that some liquefied gas tankers may have screw compressor			
2.2.6.3	States that the reciprocating and screw compressors used on board liquefied gas tankers are commonly of the oil-free type			
2.2.6.4	States that LNG carrier have High duty and Low Duty compressors which transfers large quantities of boil of vapours			
2.2.6.5	States that some LNG carriers may have additional compressors for reliquefaction plants.			
2.3	**Loading, Unloading and care in transit**	**R2,R4,R6,R7, R9, R10**	**T1,T2,B7,B8,B1,B2**	**A1,A2, A4,**
2.3.1	Describe briefly preparations for loading / unloading and precautions to be taken during these operations.			
2.3.2	Describes briefly cargo conditioning during loaded passage			

TOPIC 2 CARGO OPERATIONS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
2.4	**Emergency shutdown (ESD) system**	**R2,R6,R7, R9, R10**	**T1,T2,B7,B8,B1,B2**	**A1,A2, A4**
2.4.1	States that ESD system is required to shut down all operations in case of an emergency			
2.4.2	States that an umbilical cord (ship-shore ESD pendant) may be used to stop all cargo operations			
2.5	**Tank cleaning, purging, gas-freeing and inerting**	**R2,R4,R6, R9, R10**	**T1,T2,B7,B8,B1,B3,**	**A1,A2, A4**
2.5.1	States that inert gas is a gas which is incapable of burning			
2.5.2	States that inert gas or nitrogen is used in cargo tanks and hold spaces to replace air, thereby preventing fire and explosion			
2.5.3	States that inert gas is commonly produced on gas tankers by an oil-burning gas generator			
2.5.4	States that inert gas produced by an oil-burning gas generator is composed of: - Approximately 0.5% oxygen - Approximately 84% nitrogen - Approximately 15% carbon dioxide - Approximately 0.5% carbon monoxide, oxides of nitrogen and sulphur dioxide			
2.5.5	Explains briefly purging, gas freeing and inerting requirements and precautions to take during such operations.			
2.5.6	States that tank cleaning will only be carried out on a liquefied gas tanker after dry docking.			

TOPIC 3	PHYSICAL PROPERTIES OF LIQUEFIED GASES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
3.0	**Basic knowledge of the physical properties of liquefied gases**	**R2,R5,R6**	**T1,T2,B7,B8,B1**	**A1,A2,A3, VG5**
3.1	**Properties and characteristics**	**R2,R5,R6**	**T1,T2,B7,B8,B1**	**A1,A2,A3**
3.1.1	States that, a liquefied gas is the liquid form of a substance which at ambient temperature and atmospheric pressure would be in gaseous form.			
3.1.2	States that cargoes transported by gas tankers are listed in IMO's Gas Carrier Code, chapter XIX/ 19			
3.1.3	Explains that these cargoes can be divided into the following four groups: - Liquefied natural gas, LNG - Liquefied petroleum gas, LPG - Liquefied ethylene gas, LEG - Chemical gases and certain other substances			
3.1.4	States that LNG is liquefied natural gas from which impurities are removed			
3.1.5	States that the principal constituent of LNG is methane			
3.1.6	States that liquefied petroleum gas – LPG is a common name for petroleum gases, mainly propane and butane.			
3.1.7	States that LPG is produced from two sources: - From crude oil processing in refineries, or as a by-product of chemical plants - From natural gas streams or from crude oil at or close to production points (wells/platforms)			
3.1.8	States that liquefied ethylene gas - LEG - is produced by "cracking" of LPG			
3.1.9	States that chemical gases are a group of liquefied gases produced through a chemical process			
3.1.10	Lists chlorine, ammonia and vinyl chloride monomer (VCM) as examples of chemical gases			
3.1.11	States that some substances in the "borderland" between liquefied gas and chemicals are carried on gas tankers			
3.1.12	Lists acetaldehyde and propylene oxide as examples of such cargoes			

3.2	**Pressure and temperature, including vapour pressure / temperature relationship**	**R2,R5,R6**	**T1,T2,B7,B8,B1**	**A1,A2**
3.2.1	Explains in simple terms: - States of aggregation - Boiling point - Liquid density - Vapour density - Flashpoint			
3.2.2	States that vapour, pressure and, temperature are interrelated			
3.2.2.1	States that refrigerated liquefied gas cargoes are transported in cryogenic condition at or close to their boiling point			
3.2.2.2	States that the boiling temperatures of these cargoes range from -162^{0}C for methane to near zero for butane.			
3.2.2.3	States that low temperatures can cause cold burns which may damage skin and tissue when in direct contact with cold liquid or vapour			
3.2.2.4	States that these low temperatures can cause brittle fracture if cold cargo comes in sudden contact with some metals			
3.2.2.5	States that liquefied gas cargoes give off vapour readily because they are boiling			
3.2.2.6	States that cargo vapour can be flammable, toxic or both			
3.2.2.7	States that cargo vapour in sufficient concentration will exclude oxygen and may cause asphyxiation whether the vapour is toxic or not			
3.2.2.8	States that an explosive mixture may be produced when most cargo vapours are mixed with air			
3.2.2.9	States that some toxic gases carried in gas tankers can be absorbed into the body through the skin			
3.2.2.10	States that gases are made up of molecules that are in constant motion and exert pressure when they collide with the walls of their container.			
3.2.2.11	States that Temperature and pressure are directly proportional to each other			
3.2.2.12	States that as the temperature decreases, the pressure also decreases and vice versa.			

3.3	**Types of electrostatic charge generation**	**R2,R6**	**T1,T2,B7,B8,B1**	**A1,A2**
3.3.1	States that electrostatic discharge occurs after charges are generated (separated) and accumulated.			
3.4	**Chemical symbols**	**R2,R6**	**T1,T2,B7,B8,B1**	**A1,A2, A3,VG6**
3.4.1	States that chemical symbols are used to denote any liquefied gas.			
3.4.2	States that C denotes an atom of carbon and H an atom of hydrogen. CH_4 represents one molecule of methane consisting of one atom of Carbon and 4 atoms of hydrogen..			

TOPIC 4	TANKER SAFETY CULTURE AND SAFETY MANAGEMENT			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
4.0	**Knowledge and understanding of tanker safety culture and safety management**	**R1,R2,R7**	**T1,T2,B7,B8, B9, B10**	**A1,A2,A3**
4.1	States that ISM code is the only internationally accepted standard for the safe management and operation of ships and for pollution prevention;			
4.2	States the requirement to comply with the ISM Code as per chapter IX of the SOLAS convention in the 'Management for the safe operation of ships'.			
4.3	States that the proper implementation of the ISM Code should result in a safety culture being developed.			
4.4	States that following the spirit of the ISM Code involves, at least, a commitment to continuous improvement of the company's safety record			
4.5	States that the industry provides robust guidelines and recommendations in the form of a "safety guide" and other publications for the safe running of liquefied gas tankers.			

COMPETENCE 2: Take precautions to prevent hazards

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

5. Hazards associated with tanker operations:

.1 health hazards
.2 environmental hazards
.3 reactivity hazards
.4 corrosion hazards
.5 explosion and flammability hazards
.6 sources of ignition,
.7 electrostatic hazards
.8 toxicity hazards
.9 vapour leaks and clouds
.10 extremely low temperatures
.11 pressure hazards

6. **Hazard controls:**

.1 inerting, drying and monitoring techniques
.2 anti-static measures
.3 ventilation
.4 segregation
.5 cargo inhibition
.6 importance of cargo compatibility
.7 atmospheric control
.8 gas testing

7. **Information on a Material Safety Data Sheet (MSDS)**

TOPIC 5	HAZARDS ASSOCIATED WITH TANKER OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
5.0	**Basic knowledge of the hazards associated with tanker operations**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6, B9, B10**	**A1,A2**
5.1	**Health hazards**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.1.1	Lists health hazards of Liquefied gases as: - Toxicity - Asphyxia - Anaesthesia			
5.2	**Environmental hazards**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.2.1	States that some liquefied gases pose a threat to the surrounding natural environment and adversely affect people's health.			
5.2.2	States that cargo vapour, whether toxic or flammable, should be vented to atmosphere with extreme caution			
5.2.3	States that venting of any cargo vapours should take into account all local and international regulations and weather conditions			
5.2.4	States weather conditions include wind conditions, electrical storms and cold weather.			
5.3	**Reactivity hazards**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.3.1	States that some cargoes carried in liquefied gas tankers are reactive and may react in a number of ways			
5.3.2	Lists reactivity hazards as: - Reactivity with water forming hydrates (crystalline structures) - Self-reactivity causing polymerization - Reactivity with air - Reactivity with other cargoes - Reactivity with other materials - Examples of reactive gases are Vinyl Chloride Monomer (VCM) and Butadiene			

TOPIC 5	HAZARDS ASSOCIATED WITH TANKER OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
5.4	**Corrosion hazards**	**R2,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.4.1	States that some gases are corrosive and can damage human tissue e.g. ammonia			
5.4.2	States that carriage of some corrosive cargoes and inhibitors require tank material to be resistant to corrosion by it.			
5.5	**Explosion and flammability hazards**	**R2,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.5.1	States that cargo vapour may be flammable, toxic or both			
5.5.2	States that an explosive mixture may be produced when most cargo vapours are mixed with air			
5.5.3	States that the ability of most liquefied gases to generate flammable vapour is a major factor for starting a fire			
5.5.4	States that the minimum and maximum concentrations of vapour in air which form flammable (explosive) mixtures are known as the lower flammable limit (LFL) and upper flammable limit (UFL) respectively			
5.5.5	States that the range of flammable vapour concentrations in air between the lower and upper flammable limits is called the "flammable range" and mixtures within this range are capable of being ignited and of burning			
5.5.6	Explains the flammability diagram with respect to: Flammable range, Flammable zone and shows how use of inert gas enhances safety in operations			
5.5.7	Explains Boiling Liquid Expanding Vapour Explosion (BLEVE)			
5.6	**Sources of ignition**	**R2,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.6.1	Lists the sources of ignition as: - Smoking - Frictional sparks - Electrical sparks - Chemical sparks - Spontaneous combustion			

TOPIC 5	HAZARDS ASSOCIATED WITH TANKER OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
	- Auto Ignition Temperatures - Static electricity - Hot work			
5.7	**Electrostatic hazards**	**R2,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2,A3, VG8**
5.7.1	Explains Electro static charge separation, charge accumulation and charge discharge.			
5.8	**Toxicity hazards**	**R2,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.8.1	States that toxicity means poisonous			
5.8.2	TLV (Threshold Limit Value) is defined as a concentration of a gas which a person can be exposed to without any adverse effect.			
5.8.3	Defines - TWA (Time Weighted Average) as: the concentration of a gas to which a person can be exposed to for 8 hours a day or 40 hours a week without any adverse effects. - STEL (Short Term Exposure Limit Value) as: the concentration of a gas to which a person can be exposed to maximum 4 times. Each exposure not more than 15 minutes and rest period between two successive exposures should be not less than one hour without any adverse effects - Odour Threshold value as: the minimum concentration of a gas when a person starts smelling the gas.			
5.9	**Vapour leaks and clouds**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.9.1	States that this comprises all vapour leaks that cannot be easily stopped by operational routines, like rupture in a pipe			
5.9.2	States that ignition may not take place within immediate vicinity of the leakage due to the over-rich concentration of vapour.			
5.9.3	States that a heavy leakage will initially form a heavy white vapour cloud and this is likely to quickly envelope the deck and accommodation areas. Hence it is essential that all potential sources of ignition are isolated			
5.9.4	States that the rate of dispersal of a vapour cloud will depend on climatic conditions			

TOPIC 5	HAZARDS ASSOCIATED WITH TANKER OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
5.10	**Extremely low temperatures**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.10.1	States that liquefied gas cargoes are transported largely at cryogenic temperatures at or near to their boiling point			
5.10.2	States that low temperatures can cause cold burns which may damage skin and tissue when in direct contact with cold liquid or vapour			
5.10.3	States that these low temperatures can cause brittle fracture if cold cargo comes in sudden contact with some metals			
5.11	**Pressure hazards**	**R2,R3,R4, R5,R6**	**T1,T2,B7,B8 B6**	**A1,A2**
5.11.1	Explains high pressure and low pressure effects			
5.11.2	Describes pressure surge or liquid hammering			
5.11.3	Explains how the effect of surge pressure is minimized or avoided.			

TOPIC 6	HAZARD CONTROLS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
6.0	**Basic knowledge of hazard controls:**	**R1,R2, R6**	**B1,B3,T1,T2, B7, B8**	**A1,A2**
6.1	**Inerting, drying and monitoring techniques**	**R1,R2, R4**	**T1,T2,B7,B8 B6**	**A1,A2**
6.1.1	States that primary inerting is carried out in order to ensure that the concentration inside the containment system is dry and non-flammable prior introducing gas cargo			
6.1.2	States that aeration with dry air has to be done prior purging to reduce the dew point for low boiling point cargoes e.g. for LNG, dew point is first reduced by dry air to – 25^{o} C.			
6.1.3	States that drying with inert gas or nitrogen may be done to reduce the dew point in the cargo tanks for some cargoes e.g. LNG to reduce dew point to – 40^{o}C			
6.1.4	States that the purpose of inerting is primarily to prevent flammable vapour/air mixtures in tanks and piping			
6.1.5	States that inerting is done by replacing cargo vapours with an inert-gas until the concentration of cargo vapours is lower than the LEL			
6.1.6	States that inert gas used on gas tankers is either nitrogen or inert gas produced in the ship's inert gas plant			
6.1.7	States that the correct inerting procedure is ensured by regular checks of the tank atmosphere at different levels			
6.1.8	States that atmosphere checks are done by measuring the, percentage of oxygen and cargo vapours through the sampling tubes			
6.1.9	States that atmosphere is checked for dryness by measuring the dew point.			
6.1.10	States that the atmosphere in an inerted tank or void space is safe with regard to fire hazard but dangerous with regard to health.			

TOPIC 6 HAZARD CONTROLS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
6.2	**Anti-static measures**	**R2,R6**	**T1,T2,B7,B8**	**A1,A2**
6.2.1	States that the effectiveness of antistatic additives is dependent upon the length of time since the additive was introduced			
6.2.2	States that a low product velocity at the tank inlet minimizes turbulence and splashing as liquefied gases enters the cargo tank thus reducing the in tank static generation			
6.3	**Ventilation**	**R1,R2, R3,R6**	**T1,T2,B7,B8,B 1,B3**	**A1,A2**
6.3.1	States that pressure inside accommodation should always be maintained positive			
6.3.2	States that mechanical ventilation should be stopped and air conditioning systems run in closed cycle if possible or stopped if there is any possibility of vapour being drawn into the accommodation.			
6.3.3	States that care should be taken to ensure cargo vapour does not enter the engine room except on LNG ships where it is used as fuel for engines			
6.3.4	States that mechanical exhaust ventilation systems are provided to disperse any vapour that may collect in the compressor rooms			
6.3.5	States that all ventilation equipment should be well maintained.			
6.4	**Segregation**	**R2,R6**	**T1,T2,B7,B8,B 1**	**A1,A2**
6.4.1	States that where codes and regulations call for segregation, the position of the valves, blanks, portable bends and spool pieces associated with such segregation should be carefully arranged and clearly identified. These arrangements for segregation must be followed as part of the approved system.			
6.4.2	States that checking all the necessary blanks are fitted or that pipe spool pieces have been removed is very important.			
6.4.3	States that positive segregation is achieved by removing spool pieces and/or pipelines			

TOPIC 6 HAZARD CONTROLS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
6.4.4	States that all temporary hoses/pipe-work should be gas-freed, monitored, disconnected and properly stored when not in use.			
6.5	**Cargo inhibition**	**R2,R6**	**T2,B7,B8,B1**	**A1,A2**
6.5.1	Explain the term 'inhibitor' and the reason for and use of inhibitors			
6.6	**Importance of cargo compatibility**	**R2,R3,R6**	**T1,T2,B7,B8,B1**	**A1,A2**
6.6.1	States that compatible cargoes are those substances which can be loaded consecutively without prior need to gas freeing the tanks.			
6.6.2	States that in many cases loading compatible cargoes can be done just on top of remaining previous cargo vapours.			
6.7	**Atmospheric control**	**R1,R2, R3,R6**	**B1,B3,T1,T2,B7,B8**	**A1,A2**
6.7.1	States that when carrying flammable cargoes, the atmosphere, in interbarrier spaces and holds need to be inerted.			
6.7.2	States that cargo tanks and piping's need to have the air in the system purged with IG or Nitrogen before loading and by removing cargo vapour by IG after unloading, prior change of grade or gas freeing.			
6.8	**Gas testing**	**R1,R2,R4, R6**	**T1,T2,B7,B8,B1,B2,B3,B4**	**A1,A2,A4**
6.8.1	States that the atmosphere inside the cargo tanks needs to be monitored at different levels to ensure that representative sampling is done and there are no pockets remaining.			

TOPIC 7	**INFORMATION ON A MATERIAL SAFETY DATA SHEET (MSDS)**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
7.0	**Understanding of information on a Material Safety Data Sheet (MSDS)**	**R2,R5,R6**	**T1,T2,B7,B8,B1, B6**	**A1,A2**
7.1	**Analyze the information on a Material Safety Data Sheet (MSDS)**	**R2,R5,R6**	**T1,T2,B7,B8,B1, B6**	**A1,A2**
7.1.1	States that information about cargoes to be handled is essential to the safety of the vessel and her crew			
7.1.2	States that such information may be found in ICS Tanker safety guide "liquefied gases" or Cargo Data Sheets for each product, which includes all necessary data for the safe handling and carriage of the cargo			
7.1.3	States that cargo information for most tanker cargoes is kept on board and available for all concerned			
7.1.4	States that cargo must not be loaded if the MSDS for cargo is not supplied by the shipper or terminal			
7.1.5	States that the cargo must not be loaded unless all information necessary for its safe handling and transportation is available and understood			
7.1.6	States that the responsible officer will see to it that the necessary cargo information is posted on the notice board/s prior to cargo operations			
7.1.7	States that all personnel engaged in cargo operations should familiarize themselves with the cargo properties by studying the ICS safety guide for liquefied gases or other Cargo Data Sheets			
7.1.8	States that cargo information is fundamental in cargo planning			
7.1.9	Lists reference books where cargo information may be found as: - IGC code - MSDS - Tanker Safety Guide. (Liquefied Gas)			

COMPETENCE 3: Apply occupational health and safety measures

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

8.0 Function and proper use of gas-measuring instruments and similar equipment

9.0 Proper use of safety equipment and protective devices:
- .1 breathing apparatus and tank-evacuating equipment
- .2 protective clothing and equipment
- .3 resuscitators
- .4 rescue and escape equipment

10.0 Safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers:
- .1 precautions to be taken when entering enclosed spaces
- .2 precautions to be taken before and during repair and maintenance work
- .3 safety measures for hot and cold work
- .4 electrical safety
- .5 ship/shore safety checklist

11.0 First aid with reference to a Material Safety Data Sheet (MSDS)

TOPIC 8	PROPER USE OF SAFETY EQUIPMENT AND PROTECTIVE DEVICES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
8.0	**Function and proper use of gas-measuring instruments and similar equipment**	**R1,R2,R6**	**T1,T2,B7,B8, B1,B3,B4,B6**	**A1,A2,A3 VG4, VG13**
8.1	**Gas measuring instruments**			
8.1.1	States that gas measurements are the only way to get correct information about the composition of the atmosphere in a cargo tank			
8.1.2	Lists the different types of gas-measuring equipment common on board tankers as: - Portable oxygen meter - Portable explosion meter and Tank scope (%Vol HC meters) or infra-red analysers - Toxic gas meter (chemical absorption tubes) - Personal Multi gas meter			
8.1.3	States that gas-measuring equipment for atmosphere evaluation is available on board			
8.1.4	Demonstrates use of: - Portable oxygen meter - Portable explosion meter and tank scope (%Vol HC meters) or infra- red analysers - Toxic gas meter (chemical absorption tubes) - Personal Multi gas meter			
8.1.5	- States that every gas tanker has a fixed gas-detection system			
9.0	**Proper use of safety equipment and protective devices**	**R1,R2,R6**	**T1,T2,B7,B8, B1,B3,B4, B6**	**A1,A2**
9.1	**Breathing apparatus and tank-evacuating equipment**			
9.1.1	Describes the Self-contained Compressed air Breathing Apparatus			
9.1.2	States that spaces not normally entered (e.g. double bottoms cofferdams and pipe tunnels) are capable of being ventilated to ensure a safe environment when entry into these spaces is necessary			

TOPIC 8	PROPER USE OF SAFETY EQUIPMENT AND PROTECTIVE DEVICES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
9.1.3	Demonstrates use of: - Self-contained compressed-air breathing apparatus (SCBA) - Respiratory and eye protection equipment - A complete set of safety equipment - Tank Evacuating equipment.			
9.2	**Protective clothing and equipment**	**R1,R2,R6**	**T1,T2,B7,B8, B1,B2, B6**	**A1,A2,**
9.2.1	States that for the protection of personnel engaged in loading and unloading operations, there must be suitable protective clothing on board			
9.2.2	States that for entering spaces which may not have safe atmosphere for supporting life, there must be adequate numbers of complete sets of safety equipment on board besides that required by SOLAS for firefighting			
9.2.3	States that all equipment for personnel protection must be kept in clearly marked lockers			
9.2.4	States that all personnel should wear appropriate protective clothing when involved in cargo operations			
9.2.5	States for some specified cargo, there must be respiratory and eye protection equipment for every person on board, for purposes of emergency escape			
9.2.6	Demonstrates the use of protective clothing			
9.2.7	States that for some specified cargoes decontamination showers and eyewash must be available in certain locations on deck			
9.2.8	States that stretchers and medical first-aid equipment must be provided on board			
9.3	**Resuscitators**	**R2,R6**	**T1,T2,B7,B8, B1,B2,B6**	**A1,A2**
9.3.1	Lists the circumstances under which a resuscitator should be used eg. casualty which is unconscious or gasping for breath or breathing with difficulty			
9.3.2	Demonstrates the use of a oxygen resuscitator			

TOPIC 8	**PROPER USE OF SAFETY EQUIPMENT AND PROTECTIVE DEVICES**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
9.3.3	States that a manual resuscitator should not be used in toxic or reduced O_2 atmosphere.			
9.4	**Rescue and escape equipment**	**R2,R6,**	**T1,T2,B7,B8, B1,B2,B6**	**A1,A2**
9.4.1	States that arrangements for hoisting an injured person with a rescue line must be made and kept in readiness when persons are working in congested/ enclosed spaces			
9.4.2	Explains that timely evacuation and resuscitation may save lives			
9.4.3	Demonstrates proper use of tripods and tank evacuation equipment to rescue a person from enclosed spaces.			

TOPIC 10	SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
10.0	**Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers, including:**	**R1,R2, R6,R7**	**T1,T2,B7,B8,B 1, B4,B5, B6**	**A1,A2, A3, VG3. VG9, VG10, VG11, VG15.**
10.1	**Precautions to be taken when entering enclosed spaces**	**R1,R2, R6,R7**	**T1,T2,B7,B8,B 1,B4,B5, B6**	**A1,A2,**
10.1.1	Defines "enclosed spaces" as a space which has any of the following characteristics: - Limited openings for entry and exit - Inadequate ventilation. - Is not designed for continuous worker occupancy			
10.1.2	States that enclosed spaces includes, but is not limited to, cargo spaces, double bottoms, fuel tanks, ballast tanks, cargo compressor rooms, cofferdams, chain lockers, void spaces, duct keels, inter-barrier spaces, boilers, engine crankcases, engine scavenge air receivers, sewage tanks, and adjacent connected spaces. This list is not exhaustive and a list should be produced on a ship-by-ship basis to identify enclosed spaces.			
10.1.3	States that no person should open or enter an enclosed space unless authorized by the master or the nominated responsible person and unless the appropriate safety procedures laid down for the particular ship including permit to work have been followed			
10.1.4	States that only a tank or space declared gas-free can be entered by personnel without breathing apparatus and protective clothing			
10.1.5	States that a gas-free tank or space may not be considered to remain gas-free unless regular measurements of the atmosphere prove so			

TOPIC 10	**SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS**		
Knowledge, Understanding and Proficiency	**IMO Reference**	**Text books Bibliography**	**Teaching aid**
10.1.6 Lists requirements for cargo tank entry as: Tank atmosphere must be checked and following confirmed: - Oxygen content must be 21% by volume - Hydrocarbon content must be less than 1% LFL - Toxic gas concentration must be less than 50% of its OEL - Tank to remain open to atmosphere with ventilation running at all times to ensure continuous ventilation. - Rescue and resuscitation equipment easily available and ready for use. - Means of communication agreed and tested. - All persons entering a potentially dangerous space should wear a personal multi gas detection meter capable of detecting oxygen deficiency, toxic gases and flammable atmospheres - Communications set up between Bridge and deck or between Duty Officer and Enclosed Space entry team. - Duty officer to be kept informed that tank entry is in progress - All requirements as required by enclosed space permit are complied with - Authorizing Officer has verified and signed the entry permit			
10.2 Precautions to be taken before and during repair and maintenance work	**R2,R7**	**T1,T2,B7,B8,B1,B3,B4,B5**	**A1,A2**
10.2.1 States that the use of appropriate PPE is mandatory to protect the crew against the various hazards			
10.2.2 States Monitoring and evaluation of spaces adjacent to cargo tanks for vapour content must be carried out at regular intervals			
10.2.3 States that in case of a doubt on the integrity of a cargo tank, the adjacent spaces also to be monitored and logged for toxic gases/cargo vapours			

TOPIC 10	**SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
10.2.4	Explains that if gas concentrations are observed, repairs and maintenance work must be stopped when working in the concerned area. Additionally, the cause of the presence of gas concentration must be investigated into and the same eliminated. Other adjoining spaces must be checked for similar defects.			
10.3	**Safety measures for hot and cold work**	**R2,R7**	**T1,T2,B7,B8,B1,B4,B5**	**A1,A2**
10.3.1	States that Hot work outside the main machinery spaces (and in the main machinery spaces when associated with fuel tanks and fuel pipelines) must take into account the possible presence of flammable vapours in the atmosphere, and the existence of potential ignition sources			
10.3.2	States that Hot work should only be carried out outside the main machinery spaces if no other viable means of repair exists			
10.3.3	States that any hot work outside the designated hot work area in machinery room should be under SMS and Permit control. This would thus also include ALL work in engine room outside designated hot work area. Hot work outside the main machinery spaces should only be permitted in accordance with prevailing national or international regulations and/or port/terminal requirements and should be subject to the restrictions of a shipboard hot work permit procedure of company's SMS (safety management system)			
10.3.4	States that Hot work in dangerous and hazardous areas should be prohibited during cargo, ballast, tank cleaning, gas freeing, purging or inerting operations			
10.3.5	Lists the Checks by Officer Responsible for Safety - Oxygen is 21% by volume - Tests with a combustible gas indicator show not more than 1% LFL.			

TOPIC 10	SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
	- Adequate firefighting equipment must be laid out and be ready for immediate use. - Adequate firefighting equipment must be laid out and be ready for immediate use. - Fire-watch procedures must be established for the area of hot work, and in adjacent, non-inerted spaces where the transfer of heat, or accidental damage, may create a hazard e.g. .damage to hydraulic lines, electrical cables, thermal oil lines etc. Monitoring should be continued for sufficient time after completion of hot work. - Effective means of containing and extinguishing welding sparks and molten slag must be established. - The work area must be adequately and continuously ventilated. The frequency of atmosphere monitoring must be established. Atmospheres should be re-tested after each break during work periods, and at regular intervals. Checks should be made to ensure there is no ingress of flammable vapours or liquids, toxic gases or inert gas from adjacent or connected spaces			
10.3.6	States that Cold work permits are used in hazardous maintenance work that does not involve "hot work". Cold work permits are issued when there is no reasonable source of ignition, and when all contact with harmful substances has been eliminated or appropriate precautions taken.			
10.4	**Electrical safety**	**R1,R2, R6,R7**	**T1,T2,B7,B8,B 1,B4**	**A1,A2**
10.4.1	States all electrical equipment employed should be carefully inspected before each occasion of use to ensure it is in good condition. Where required it must be correctly earthed			

TOPIC 10	SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
10.4.2	Lists precautions when using electric-arc equipment as: - That electrical supply connections are made in a gas free space; - The cable route to the worksite is the safest possible, only passing over gas free or inerted spaces - The earthing connection is adjacent to the work site with the earth return cable led directly back to the welding machine			
10.5	**Ship / shore safety checklist**	**R2**	**T1,T2,B7,B8,B1, B6**	**A1,A2**
10.5.1	States that the Ship/shore safety checklist concerns the ship, the terminal and all personnel. It is to be completed jointly by the responsible officer and the terminal representative			
10.5.2	States that all items need to be verified physically before it is ticked			
10.5.3	Discuss the ship shore safety checklists			
10.5.4	Discuss the importance of repetitive checks			
10.5.5	Emphasize that the completed checklist is of no value if regarded as a paper exercise and should be physically used prior and during transfer of Cargo			

TOPIC 11	FIRST AID WITH REFERENCE TO A MATERIAL SAFETY DATA SHEET (MSDS)			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
11.0	**Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)**	**R2**	**T1,T2,B7,B8,B1**	**A1,A2, A3, VG14**
11.1	Displays and Identify 'health data' from MSDS			
11.2	Displays and Identify health hazard criteria from the IMDG Code Supplement (MFAG)			
11.3	Displays and explains first aid medical aspects from a Material Safety Data Sheet for sample products gases.			
11.4	Identify medical first-aid equipment provided onboard including oxygen resuscitation equipment and antidotes for products carried			

COMPETENCE 4: Carry out firefighting operations

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

12. Firefighting operations

.1 tanker fire organization and action to be taken
.2 special hazards associated with cargo handling and transportation of liquefied gases in bulk
.3 firefighting agents used to extinguish gas fires
.4 fixed firefighting foam system operations
.5 portable firefighting foam operations(##)
.6 fixed dry chemical system operations (##)
.7 basic knowledge of spill containment in relation to firefighting operations

The items marked with double hash (##) in the course outline and time table could be be part of a specific firefighting module or other appropriate practical firefighting training as determined by the administration. The practical exercise (3 hours) corresponding to this competence may not be carried out if the candidates have already undertaken an approved Fire prevention and Firefighting course with Gas firefighting training.

TOPIC 11	FIREFIGHTING OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
12.0	**Fire safety and firefighting operations**	**R1,R2,R4**	**T1,T2,B7,B8,B1,B4**	**A1,A2,A3 VG2,VG7**
12.1	**Tanker fire organization and action to be taken**			
12.1.1	States that planning and implementation of fire emergency procedure requires an emergency organization			
12.1.2	States that training and drills especially for firefighting, prepare the fire response organization to become familiar with their duties and equipment and to respond to emergencies in a timely and correct manner.			
12.1.3	States that Find, Inform, Restrict and Extinguish technique is a good maxim when attending to a Fire emergency			
12.1.4	States that the Master must ensure that the Duty Officer is authorized to stop cargo in the event of an emergency or if in the opinion of the Duty Officer such stoppage is necessary to prevent an emergency situation			
12.1.5	States that the duty officer must inform the Cargo Officer and / or the Master in any event of an emergency situation at the earliest opportunity			
12.1.6	Lists the emergency actions to be taken by the Duty Officer after informing the Master: - Stop Cargo work, bunkering, tank cleaning or ballasting operations immediately - Muster ship's crew - Disconnect hoses if alongside the terminal or a ship. - Inform the terminal/ship if alongside the terminal/ship. - If at the terminal, external help may be summoned. - Cast off any boats, which are alongside - If at anchor, alert port authorities - If at sea, maneuver the vessel in such a way that the spread of fire can be restricted and it can then be tackled from the windward side.			

TOPIC 11 FIREFIGHTING OPERATIONS

Knowledge, Understanding and Proficiency	IMO Reference	Text books Bibliography	Teaching aid
- Cool adjacent compartments especially if they carry flammable cargo. - Select the suitable firefighting equipment to be used			
12.2 Special hazards associated with cargo handling and transportation of liquefied gas in bulk	**R1,R2,R4**	**T1,T2,B7,B8,B 1,B4**	**A1, A2**
12.2.1 Explain the need to be alert to the fact that toxic fumes may enter the accommodation and an evacuation of non-essential crew and visitors may become necessary.			
12.2.2 States that most Flammable Vapours are heavier than air and may travel long distances to a point of ignition and flash back.			
12.2.3 States that personnel in gas dangerous spaces involving toxic vapours must be immediately vacated from the downwind areas.			
12.2.4 Describes that "jet fire" should be allowed to burn till fuel is exhausted or cut off. Flames emanating from such fire could be bent by as much as 90^{o} using water spray.			
12.2.5 States that on any vessel, especially Liquefied Gas tankers, emergencies may have catastrophic consequences, unless proper action is taken. Actions therefore must be prompt, timely and adequate			
12.2.6 Explains that It is very essential for the ship's staff to know and understand the various properties of the cargo. The MSDS sheets are the best guides for understanding the cargo properties.			
12.2.7 Lists the fire hazards associated with Liquefied gases including petrochemical gases as: - Some cargoes give out oxygen when on fire, thereby supporting the fire. - Chemical gases miscible in fire will render normal foam useless. For such chemicals alcohol resistant or dual-purpose foam shall be used. - Some liquefied gases evolve large volumes of toxic vapours when heated			

TOPIC 11	FIREFIGHTING OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
	Some gases have a low auto-ignition temperature. There is a high risk of re-ignition in such cases			
12.3	**Firefighting agents used to extinguish gas fires**	**R1,R2,R4, R8**	**T1,T2,B7,B8,B 1,B4**	**A1,A2,**
12.3.1	Lists Firefighting agents used on liquefied gas tankers as: - Applicator foam for fighting oil bunker fires - Dry chemical powder for fighting liquefied gas jet or liquefied pool fires			
12.3.2	States that for cooling, fire prevention, and crew protection – water spray system is fitted which is unique to liquefied gas tanker.			
12.3.3	States that Dry Chemical Powder is used for fighting liquefied gas fire and nitrogen snuffers are used for vent riser fire			
12.4	**Fixed firefighting foam system operations**	**R1,R2,R6, R8**	**T1,T2,B7,B8,B 1,B1,B4**	**A1,A2,**
12.4.1	States that in general foam installations are not provided on liquefied gas tankers for liquefied gas firefighting. However when the vessel has the capability of carrying cargoes also covered by the IBC code then the flag administration may require a foam installation.			
12.4.2	States that for liquefied gases, therefore, foam is only appropriate for use in bonded areas and for this reason is only found at terminals and is not provided on liquefied gas tankers			
12.5	**Portable firefighting foam operations**	**R1,R2,R6, R8**	**T1,T2,B7,B8**	**A1,A2,**
12.5.1	States portable firefighting equipment are Fire extinguishers and applicator foam system			
12.5.2	Describes Applicator foam systems and portable foam fire extinguishers			

TOPIC 11	FIREFIGHTING OPERATIONS			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
12.6	**Fixed dry chemical system operations**	**R1,R2,R6, R8**	**B1,B2,T1,T2,B 7,B8**	**A1,A2,**
12.6.1	Explains Portable extinguishers and Fixed dry chemical system operations			
12.6.2	States briefly the regulations governing fixed DCP installations - Describes Monitors and Hand held hose length requirements - States the System Capacity requirements of DCP should be of sufficient quantity and stored in each container to provide a minimum 45 seconds discharge time for all monitors and hand hose lines attached to each powder unit			
12.6.3	Explains the layout of fixed DCP installation			
12.6.4	Describes the operational principle of extinguishing LPG/LNG fire - using DCP as an extinguishing medium - advantages of DCP as an extinguishing medium			
12.6.5	Lists the different types of DCP as: - BC – Sodium bicarbonate or Potassium bicarbonate - ABC –Mono-ammonium phosphate - Monnex Powder – potassium bicarbonate urea - M28 and L2 Powder – sodium, Magnesium and aluminum			
12.6.6	States that the components and pipeline system of the fixed DCP installation includes the following : - Main DCP cylinder or container - Propellant gas cylinder (Nitrogen) - Pilot cylinder (Nitrogen / CO_2) - Release levers in the release cabinet - Pilot stations - Remote operated valve - Piping arrangement - Flexible hose with snap shut handling valve			

TOPIC 11 FIREFIGHTING OPERATIONS

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
	- Pressure gauges in the system for monitoring			
12.6.7	Demonstrates the proper Firefighting procedure using fixed DCP system as regards - Dons fire suit and Personal Protective gear and brings appropriate equipment - Activates the release of the DCP in the fixed DCP system following the correct sequence of operation - Approaches the fire with a charged DCP hose - Extinguishes the fire by applying the proper firefighting technique such as sweeping action to the overall area of the fire.			
12.7	**Basic knowledge of spill containment in relation to firefighting operations**	**R2,R6**	**B1,T1,T2,B7, B8**	**A1,A2**
12.7.1	Describes spill containment in relation to firefighting operations of a liquefied gas tanker. - Prompt initiation of the ESD (Emergency Shut Down) will do much to limit the amount of liquid spilled - Restrict sources of ignition that could ignite the vapour - Direct DCP jets on the spilled pool must be avoided as this will prevent smothering of the fire and will allow the liquid and its vapours to spread.			

COMPETENCE 5: Respond to emergencies

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

13.0 Emergency procedures including emergency shutdown

1. **Emergency organization**
2. **Alarms**
3. **Emergency procedures**
4. **ESD**

TOPIC 13 EMERGENCY PROCEDURES INCLUDING EMERGENCY SHUTDOWN

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
13.0	**Basic knowledge of emergency procedures**	**R2,R6,R7**	**T1,T2,B7,B8, B1, B9, B10**	**A1,A2**
13.1	**Emergency organization**	**R2,R6,R7**	**T1,T2,B7,B8, B1**	**A1,A2**
13.1.1	States that on most ships the basic structure of the emergency organization consists of four elements: - Command centre - Emergency party - Back-up emergency party - Technical party			
13.1.2	States that all personnel on board should know their place in the emergency organization and their duty in case the emergency procedure is being initiated			
13.1.3	States the need to identify a senior officer as being in control during the emergency, with another senior officer identified as his deputy			
13.1.4	States the general composition and the task of the command centre			
13.1.5	States the general composition and the task of the emergency party			
13.1.6	States the general composition and the task of the back-up emergency party			
13.1.7	States the general composition and the task of the engineers group			

TOPIC 13	**EMERGENCY PROCEDURES INCLUDING EMERGENCY SHUTDOWN**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
13.1.8	States that all personnel on board should know their place in the emergency organization and their duty in case an emergency procedure is being initiated			
13.2	**Alarms**	**R2,R6,R7**	**T1,T2,B7,B8, B1**	**A1,A2**
13.2.1	States that fire alarm signals or general alarm signals are given in case of: - Fire - Collision - Grounding - Hose burst - Major spillage of cargo liquid or escape of vapour - Other emergency situations which call for emergency actions			
13.2.2	States that all crew members should be familiar with the emergency plan and act according to the plan when the alarm is raised			
13.2.3	States that any person who discovers an emergency should raise the alarm and pass on information as quickly as possible			
13.3	**Emergency procedures**	**R1,R2,R6**	**T1,T2,B7,B8, B1,B4**	**A1,A2,**
13.3.1	States that the ship's muster list and emergency instructions specify action to be taken by all crew members and officers in case of an emergency			
13.3.2	States that the vessel's safety plan and fire control plan specify details and location of all equipment for emergency use			
13.3.3	States that all personnel should know the location of emergency equipment and be familiar with its use			
13.3.4	States that it is essential that personnel are property trained for emergency operations			
13.3.5	States that all equipment which may be used in an emergency must be maintained in good order and be ready for use at all times			

TOPIC 13	EMERGENCY PROCEDURES INCLUDING EMERGENCY SHUTDOWN			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books Bibliography**	**Teaching aid**
13.4	**Emergency Shut Down (ESD)**	**R2,R6,R7**	**T1,T2,B7,B8, B1,B2**	**A1,A2**
13.4.1	States that the Emergency Shut Down (ESD) system is a requirement of the IGC Code for the carriage of liquefied gases in bulk and may have a linked ship-shored ESD system			
13.4.2	States that all crew members of the ship must be aware of locations and the methods of activating the Emergency Shut Down System specific to their vessel.			
13.4.3	States that ESD on a typical gas tanker will be initiated by one of the following: - Manual activation by personnel using the ESD pushbuttons - Blackout of the ship - Shore activation of their ESD system if linked system is being used - Fusible links around each tank domes, manifold and compressor house in case of fire - Cargo tank Very High level alarm - Low tank pressure - Hold/cargo tank differential pressure - Low cargo valves hydraulic pressure - Low control air pressure			
13.4.4	States that the initiation of ESD will generally lead to the following: - All ESD manifold loading valves will close - The gas compressors will trip - The main discharge and spray pumps will trip - All shore pumps will trip if ESD system is inter linked - In case of LNG ships the Master gas valve to engine room will close - Inert gas generator will trip			
13.4.5	States that while loading if system is not inter linked there will be danger of pressure surge if ESD is operated.			

COMPETENCE 6:	**Take precautions to Prevent pollution of the environment from the release of liquefied gases**

TRAINING OUTCOMES:

Demonstrates a knowledge and understanding of:

14. Effects of pollution on human and marine life.

15. Shipboard procedures to prevent pollution.

16. Measures to be taken in the event of spillage, including the need to:
.1 report relevant information to the responsible persons
.2 assist in implementing shipboard spill-containment procedures
.3 prevent brittle fracture

TOPIC 14 EFFECTS OF POLLUTION ON HUMAN AND MARINE LIFE

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
14.0	**Basic knowledge of the effects of pollution on human and marine life**	**R2,R3**	**T1,T2,B7,B8, B1**	**A1,A2**
14.1	Defines pollution as inconvenience or damage caused by human activities, to humans, animals, plants and to our environment as a whole, by introducing pollutants into the air, into the water or onto the land			
14.1.1	States that these pollutants causes harm to living resources, hazards to human health and damage to amenities and other uses of the environment.			

TOPIC 15 SHIPBOARD PROCEDURES TO PREVENT POLLUTION

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
15.0	**Basic knowledge of shipboard procedures to prevent pollution**	**R2,R3**	**T1,T2,B7,B8, B1,B2**	**A1,A2**
15.1	States that all operations on board involving cargo, ballast and bunkers should be done in accordance with the applicable pollution regulations	**R2,R3**	**T1,T2,B7,B8, B1,B2**	**A1,A2**
15.1.1	States that during cargo-transfer operations, care should be taken to avoid release of cargo liquid and/or vapours			
15.1.2	States that the preparation for cargo transfer includes procedures to be followed to prevent pollution of air and of water			
15.1.3	States that these procedures include: - Inspection of cargo hoses, loading arms, valves and gaskets - Inspection of cargo system and instrumentation - Inspection of flanges, valves, connections and tank hatches for tightness - Closed loading and unloading cargo operations			

TOPIC 16 MEASURES TO BE TAKEN IN THE EVENT OF SPILLAGE

Knowledge, Understanding and Proficiency		IMO Reference	Text books Bibliography	Teaching aid
16.0	**Basic knowledge of measures to be taken in the event of spillage.**	**R2,R3**	**T1,T2,B7,B8,B1**	**A1,A2,**
16.1	Report relevant information to the responsible persons			
16.2	Assist in implementing shipboard spill-containment procedures			
16.2.1	States that personnel on watch should be present on deck at all times during cargo-transfer operations, and should regularly carry out the inspections to prevent pollution.			
16.3	Prevent brittle fracture			

Part D: Instructor Manual

■ Introduction

This manual reflects the views of the course designer on methodology and organization, and what is considered relevant and important in the light of his experience as an instructor. Although the guidance given here would be of value initially, the course instructors are advised to work out their own methods and ideas, refining and developing it further what is found more constructive and discarding those methods which are not found effective.

The course Instructors should also bear in mind that preparation and planning constitute a major contribution to effective presentation of the course.

The instructor's manual provides guidance on the material that is to be presented during the course. The course material reflects the mandatory minimum requirements for the training and qualifications of officers and ratings on Gas tankers as specified in paragraph 2 of regulation V/1-2 of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended.

The competences mentioned in the above mentioned STCW regulation is broken down in the following topics is reflecting, how the trainer should design their course and delivery and is for guidance only.

To show consistency and adherence to STCW 2010, as given in table A-V/1-2-1, a mapping is provided for easy reference in part A of this Model course from STCW's competences and training outcomes to the topics covered in the IMO Model course 1.04.

Design and Operational Characteristics of Liquefied Gas tankers.

1. Basic knowledge of liquefied gas tankers
2. Basic knowledge of cargo operations.
3. Basic knowledge of the physical properties of liquefied gas
4. Knowledge and understanding of tanker safety culture and safety management
5. Basic knowledge of the hazards associated with liquefied gas tanker operations
6. Basic knowledge of hazard controls
7. Understanding of information on a Material Safety Data Sheet (MSDS)
8. Function and proper use of gas-measuring instruments and similar equipment.
9. Proper use of safety equipment and protective devices.
10. Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to liquefied gas tankers
11. Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)
12. Gas Tanker Firefighting
13. Basic knowledge of Emergency procedures, including emergency shutdown (ESD)
14. Basic knowledge of the effects of pollution on human and marine life
15. Basic knowledge of Shipboard procedures to prevent pollution
16. Basic knowledge of measures to be taken in the event of spillage

The texts used as references throughout the course are given in part A Course framework and are; Teaching Aids (A), IMO Reference Books (R), Text books (T), Bibliography (B) and Videos/CBTs (VG).

The course outline and timetable provide guidance on the time allocations for the course material, but the instructor is free to make adjustments as necessary. The detailed teaching syllabus must be studied carefully, and lesson plans or lecture notes compiled where appropriate.

It will be necessary to prepare material for use with overhead projectors or for distribution to trainees as handouts. Some sketches and diagrams are provided at the end of the guidance notes. These will provide examples of the kind of material, which is useful in supporting the presentation of the course.

Whenever Knowledge based learning objectives are incorporated in part C of this model course, these can be defines, states or lists, and can be displayed in power-point presentations along with the figures appended herein in part D for the corresponding learning objectives. Where explanations and descriptions are stated in Part C of this model course, further guidance notes are given below in part D.

Throughout the course it is important to stress that, aboard ships rules and regulations must be strictly observed and all precautions taken to maximize safety and minimize harmful effects to the environment.

Topics marked with an asterisk (*) could be explained better on a Liquefied Gas Tanker Cargo and Ballast Handling Simulator.

Guidance Notes

Learning Objectives

1.0 BASIC KNOWLEDGE OF LIQUEFIED GAS TANKERS (3.0 hours)

This will be a brief review of the way Liquefied gas tankers have evolved. The material in the Tanker safety guide for Liquefied gases will give all required details needed for the instructor. The level at which the lecture should be based will depend on the level and responsibilities of the trainees.

1.1.3. Describes generally LPG ships

Fully refrigerated LPG Ships
These ships are designed to carry fully refrigerated cargoes at near atmospheric pressure at temperatures down to -50 "C. The cargoes include LPG, ammonia and in most cases, some of the chemical gases, butadiene, propylene and VCM.

Ships of the fully refrigerated type generally have capacities above 15,000 m3, up to about 85-100,000 m3. These ships are normally equipped with between three and six cargo tanks, extending almost the full beam of the ship. Double bottom tanks are fitted, together with topside or complete side ballast tanks. Prismatic free-standing tanks (Type A) are the most common, being supported on wooden chocks and keyed to the hull to permit expansion and contraction. This type of tank usually has an internal centreline bulkhead to improve stability and reduce sloshing. The secondary barrier is normally provided by the use of special steels for all hull structure which may be exposed to the cargo if a rupture of the primary barrier occurs. The hold is inerted when flammable cargoes are carried or filled with dry air for non-flammable cargoes.

1.1.4. Describes generally LEG ships

Ethylene Carriers
In appearance this type of ship is very similar to the semi-pressurised ship, and competes for the same cargoes when the ethylene market is less profitable. The main difference is the design temperature of -104 °C for the cargo containment system.

The sizes are typically between 2000-12,000 m3, and the cargo tanks are independent pressure vessel Type C tanks made from nickel-steel or stainless steel. For the Type C tanks, no secondary barrier is required. The ships are normally fitted with a double bottom.

A cascade type refrigeration plant is fitted, of sufficient capacity for reliquefaction of ethylene carried fully refrigerated at -104 °C, and the cargo tanks normally have a thicker insulation than on fully refrigerated LPG ships. A few ethylene carriers of small size have been built with semi-membrane tanks and secondary barrier.

1.1.5. Describes generally LNG ships

Methane / LNG Carriers
Methane/LNG is carried at atmospheric pressure at -163 °C in cargo tanks made from aluminium, nickel-steel or stainless (austenitic) steel. Insulation is fitted and most LNG ships are more correctly described as fully insulated since they usually have no reliquefaction plant; boil-off gas is normally burnt in the main propulsion machinery.
The ships are large, mainly from 40,000 to 135,000 m^3, with four to six cargo tanks of Type A, B or membrane. The space between the primary and secondary barriers is inerted. However, for Type B systems with only a partial secondary barrier, the hold space is usually filled with dry air. A full double bottom and side ballast tanks are fitted.
The arrangement of primary and secondary barriers varies widely from system to system

1.1.6. Describes generally chlorine ships

Chlorine is a very toxic gas that can be produced by the dissolution of sodium chloride in electrolysis. Because of the toxicity of Chlorine it is therefore transported in small quantities, and must not be transported in a larger quantity than 1200 m^3. The liquefied gas tanker carrying chlorine must be type 1G with independent type C tanks. That means the cargo tank must at the least, lie B/5 "Breadth/5" up to 11.5 meter from the ships side. To transport Chlorine, the requirements of IMO IGC code, chapters 14, 17 and 19 must be fulfilled. Cooling of chlorine requires indirect cargo cooling plants.

The difference of Chlorine and other gases transported is that Chlorine is not flammable. Chlorine is utilised in producing chemicals and as bleaching agent in the cellulose industry

1.1.7. Describes LPG / Chemical ships

Liquefied gas tankers that are allowed to transport ethylene oxide or propylene oxide must be specially certified for this. Ethylene oxide and propylene oxide have a boiling point at atmospheric pressure of respectively 11°C and 34°C and are therefore difficult to transport on tankers without indirect cargo cooling plants. Ethylene oxide and propylene oxide cannot be exposed to high temperature and can therefore not be compressed in a direct cargo cooling plant. Ethylene oxide must be transported on gas tanker type 1G.
Chemical gases like propylene, butadiene and VCM are transported with medium-sized atmospheric pressure tankers from 12000 m^3 to 56000 m^3.

Semi-pressurised liquefied gas tankers are also used in chemical gas trade and then in smaller quantity as from 2500 m^3 to 15000 m^3.

Chemical gases are transported all over the world, and especially to the Far East where there is a large growth in the petro-chemical industry.

1.1.8. Describes briefly tank containment systems of a liquefied gas tanker.

The information below is much more than what is necessary to be stated in the basic level course. It is recommended that the instructor shows the diagrams of the containment systems and gives only a brief description of the different containment systems mentioned herein under.

A cargo containment system is the total arrangement for containing cargo including, where fitted:

The basic cargo tank types utilized on board liquefied gas tankers are in accordance with the list below:-

Independent Type 'A': Some other types such as:
Independent Type 'B': Internal insulation Type '1'
Independent Type 'C': Internal insulation Type '2'
Membrane: Integral

Independent Tanks

Independent tanks are completely self-supporting and do not form part of the ship's hull structure. Moreover, they do not contribute to the hull strength of a ship. As defined in the IGC Code, and depending mainly on the design pressure, there are three different types of independent tanks for liquefied gas tankers: these are known as Type 'A', "B' and 'C'.

Type 'A' Tanks

Type 'A' tanks are constructed primarily of flat surfaces. The maximum allowable tank design pressure in the vapour space of for this type of system is 0.7 barg; this means cargoes must be carried in a fully refrigerated condition at or near atmospheric pressure (normally below 0.25 barg).

The IGC Code stipulates that a secondary barrier must be able to contain tank leakage for a period of at least 15 days.

Type 'B' Tanks

Type 'B' tanks can be constructed of flat surfaces or they may be of the spherical type. This type of containment system is the subject of much more detailed stress analysis compared to Type 'A' systems. These controls must include an investigation of fatigue life and a crack propagation analysis. The most common arrangement of Type 'B' tank is a spherical tank. This tank is of the Kvaerner Moss design.

There are Type 'B' tanks of prismatic shape in LNG service. The prismatic Type 'B' tank has the benefit of maximizing ship-deck. Where the prismatic shape is used, the maximum design vapour space pressure is, as for Type 'A' tanks, limited to 0.7 barg.

Type 'C' Tanks

Type 'C' tanks are normally spherical or cylindrical pressure vessels having design pressures higher than 2 barg. The cylindrical vessels may be vertically or horizontally mounted. This type of containment system is always used for semi-pressurized and fully pressurized liquefied gas tankers.

In the case of the semi-pressurized ships it can also be used for fully refrigerated carriage, provided appropriate low temperature steels are used in tank construction. For a semi-pressurized ship the cargo tanks and associated equipment are designed for a working pressure of approximately 5 to 7 barg and a vacuum of 0.5 barg. Typically, the tank steels for the semi-pressurized ships are capable of withstanding carriage temperatures of -48 degree C for LPG or -104 degree C for ethylene (an ethylene carrier may also be used to transport LPG).

In the case of a typical fully pressurized ship (where the cargo is carried at ambient temperature), the tanks may be designed for a maximum working pressure of upto 18 barg.

Type 'C' tanks as fitted in a typical fully pressurized liquefied gas tanker. With such an arrangement there is comparatively poor utilization of the hull volume; however, this can be improved by using intersecting pressure vessels or bi-lobe type tanks which may be designed with a taper at the forward end of the ship. This is a common arrangement in semi-pressurized ships.

Membrane Tanks (membrane – 0.7 to 1.5 mm thick)

The concept of the membrane containment system is based on a very thin primary barrier (membrane – 0.7 to 1.5 mm thick) which is supported through the insulation. Such tanks are not self-supporting like the independent tanks. An inner hull forms the load bearing structure. Membrane containment systems must always be provided with a secondary barrier to ensure the integrity of the total system in the event of primary barrier leakage.

Semi-Membrane Tanks

The semi-membrane concept is a variation of membrane tank system. The primary barrier is much thicker than in the membrane system, having flat sides and large roundish corners. The tank is self-supporting when empty but not in the loaded condition. In this condition the liquid (hydrostatic) and vapour pressures acting on the primary barrier are transmitted through the insulation to the inner hull as is the case with the membrane system. The corners and edges are designed to accommodate expansion and contraction.

Integral Tanks

Integral tanks form a structural part of the ship's hull and are influenced by the same loads which stress the hull structure. Integral tanks are not normally allowed for the carriage of liquefied gas if the cargo temperature is below -10 degree C. Certain tanks on a limited number of Japanese-built LPG carriers are of the integral type for the dedicated carriage of full refrigerated butane.

Internal Insulation Tanks

Internally insulated cargo tanks are similar to integral tanks. They utilize insulation materials to contain the cargo. The insulation is fixed inside ship's inner hull or to an independent load-bearing surface. The non-self-supporting system obviates the need for an independent tank and permits the carriage of fully refrigerated cargoes at carriage temperatures as low as -55 degree C.

Internal insulation systems have been incorporated in a very limited number of fully refrigerated LPG carriers but, to date, the concept has not proved satisfactory in service.

2.0 BASIC KNOWLEDGE OF CARGO OPERATIONS: (7.5 hours)

The Instructor should point out that carrying and handling liquefied gas cargo onboard poses significant potential hazards including risk of injury or death, threats to environment and each person working on a liquefied gas tanker and terminal ashore needs to understand the risks involved, obtain the necessary training and take all the needed precautions.

2.1.1 Describes generally the cargo piping arrangement

The loading lines and pipes mentioned here refer to liquefied gas tanker's cargo handling system. This involves liquid lines, vapour lines, condensate return lines, lines to vent mast, pipes inside the cargo tank and seawater pipes to the cargo cooling plant. All loading lines on liquefied gas tanker: liquid lines, gas lines and lines to vent mast have the same requirements as pressure vessels regarding of temperature and pressure they are meant to handle. All welding on pipes exceeding 75 mm in diameter and 10 mm wall thickness or more must be X-rayed and classed by the class company. The same regulation do we have on flanges and spool pieces also. All loading lines outside the cargo tank must be produced by material with melting point no less than 925 0C. The loading lines on liquefied gas tankers are mostly produced of stainless steel, but low temperature nickel steel is also in use. All loading lines with an outside diameter of 25 mm or more must be flanged or welded. Otherwise, lines with an outside diameter less than 25 mm can be connected with treads. Loading lines designed for cargo with low temperature, less than –10 0C must be insulated from the ship hull. This to prevent the ship hull to be cooled down to below design temperature. The hull has to be protected against cold cargo spill under spool pieces and valves on all liquid lines. This is done with wood planks or plywood. To prevent cold cargo spill on the hull plates, a drip tray must be placed under the manifold flanges. All lines that are thermally insulated from the hull must be electrically bonded to the hull with steel wire or steel bands. On each flange on lines and pipes where gaskets is used, there must be electrical bonding with steel wire or steel band from flange to flange.

2.2.1.4 Describes generally a float gauge

The float gauge is widely used in all tanker work and consists of a float attached by a tape to an indicating device which can be arranged for local and remote readout. A typical float gauge which is normally installed in a tubular well or with guide wires, with a gate valve for isolation so that the float can be serviced in a safe atmosphere. The float must be lifted from the liquid level when not in use; if left down, the fluctuation in level at sea will damage the tape-tensioning device. Float gauges cannot normally register a liquid level of less than 100mm in depth.

2.2.4 Describes generally the unloading system

If a simulator is available, it would be best to let the candidates locate and operate the equipment to understand its operational requirements with due diligence to safety. The Unloading system comprises of:

Cargo pumps

Fitted aboard refrigerated gas tankers are normally of the centrifugal type, either deepwell or submerged, operating alone or in series with a deck-mounted booster pump where cargo heating is required on unloading to pressurise storage from a refrigerated vessel. Some fully pressurised ships unload cargo by pressurising tanks and require booster pumps to assist in the transfer of cargo ashore.

Deepwell pumps

Deepwell pumps are the most common type of cargo pump for LPG carriers. Figure in part D2 shows a typical deepwell pump assembly. The pump is operated electrically or hydraulically by a motor, which is flange-mounted outside the tank. The drive shaft is guided in carbon bearings inside the discharge tube and these bearings are in turn lubricated and cooled by the cargo flow up the discharge tube.

The impeller assembly is mounted at the bottom of the cargo tank and will frequently comprise two or three impeller stages together with a first stage inducer; this latter is an axial flow impeller used to minimise the NPSH (net positive suction head) requirement of the pump. The shaft sealing arrangement consists of a double mechanical seal with an oil flush. The accurate installation and alignment of the motor coupling, thrust bearing and mechanical oil seal is important.

Submerged pumps

This type of pump is used on all LNG carriers, and on many of the larger fully refrigerated LPG carriers. The pump assembly and electric motor are close coupled and installed in the bottom of the cargo tank; power is supplied to the pump motor through copper or stainless steel sheathed cables, which pass through a gastight seal in the tank dome and terminate in a flameproof junction box. Submerged pumps and their motors are cooled and lubricated by the cargo and are therefore susceptible to loss of flow rate damage. Figure in part D2 shows a typical submerged pump/motor assembly.

Booster pumps

Booster pumps are also of the centrifugal type and may be either vertical in-line pumps deck-mounted in the appropriate discharge line and driven by an "increased safety" electric motor or, alternatively, horizontal pumps installed on deck or in the cargo compressor room driven through a gastight bulkhead by an electric motor installed in the electric motor room.

Figures appended in part D2 show examples of these types of pump. The particular pumps shown are fitted with a double mechanical seal, which is methanol-flushed and pressurised between the seals.

CARGO HEATERS AND CARGO VAPORIZERS

A cargo heater is used to heat the cargo when discharging to an ambient shore tank.

A cargo heater is also used when loading a fully pressurised liquefied gas tanker with cargo with temperature less than –10 0C. Seawater or oil is used to heat the cargo in the cargo heater.

It is of importance to remember that the cargo heater is full of water and have good flow out with water before letting cold cargo into the heater. Fully pressurised liquefied gas tankers are carriers that are designed to transport condensed gases at ambient temperature, and they normally don't have cargo cooling plant.

Heat exchanger

Heat exchangers are utilised in several different parts of cargo handling on liquefied gas tankers, as heat exchangers (cargo heater), condensers for cargo cooling plant, vapour risers, super heaters and oil coolers for compressors.

In most of the heat exchangers seawater is used as the medium on liquefied gas tankers, which the products are cooled or heated against. The heat exchangers that are used for cargo handling must be designed and tested to tolerate the products the liquefied gas tanker is certified for. Heat exchangers are used for cargo handling are considered as pressure vessels. All heat exchangers that are used for cargo handling must be pressure tested and certified by the liquefied gas tanker's Class Company.

2.3 Loading, Unloading and care in transit

2.3.1 Describe briefly preparations for loading / unloading and precautions to be taken during these operations.
At beginning of Loading and Unloading operations, the officers involved in cargo operations should be positioned on Manifold, on cargo deck and in CCR. They will remain in these stations until full loading/unloading rate and steady flow conditions have been reached.

Preparation must follow the instruction and sequence set up in the vessel's Cargo Handling Manual and as per responsible officer's plans. This is also important with loading preparations for drying, inerting, gassing up and initial cool down is undertaken and after unloading when warming up, gas freeing, inerting, aerating, Atmosphere and temperature control of cofferdams, hold spaces and tank space prior to each of the above operations is significantly important when preparations for loading/unloading low temperature cargo are done.

The line-up must be checked by the Cargo Engineer and verified by Chief Officer, and logged down.

All cargo operations related checklists must be initialled by all duty officers, Chief Officer and Cargo Engineer. The verification needs to be done by both senior officers participating in the cargo operations, to ensure that all systems have been cross-checked.

Prior to taking over watch during cargo operations, all Deck Officers and ratings must read and be familiar with any additional standing orders that the Chief Officer has issued.

The following precautions should be observed:

(1) Where codes and regulations call for segregation, the position of the valves, blanks, portable bends and spool pieces associated with such segregation should be carefully arranged and clearly identified. These arrangements for segregation must be followed as part of the approved system.
(2) If the cargoes to be carried are not compatible, the responsible officer should ensure that the pipeline systems for each cargo are completely isolated from each other. This entails checking that all necessary blanks are fitted and that

pipe spool pieces have been removed as required. A cargo log book entry should be made of the action taken.

(3) In case where two cargoes such as Propane and Butane are compatible and an apparent negligible mix is permitted, the adjacent systems carrying the different cargoes should be isolated by at least two valves at each connection, or by one positive visible blank.

(4) Common pipelines and associated equipment should be drained, dried, ventilated and monitored before being used for another cargo.

(5) All temporary pipe-work should be gas-freed, monitored, disconnected and properly stored when not in use.

2.3.2 Describe briefly cargo conditioning during loaded passage

The term "cargo conditioning" refers to the care and attention given to the cargo on passage to ensure that:

(1) There are no undue losses in cargo quantity

(2) Cargo tank pressures are kept within design limits; and

(3) Cargo temperature is maintained or adjusted as required.

These aims are achieved either by reliquefaction for LPG and other gases or, on most LNG ships, by using boil-off as propulsion fuel. Cargo conditioning may not be necessary on ships with pressure vessel tanks.

If reliquefaction plant is fitted the responsible personnel should have a thorough understanding of its operational principles. When running, the plant should be monitored so that anything which might adversely affect its safety or efficiency is quickly recognized and corrective action taken. Plant is normally fitted with shutdown devices to sense high liquid level, temperature or pressure.

2.5.5 Explains briefly purging, gas freeing and inerting requirements and precautions to take during such operations.

The formation of a flammable vapour mixture in the cargo system should be prevented by replacing the air in the system with inert gas before loading, and by removing cargo vapour by inert gas after unloading, prior to changing cargoes or gas-freeing. Suitable pipe connections should be provided for this purpose. Inerting should be continued until the concentration of oxygen or cargo vapour in the space is reduced to the required level. The tank atmosphere should be monitored at different levels to ensure these are no pockets of excessive concentrations of oxygen or cargo vapour, particularly in tanks with complex internal structures or bulkheads.

Some cargoes require the oxygen content in the vapour space to be kept extremely low (in some case less than 0.2%) to prevent a chemical reaction occurring. For instance, ethylene oxide / propylene oxide mixtures can decompose spontaneously unless special precautions are taken to control the atmosphere; and butadiene can react with oxygen to form unstable peroxide compounds. The oxygen content in the tanks must be reduced as necessary before loading begins. While such cargoes remain on board, oxygen is excluded either by keeping the ullage space full of inert gas at a positive pressure or, in the case of butadiene, by keeping the cargo vapour above atmospheric pressure. In every case, shippers' requirements should be strictly observed.

After lay-up or dry dock, the cargo tanks are filled with inert gas or nitrogen. If the purging has been done with inert gas, the cargo tanks have to be gassed up and cooled down when the vessel arrives at the loading terminal. This is because, inert gas contains about 14% carbon-dioxide, which will freeze at around -60ºC and produces a white powder which can block valves, filters and nozzles.

Gassing up or Purging at sea using liquid from deck storage tanks

This method is normally available only to the larger fully, or semi-refrigerated vessel which is equipped with deck storage tanks. in this case, either vapour or liquid can be taken into the cargo tanks.
Liquid can be taken directly from deck storage through the tank sprays (with the exception of ammonia) at a carefully controlled rate to avoid cold liquid impinging on warm tank surfaces.
The reliquefaction plant be started and cool down of the system begin.

Gassing up or Purging alongside

The "gassing operation may also be undertaken using cargo supplied from shore. At certain terminals facilities exist to allow the operation to be carried out alongside but these tend to be the exception as venting of hydrocarbon vapours alongside may present a hazard and is not permitted by most terminals and port authorities.

Before commencing purging operations alongside, the terminal will normally require sampling the tank atmosphere to check that the oxygen is less than five per cent for LPG cargoes (some terminals require as low as two per cent) or the much lower concentrations required for chemical gases such as VCM.

Where venting to atmosphere is not permitted, a vapour return facility must be provided and used throughout the purging operation. Either the ship's cargo compressors or a jetty vapour blower can be used to handle the efflux. Some terminals, while prohibiting the venting of cargo vapours, permit the efflux to atmosphere of inert gas. Thus, if a displacement method of purging is used, the need for the vapour return flow to shore may be postponed until cargo vapours are detected in the most vented efflux. This point may be considerably postponed if tanks are purged in series.

Where a terminal supplies a cargo liquid for purging, it should be taken aboard at a carefully controlled rate and passed through the ship's vaporizer or allowed to vaporize in the tank(s). If the supply is of vapour, this can be introduced into the tank(s) at the top or bottom depending on the vapour density.

During gassing up, the inert gas in the cargo tanks is replaced with warm LNG vapor. This is done to remove carbon dioxide and to complete drying of the tanks. The LNG vapour is lighter than the inert gas, which allows the inert gases in the cargo tank to be exhausted up the tank filling line to the liquid header. The inert gas then vents to the atmosphere via the vent mast.

During all purging and gas freeing operations consider the risk to personnel on deck encountering a concentration of cargo vapour. If the cargo is particularly hazardous, precautions for all personnel working on deck to carry the Emergency Life Support Apparatus must be taken.

In vessels carrying Vinyl Chloride Monomer or Propylene Oxide where there is a possibility of vapour of liquid escaping, all operations such as hose disconnection and cargo sampling will be carried out or supervised by personnel wearing full CABA and totally enclosed protective clothing.

3.0 BASIC KNOWLEDGE OF THE PHYSICAL PROPERTIES OF LIQUEFIED GASES (1.5 hours)

It has to be explained here that transport requirements IGC Code) divide chemical cargoes and Gas cargoes based on the Vapour pressures exerted by the Liquids.

IMO divides liquefied gases into the following groups:

- LPG - Liquefied Petroleum Gas
- LNG - Liquefied Natural Gas
- LEG - Liquefied Ethylene Gas
- NH_3 - Ammonia
- CL_2 - Chlorine
- Chemical gases

The IMO gas carrier code define liquefied gases as gases with vapour pressure higher than 2.8 bar with temperature of 37.8 ^{0}C. IMO gas code chapter 19 defines which products are liquefied gases and have to be transported by liquefied gas tankers. Some products have vapour pressure less than 2.8 bar at 37.8 ^{0}C, but are defined as liquefied gases and have to be transported according to chapter 19 in IMO Gas code. Propylene oxide and ethylene oxides are defined as liquefied gases. Ethylene oxide has a vapour pressure of 2.7 bar at 37.8 ^{0}C. To control temperature on ethylene oxide we must utilise indirect cargo cooling plants. Products not calculated as condensed gas, but still must be transported on liquefied gas tankers, are specified in IMO's gas code and IMO's chemical code. The reason for transportation of non-condensed gases on liquefied gas tankers is that the products must have temperature control during transport because reactions from too high temperature can occur. Condensed gases are transported on liquefied gas tankers either at atmospheric pressure (fully cooled) less than 0.7 bars, intermediate pressure (temperature controlled) 0.5 bars to 11 bars, or by full pressure (surrounding temperature) larger than 11 bars. It is the strength and construction of the cargo tank that is conclusive to what over pressure the gas can be transported.

3.2.1 Explains in simple terms:

- **states of aggregation**
- **boiling point**
- **liquid density**
- **vapour density**
- **flashpoint**

States of aggregation

Every material in our environment is in a particular state, like **liquid**, **solid** or **gaseous**. Every material can be in every state. Sometimes it is quite difficult to imagine materials like iron in a gaseous state, but if a certain level of **temperature** is reached, also iron can be in a gaseous state
Hence, every material can be in every state of aggregation and the state of aggregation depends on the material's temperature
In changing from solid to liquid (fusion) or from liquid to vapour (vaporisation), heat must be given to the substance. Similarly in changing from vapour to liquid (condensation) or from liquid to solid (solidification), the substance must give up heat. The heat given to or given up by the substance in changing state is called **latent heat.** For a given mass of the substance, the latent heats of fusion and solidification are the same. Similarly, latent heats of vaporisation and of condensation are the same, although different from the latent heat of fusion or solidification.

Fusion or solidification occurs at a specific temperature for the substance and this temperature is virtually independent of the pressure. Vaporisation or condensation of a pure substance, however, occurs at a temperature which varies widely dependent upon the pressure exerted on the substance. The latent heat of vaporisation also varies with pressure. For liquefied gases, we are not concerned with the solid state since this can only occur at temperatures well below those at which the liquefied gas is carried. Temperatures, pressures and latent heats of vaporisation, however, are of fundamental importance. This data may be presented in graphical form appended in part D2 which gives curves for vapour pressure, liquid density, saturated vapour density and latent heat of vaporisation against temperature for methane.

The **boiling point** of a substance is the temperature at which the vapour pressure of the liquid equals the pressure surrounding the liquid and the liquid changes into a vapour state.

Liquid and vapour densities The density of a liquid is defined as the mass per unit volume and is commonly measured in kilograms per decimetre cubed (kg/d m^3). Alternatively, liquid density may be quoted in kg/litre or in kg/m^3. The variation with temperature of the density of a liquefied gas in equilibrium with its vapour is shown for propane in curve **y'** in figure appended in **part D2** of as can be seen, the liquid density decreases markedly with increasing temperature. This is due to the comparatively large coefficient of volume expansion of liquefied gases. All liquefied gases, with the exception of chlorine, have liquid relative densities less than one. This means that in the event of a spillage onto water these liquids would float prior to evaporation.

Vapour density is the density of a vapour in relation to that of hydrogen. It may be defined as mass of a certain volume of a substance divided by mass of same volume of hydrogen.
Vapour density is also defined with respect to air and not hydrogen. Air is given a vapour density of one.
All gas and vapour molecular weights are divided by 22.414 to derive their vapour density at 0^oC and 1 bar atmospheric pressure.

Flashpoint

The lowest temperature at which a combustible liquid gives off sufficient vapour to form a flammable mixture with air near the surface of the liquid. Flashpoint is determined by laboratory testing in a prescribed apparatus

4.0 KNOWLEDGE AND UNDERSTANDING OF TANKER SAFETY CULTURE AND SAFETY MANAGEMENT (1.5 hours)

It addresses Safety and Health (OHSAS 18001 – Occupational Health and Safety Assessment Systems) procedures and guidelines.

The process of a safety management system addresses safety aspects of shipboard activities and lays requisite guidelines. These guidelines requires due diligence combined with professional judgment and good seamanship which is inherited from within an organization and which assists the development of a safety culture.

The requirements of work permit, personal protective equipment and health safeguards are tools to assist the ship-staff with the sole objective of safely carrying out onboard activities and to further an aim of "Zero Accident and Incidents"

The safety management basic components are:

- Policy – Establish within policy statements what the requirements are for the organisation in terms of resources, defining management commitment and defining targets
- Organizing – How is the organisation structured, where are responsibilities and accountabilities defined, who reports to whom and who is responsible for what.
- Planning and Implementation – What legislation and standards apply to the organisation, what objectives are defined and how are these reviews, hazard prevention and the assessment and management of risk.
- Evaluation – How is on board performance measured and assessed, what are the processes for the reporting of accidents and incidents and for the investigation of accidents and what internal and external audit processes are in place to review the system.
- Action for Improvement – How are preventative and corrective actions managed and what processes are in place to ensure the continual improvement process. There is a significant amount of detail within each of these sections and these should be examined in detail from the ILO-OSH Guidelines document

5.0 BASIC KNOWLEDGE OF THE HAZARDS ASSOCIATED WITH TANKER OPERATIONS(1.5 hours)

While the carriage of liquefied gases incurs its own special hazards, some of its features are less hazardous than those of the heavier petroleum. Hazards peculiar to carriage of liquefied gases:

a. Leaks and spillages of cold liquid can affect the strength and ductility of ship's structural steel.
b. Contact by personnel with the liquids, or escaping gases, or with cold pipe work can produce frost burns.
c. Rupture of a pressure system containing liquefied gas could release a massive evolution of vapour.
d. Features of liquefied gas carriage that result in a reduction of hazard compared with normal tanker operation:
    (i) Loading does not eject gases to atmosphere in vicinity of decks and superstructures.
    (ii) Liquefied gas compartments are never flammable throughout the cargo cycle. Static electricity and other in-tank ignition sources are therefore no hazard.
    (iii) There is no requirement for tank cleaning and its associated hazards.

5.5.6: Explains the flammability diagram with respect to: Flammable range, Flammable zone and shows how use of inert gas enhances safety in operations

The Instructors should sketch and explain the flammability diagram for some flammable gases separately showing the differences in LFL and UFL. It must be explained how addition of inert gas reduces the UFL and raises the LFL.
As concentration of inert gas in the mixture is increased the flammable range decreases until the oxygen content reaches a level at which no mixture can burn.

5.5.7 Explains Boiling Liquid Expanding Vapour Explosion (BLEVE) :

A BLEVE occurs when a vessel containing liquefied gas under pressure (e.g., propane) catastrophically fails, usually as a result of external fire exposure (i.e., a pool fire under the vessel or a jet or torch-type fire impinging on the vessel walls). The fire pressurizes the vessel, causing the relief valve to open, which allows the pressurized vapor to escape. As the liquid level in the vessel decreases, the flames impinge on the vessel wall above the liquid level. The vessel wall rapidly heats up due to the poor heat transfer provided by the vapor on the inner side of the vessel wall. The wall weakens and then tears, resulting in a sudden catastrophic failure of the vessel.

The consequences of a BLEVE event are (i) the overpressure blast wave that is generated as a result of the rapid expansion of the superheated liquid, (ii) the fireball thermal radiation generated as a result of the rapid combustion of the released flammable material, and (iii) the potential vessel fragments that may be propelled as missiles. BLEVE events have the potential for causing severe human and/or facility damage at significant distances from the source of the BLEVE.

5.7.1 Explains Electro static charge generation, charge accumulation and charge discharge.

Static electricity presents fire and explosion hazards during the handling of liquefied flammable gases in any non-inert atmosphere. Certain operations can give rise to accumulations of electric charge that can be released suddenly in electrostatic discharges with sufficient energy to ignite flammable mixtures. All materials, whether solid, liquid or vapour, can generate and return a static charge to some extent. The level of charge depends on the electrical resistance of the material; if it is high, a charge can build up. On board it is possible for a static charge to build up in the cargo system on materials with low resistance, e.g. pipe works that are electrically insulated from each other.

In an un-bonded system or in a system in which the bonding has been removed or damaged static charges can be generated by:

- Flow of liquid through pipes and valves
- Flow of liquid/vapour mixtures through spray nozzles
- Flow of vapour containing foreign particles, e.g. rust, through piping

A sufficiently large potential difference between the piping system and the hull may result in a discharge of static electricity, which may cause a spark, which could result in the ignition of a flammable gas/air mixture.

To minimize the risks of static discharges the cargo system must be properly bonded through to the hull. This is done by the fitting of bonding straps at each flange in the cargo pipe-work and on the mounting of pumps and valves.

The bonding straps may be made from steel, copper or other conducting material. Copper bonding straps, particularly the type made up by woven strands can deteriorate over time, with the result that the strap either disintegrates or fails to conduct.

It should be emphasized here in the training that:

ALL BONDING ARRANGEMENTS ON BOARD MUST BE THE SUBJECT OF REGULAR INSPECTIONS WITH RECORDS OF THE INSPECTIONS MAINTAINED.

When maintenance work is carried out on the cargo system, checks must be made to ensure that the bonding arrangements have been reinstated correctly.

Due to the risk of static electricity, neither steam nor CO_2 should be injected into a tank, compartment or pipe system, which contains a flammable mixture.

5.11.1 Explains high pressure and low pressure effects

Gases expand with increase in temperature and if the space available is limited as in a tank or an isolated section of pipeline, the pressure will increase. This characteristic can lead to various hazards and makes monitoring of pressure very critical. It is very important that pressure sensors are well maintained and accurately calibrated.

<u>High and Low Pressure Effects</u>

As pressures either above or below the design range can cause damage, it should always be kept within the specific maximum and minimum values.

Cargo trapped in a closed system (e.g. between closed valves) can cause changes in pressure. Cold liquid can heat up and cause the pressure to rise and warm vapour (especially butane and butadiene) can condense and reduce pressure.

Care should be taken to ensure that liquid does not remain in a closed system and the necessary precautions concerning cargo vapour should be taken.

5.11.2 Describes pressure surge or liquid hammering

A pressure surge or wave resulting when a fluid (usually a liquid but sometimes also a gas) in motion is forced to stop or change direction suddenlychanges in pressure arise in pipelines when there is a change in fluid velocity. These changes are the result of events such as pump switching and valve operation.

5.11.3 Explains how the effect of surge pressure is minimised or avoided

When using the ship and shore ESD systems consideration must be given to avoiding escalation of an incident by creating disruptive surge pressures at the ship/shore cargo connection by the over-rapid closure of ESD valves against cargo flow. It is desirable that the maximum cargo flow rate be limited to that which will not cause excessive surge pressure should ESD valves downstream of the cargo connection be closed, at their known rate of closure, against the cargo flow.

6.0 BASIC KNOWLEDGE OF HAZARD CONTROLS (1.5 hours)

Liquid Petroleum Gas (LPG) and Liquefied Natural Gas (LNG) are petroleum product switch are quite safe when contained in their storage containers. Released into the atmosphere they condense the moisture in the air producing vapour clouds these vapour clouds pose a serious hazard to the safety of personnel and plant alike should they be ignited. Knowing how to properly respond to releases of LNG and LPG product scan make the difference between a small leak or a catastrophic event which kills many people and destroys property.

No LPG / LNG release should be considered a minor event. The potential for it to rapidly escalate into a catastrophe is ever present. The relevant sections of ISGOTT and ICS Tanker Safety Guide (Liquefied Gas) shall be consulted.

The major hazards of liquefied gases derive from their flammability and their low temperatures. Some chemical gases may also be toxic and corrosive. Most vapour clouds are also heavier than air and so tend to remain at ground level.

A characteristic of liquefied gases is the large quantity of vapour readily produced by a small volume of liquid.

If possible, the venting of cargo vapour should be avoided.

If necessary, it should be done with care and in full knowledge of potential hazards. In most areas the venting of flammable or toxic vapour is forbidden, and any such local regulation should be observed.

6.5.1 Explain the term 'inhibitor' and the reason for and use of inhibitors

Self-reaction in the most common form is polymerization. Polymerization may be prevented or the rate of polymerization may be reduced by adding suitable inhibitor to the cargo. In general, cargoes which may self-react are inhibited before shipment. There are no inhibitors available for certain cargoes that can self-react (e.g. ethylene oxide) and these have to be carried under an inert gas blanket.

The inhibitor may not boil off with the cargo and it is possible for reliquefaction systems to contain uninhibited cargo, therefore, the system should be drained or purged with inhibited cargo when shut down.

Many inhibitors are much more soluble in water than in the cargo, and care should be taken to exclude water from the system; otherwise the concentration of inhibitor in the cargo could be considerably reduced.

Similarly, the inhibitor may be very soluble in antifreeze additives if these form a separate phase, thus shipper's instructions on use of antifreeze should be observed. If the ship is anchored in still conditions, the inhibited cargo should be circulated daily to ensure a uniform concentration of inhibitor.

Certain cargoes (e.g., Vinyl Chloride) even though inhibited may be protected by inert gas. Care should be taken to ensure that a positive pressure of inert gas is maintained at all times and that the oxygen concentration never exceeds 0.1% by volume.
For butadiene cargo, the compressor discharge temperature must not exceed 60^{o}C.

It must be stated here to the trainees that:

A cargo required to be inhibited should not be loaded until a certificate giving following details is provided by manufacturer:

- *Name and amount of inhibitor added.*
- *Date inhibitor was added and the normally expected duration of its effectiveness.*
- *Any temperature limitations affecting the inhibitor.*

The action to be taken should the length of the voyage exceed the effective lifetime of the inhibitors.

Ensure that the expiry date of the inhibitor is appropriate for the contemplated voyage. Typically, the inhibitor should not expire within six months of loading the cargo. In case of language difficulties, do not hesitate to suggest the correct wording for this certificate.

7.0 UNDERSTANDING OF INFORMATION ON A MATERIAL SAFETY DATA SHEET (MSDS) (1.5 hours)

A Material Safety Data Sheet (MSDS) provides basic information on a cargo carried on board liquefied gas tankers. This includes the properties and potential hazards of the material, how to use it safely and what to do in an emergency.

The MSDS is an essential starting point for the development of a complete health and safety program for the material. MSDS are prepared by the manufacturer or supplier of the material. They tend to be general in nature, since they provide summarized information which tries to address all reasonably anticipated uses of the material.

The information on MSDS's is organized into sections. The specific names and content of these sections can vary from one supplier's MSDS to another, but are often similar to the 16 sections of the ANSI Standard MSDS. The MSDS are also included in the CHRIS Code and the ICS data sheets appended in part D2.
As per chapter 18 – 'Operating requirements' of IGC Code

– Information should be on board and available to all concerned, giving the necessary data for the safe carriage of cargo. Such information should include for each product carried:
    - A full description of the physical and chemical properties necessary for the safe containment of the cargo.
    - Action to be taken in the event of spills or leaks.
    - Counter-measures against accidental personal contact.
    - Firefighting procedures and firefighting media.
    - Procedures for cargo transfer, gas-freeing, ballasting, tank cleaning and changing cargoes;
    - Special equipment needed for the safe handling of the particular cargo;
    - Minimum allowable inner hull steel temperatures; and
    - Emergency procedures.

– Additionally products required to be inhibited should be refused if a certificate from the manufacturer stating the below information is not provided:
    - name and amount of inhibitor added.
    - date inhibitor was added and the normally expected duration of its effectiveness.

- any temperature limitations affecting the inhibitor.
- the action to be taken should the length of the voyage exceed the effective lifetime of the inhibitors.

8.0 FUNCTION AND PROPER USE OF GAS-MEASURING INSTRUMENTS AND SIMILAR EQUIPMENT

This learning objective can be done with practical demonstration along with explanations as given below:

GAS DETECTION EQUIPMENT

Gas detection equipment is required by IGC Codes for the following reasons:

- Detection of cargo vapour in air, inert gas or vapour of another cargo.
- Concentrations of gas in or near the flammable range.
- Concentrations of oxygen in inert gas, cargo vapour or enclosed spaces.

The equipment can be fixed or portable. There are several types like infrared detectors, thermal conductivity meters, combustible gas detectors, tank scopes, chemical absorption indicators and oxygen indicators. All personnel should fully understand the purpose and limitations of vapour detection equipment, whether fixed or portable.

A permanently installed Vapour detection system must cover cargo compressor room, motor room, hold spaces, air locks, CCR and other enclosed spaces within cargo area. Each liquefied gas tanker should carry at least two each oxygen, percent volume hydrocarbon, LEL and toxic gas analysers. Vessels carrying chemical gases should also have suitable detection tubes for the cargo being carried. In addition, vessels should have personal hydrocarbon and oxygen analysers which can be carried in a pocket or on belt.

The following common precautions should be taken:

The maker's handbook should be consulted before use or calibration.

All oxygen and hydrocarbon analysers should be checked for correct operation before each use.

Zero setting should be checked regularly and reset if necessary before the instrument is calibrated. Pure nitrogen should be used if possible, when carrying out zero settings.

The instrument should be calibrated frequently throughout its operating range. Concentration and composition of the span gas should be accurately known. Recalibration should be logged on or near the instrument. Supplies of span gas should be replenished as necessary.

For calibration of oxygen some detectors, use clean and uncontaminated air.

Tubes or liquids for equipment using chemical absorption or reaction principles have a limited shelf life and they should be replaced before it is exceeded.

All sample lines should be clean, unobstructed, leak tight and connected to the correct points. During routine testing, sample gas should be introduced from different points with a view check each sampling point in rotation.

If upper and lower sample points are provided, the correct one should be used for the relative density of the cargo carried and care should be taken to change sample points when changing cargoes, if required. Lower level sampling heads should be in use for all cargoes except Ammonia.

Due precautions should be taken when using portable detectors while taking readings.
Portable sensing equipment should not be used in flammable atmospheres, unless it is intrinsically safe.

Pumps, filters, flame screens and other components should be well maintained to ensure accurate readings.

Catalytic filament elements should not be exposed to water or oil vapour.

Remote and local readouts should be checked to ensure accuracy.
Calibration of most fixed instruments depends on flow rate and fluctuations can cause inaccuracy, flow should be kept steady and flows from each point should be balanced.
Battery voltage of portable instruments should be checked frequently to ensure accurate readings.

Audible and visual alarms for fixed gas detection system should be operational at all times.

During routine inspection of the fixed system, sampling cycle should be checked for correct operation. System should sample and analyse each sampling head at intervals not exceeding 30 minutes.

9.0 PROPER USE OF SAFETY EQUIPMENT AND PROTECTIVE DEVICES. (1.5 hours)

Proper and correct use of personal protective equipment (PPE) and clothing is one of the basic safety measures to be taken on the ship.

Various personal protective equipment such as boiler suits, safety shoes, hand gloves, hard hats, ear muffs, safety harness, goggles, face masks, working vests etc. are provided on board ships. Correct combinations of such equipment should be worn to protect from hazards when working.

The Master and Safety officer shall ensure that each crewmember wears proper protective equipment and clothing when working.

Improper use and faulty personal protective equipment (PPE) may in itself cause a hazard. PPE, therefore, should always be maintained in good condition and it should be checked properly each time prior using it.

Proper training shall be undertaken for correct usage of PPE.

REFER TO "CODE OF SAFE WORKING PRACTICES" FOR THE DUTIES AND PRINCIPLES GOVERNING THE GUIDANCE ON SAFE PRACTICES WHICH ARE REQUIRED TO BE FOLLOWED.

Safety Equipment

SOLAS and IGC regulations lay down specific requirements for standards of safety equipment.

Details about Safety Equipment regulations are contained in chapter 14 of the International Gas Carrier Code relevant to liquefied gas tankers.

9.4.2 Explains timely evacuation and resuscitation may save lives

Experience has shown that the rescue of persons from within an enclosed space can be extremely hazardous and especially in cases of oxygen deficiency. These risks are heightened where access to a compartment can only be achieved with difficulty. In such circumstances, it is vital that rescuers always pay strict attention to the correct procedures and the use of proper equipment and do not rush into ill-considered action. Many fatalities have resulted from failure to comply with these basic rules. For training purposes, full-scale exercises in non-hazardous atmospheres have been found extremely beneficial. Exercises involving weighted dummies, with rescuers wearing protective equipment and breathing apparatus, are essential if rescue teams are to be properly prepared for a real emergency. Class room drills may be conducted with such simulations. They can perform resuscitation on dummies. It is important to understand that very less time is available if the person stops breathing, the brain cells starts degenerating. If resuscitation is not done timely, the victim even if revived will be living as a vegetable for the rest of his life.

10.0 BASIC KNOWLEDGE OF SAFE WORKING PRACTICES AND PROCEDURES IN ACCORDANCE WITH LEGISLATION AND INDUSTRY GUIDELINES AND PERSONAL SHIPBOARD SAFETY RELEVANT TO LIQUEFIED GAS TANKERS (3.0 hours)

The purpose of this lecture is to provide those serving on ships carrying liquefied gases in bulk with information on recognised good practice. It is recommended to state here the use of The Tanker Safety Guide (Liquefied Gases). It provides the best general guidance currently available on safe procedures.

For the purpose of promoting consistent and uniform safe working practices it is recommended that a copy of this Guide be kept - and used - on board all liquefied gas tankers. The Guide deals primarily with operational matters and good safety practices.

It should be borne in mind that in all cases the advice given in this Guide is subject to any local or national regulations that may be applicable. In addition, terminal operators have their own safety procedures which could affect the cargo handling operations and procedures to be adopted in emergencies. It is necessary for all personnel working on board gas tankers to be aware of, and to comply with, these regulations and procedures. They will be highlighted by the use of the Ship/Shore Safety Checklist.

10.2.4 Explains that if gas concentrations are observed, repairs and maintenance work must be stopped when working in the concerned area. Additionally, the cause of the presence of gas concentration must be investigated into and the same eliminated. Other adjoining spaces must be checked for similar defects.

Repairs and maintenance work must be stopped when working in the concerned area. Additionally, the cause of the presence of gas concentration must be investigated into and the same and eliminated. Other adjoining spaces must be checked for similar defects.

10.3.1 States that Hot work outside the main machinery spaces (and in the main machinery spaces when associated with fuel tanks and fuel pipelines) must take into account the possible presence of flammable vapours in the atmosphere, and the existence of potential ignition sources

Hot work means any work requiring the use of electric arc or gas welding equipment, cutting burner equipment or other forms of naked flame, as well as spark generating tools. It covers all such work, regardless of where it is carried out aboard a ship, including open decks, machinery rooms and the engine room.

Repair work outside the engine room which necessitates hot work should only be undertaken when it is essential for the safety or immediate operation of the ship, and no alternative repair procedure is possible.

Hot work outside the engine room (and in the engine room when associated with fuel, lubrication or cargo systems) must be prohibited until the requirements of national legislation and other applicable regulations have been met, safety considerations taken into account, and a hot work permit has been issued. This may involve the master, owners' superintendent, shore contractor, terminal representative and port authority as appropriate.

Hot work in port at a gas terminal is normally prohibited. If such work becomes essential for safety or urgent operational needs, then port regulations must be complied with. Full liaison must be arranged with port and terminal authorities before any work is started and must take into account the possible presence of flammable vapours in the atmosphere, and the existence of potential ignition sources.

10.3.4 States that Hot work in dangerous and hazardous areas should be prohibited during cargo, ballast, tank cleaning, gas freeing, purging or inerting operations

No hot work must be undertaken inside a compartment until it has been cleaned and ventilated, and tests of the atmosphere in the compartment indicate 21% oxygen content by volume, not more than 1% LFL and it is free from toxic gases. It is important to continue ventilation during hot work. No hot work should be undertaken on the open deck unless the area is free from flammable vapour and all compartments, including deck tanks, within a radius of at least 30 metres around the working area have been washed and freed of flammable vapour and/or inerted.

All sludge, cargo-impregnated scale, sediment or other material likely to give off flammable or toxic vapour, especially when heated, should be removed from an area of at least 10 metres around all hot work. All combustible material such as insulation should either be removed or protected from heat.

Adjacent compartments should either be cleaned and gas freed to hot work standard, freed of cargo vapour to not more than 1% by volume and kept inerted, or completely filled with water. No hot work should be undertaken in a compartment beneath a deck tank in use.

Care should be taken to ensure that no release of flammable vapour or liquid can occur from non-adjacent compartments that are not gas-free.

No hot work should be carried out on bulkheads of bunker tanks in use. An adjacent fuel oil bunker tank may be considered safe if tests using a combustible gas indicator give a reading of not more than 1% LFL in the ullage space of the bunker tank, and no heat transfer through the bulkhead of the bunker tank will be caused by the hot work.

All pipelines interconnecting with cargo spaces should be flushed, drained, vented and isolated from the compartment or deck area where hot work will take place.

Hot work on pipelines and valves should only be permitted when the item needing repair has been detached from the system by cold work, and the remaining system blanked off. The item to be worked on should be cleaned and gas freed to a safe-for-hot work standard, regardless of whether or not it is removed from the hazardous cargo area.

Emphasize that all other operations utilising the cargo or ballast system should be stopped before hot work is undertaken, and throughout the duration of the hot work. If hot work is interrupted to permit pumping of ballast or other operations using the cargo system, hot work should not be resumed until all precautions have been re-checked, and a new hot work permit has been issued.
The Tanker Safety Guide (Liquefied Gases) gives detailed information regarding precautions and control actions to be taken prior carrying out hot work.

11.0 BASIC KNOWLEDGE OF FIRST AID WITH REFERENCE TO A MATERIAL SAFETY DATA SHEET (MSDS) (1.5 hours)

The First Aid Measures section on a Material Safety Data Sheet (MSDS) provides recommendations that describe measures that trained first aid providers can take at the scene of a chemical gas exposure, to minimize injury and disability, before obtaining medical assistance.

It is recommended here that the Instructor should conduct a table top exercise, simulated with an injury and use of MSDS should be carried out to give the trainee a more practical approach.

12.0 FIRE SAFETY AND FIREFIGHTING OPERATIONS (5.5 hours)

12.2 Special hazards associated with cargo handling and transportation of liquefied gases in bulk

The requirements for firefighting equipment are laid down by national and international regulations and are not covered in this guide. General firefighting theory is included in the International Safety Guide for Oil Tankers and Terminals (ISGOTT) and ICS Tanker Safety Guide (Liquefied Gas).

Company regulations will be tailored to individual ships, and will cover organisation and training of personnel and maintenance of firefighting equipment. Firefighting cannot be successful unless all equipment is operational and all personnel are well trained in the use of the equipment and in emergency procedures.

12.2.1 Explain the need to be alert to the fact that toxic fumes may enter the accommodation and an evacuation of non-essential crew and visitors may become necessary

In case of release of toxic vapours, if the cargo vapour is heavier than air it may accumulate on deck and enter accommodation spaces. The safety precautions should therefore be observed.

Regulations require that superstructures are designed with certain portholes fixed shut and openings positioned to minimise the possibility of vapour entry. These design features should not be modified in any way.

All doors, portholes and other openings to gas-safe spaces should be kept closed during cargo operations. Doors should be clearly marked if they have to be kept permanently closed in port, but in no circumstances should they be locked.

Mechanical ventilation and air conditioning units should be stopped if there is any possibility of vapour being drawn into the accommodation.

Summing it up, the trainee should be made to understand the need to be alert to the fact that toxic fumes may enter the accommodation and an evacuation of non-essential crew and visitors may become necessary.

12.2.4 Describes that "jet fire" should be allowed to burn till fuel is exhausted or cut off. Flames emanating from such fire could be bent by as much as 90^{o} using water spray. Adjoining area should be cooled.

12.2.6 Explains that it is very essential for the ship's staff to know and understand the various properties of the cargo. The MSDS sheets are the best guides for understanding the cargo properties.

The MSDS has independent sections which describe any fire hazards and other special hazards associated with the cargo carried. The information can be used to select the appropriate type of fire extinguishers and to plan the best response to a fire. Much of the information is intended for emergency response personnel. If the Cargo is a potential fire hazard, special handling precautions are stated.

The information in Fire and explosion section, combined with information from the Handling and Storage and the Stability and Reactivity Data sections, can be extremely useful.

General instructions for responding to an accidental release or cleaning up a spill are provided in the relevant sections.

12.4 Fixed firefighting foam operations

It is not beneficial to use low expansion foam or water for liquefied gas fires because their application increases the rate of vaporization.

Foam, will not extinguish a liquefied gas fire and, requires to be applied to a substantial depth.

For liquefied gases, therefore, foam is only appropriate for use in bunded areas and for this reason is only found at terminals and is not provided on liquefied gas tankers. However where the vessel has the capability of carrying cargoes also covered by the IBC code then the Flag administration may permit the installation of fixed foam system.

12.5.2 Describes Applicator foam systems and portable foam extinguisher as:

Medium expansion foam is used for Applicator foam. It has an expansion ratio from about 15:1 up to 150:1. It is made from the same concentrates as high expansion foam, but its aeration does not require a fan. Portable applicators can be used to deliver considerable quantities of foam on to spill fires, but their throw is limited and the foam is liable to be dispersed in moderate winds. Foam applicators are a supplement to the foam monitors .Sheltered areas not reachable by the foam monitors can be covered by a foam applicator. This gives increased flexibility. Different applicators are available, covering varying needs for proportioning ratio, Typically, an applicator needs to be supplied with a fire hose and a foam concentrate container and is stored in a foam station

12.6 Fixed dry chemical system operations

12.6.1 Explains portable extinguishers and fixed dry chemical system operations (0.25 hours)

Dry chemical powder is discharged from an extinguisher or a fixed installation as a free flowing cloud. It is most effective in dealing initially with a fire resulting from an oil or chemical spill on a jetty or on the deck of a tanker but can also be used in confined spaces. It is especially useful on burning liquids escaping from leaking pipelines and joints. It is a non-conductor and therefore suitable for dealing with electrical fires but could damage sensitive electronic equipment. It must be directed into the flames. Dry chemical powder has a negligible cooling effect and affords no protection against re ignition, arising, for example, from the presence of hot metal surfaces.

Certain types of dry chemical powder can cause a breakdown of a foam blanket and only those labelled 'foam compatible' should be used in conjunction with foam. Dry chemical powder clogs and becomes useless if it is allowed to become damp when stored or when extinguishers are being filled.

12.6.3 Explains the layout of fixed DCP installation.

The following information is provided as general guidance and instruction regarding requirements for fixed dry chemical fire extinguishing systems. However, reference should always be made to the Rules applicable to the specific vessel concerned for the complete set of requirements.

The components and essential elements of the system have been enumerated in annex 2.

Dry Powder Units

Vessels with a cargo capacity of 1,000 m^3 (35,315 ft^3) or more require a dry chemical fire extinguishing system. This system must consist of at least two (2) independents and self-contained, dry chemical powder units, which include the associated controls, pressurizing medium fixed piping, monitors and /or hand hose lines. For vessels with a cargo capacity of less than 1,000 m^3 (35,315 ft^3), only one (1) unit is necessary.

This system must be activated by an inert gas such as nitrogen, used exclusively for this purpose and stored in pressure vessels adjacent to the powder containers.
All pressure vessels associated with the powder units would be required to comply with pressure vessel regulations.

Controls
If monitors are installed, they must be capable of actuation and discharge both locally and remotely. The monitor does not have to be aimed remotely, provided it can deliver the necessary powder (from a single position) to all necessary areas of coverage.

The dry powder is non-toxic and stable at both low and high temperatures. However, it should be kept tightly closed and stored in a dry location in order to prevent absorption of moisture.

The initial action on discovering the fire

- **Isolates the source of leak**
- **Activates the alarm**
- **Informs the control station of the incident**
  Takes appropriate (immediate) measures that permit the containment of the fire as an initial action

A fire on a ship is one of the most dangerous incidents which can happen on board. If the fire is detected in good time, the crew can prevent larger damage by taking immediate measures – such as fighting the fire by use of a fire hose / monitor using proper protective clothing.

The immediate action should be to:
- Raise alarm that draws the attention of the crew at the earliest using one or all of the following methods:
  - Voice (shouting alarm condition of 'Fire' on immediately sighting the fire)
  - Call Bell or manual call point (engages the device for actuating vessels Fire alarm or General Alarm)
  - Telephone or other internal communication devices to contact the control centre
- Isolate the source of leak, stop loading / discharging, shut all manifold valves, activate the ESD.
- Ventilation should be cut-off at the first instance possible in areas where applicable. This could be by means of shut-down activation devices or controlled flap (mechanical)
- Power isolation is considered for immediate action in such instances.

Firefighting procedure using fixed DCP system as regards

- Approaches the fire with proper equipment and fire suit and Personal Protective equipment
- Activates the release of the DCP in the fixed DCP system following the correct sequence of operation of valves and levers
- Approaches the fire with a charged hose
- Extinguishes the fire by applying the proper firefighting technique such as sweeping action to the base or seat of the fire

Demonstrate the donning and doffing of PPE (Personal Protective Equipment), such as helmet with shield, hood, boots, protective coat and trousers, self-contained breathing apparatus (SCBA), and personal alert safety system (PASS)

A full PPE for firefighting consists of the following items:

- Helmet – to protect the head from impact, scalding water, and products of combustion
- Heat Resistant Protective hood-to protect face, ears, and neck from heat and flame
- Heat Resistant Protective coat and pants – to protect the firefighter against cut, abrasions, and burns. Also provides protection from the heat or cold, and from some corrosive liquids
- Gloves – to protect the hands from cut, abrasions, and burns
- Boots/Footwear – to protect feet from burn injuries and puncture wounds
- Eye Protection – to protect eyes from hazards encountered during firefighting operations
- Self- contained breathing apparatus (SCBA) – to protect from airborne contaminants, and heat, smoke, and other toxic products of combustion. It also provides some eye protection by means of the SCBA mask.

The procedure for fighting these fires is:

- Attack fire with a maximum rate of application of dry powder. Use monitor in a sweeping motion over the entire area of the fire, but direct pressure of powder jets on to the surface of the liquid should be avoided. Do not agitate the surface of any pool of liquefied gas.
- A first-aid shot with only one hose or monitor may be warranted with small fires, but continuous individual efforts can never be as successful as a simultaneous attack with as many applicators as possible being brought to bear.
- Operators must be adequately protected and positioned to obtain down wind line-of-sight application, with the powder jet slightly depressed below the horizontal. Powder jets should be swept rapidly back and forth over the entire fire area. The direct impact of powder jets on pool surfaces or leaks should be avoided. Where possible, powder should be aimed at vertical surfaces immediately behind the seat of the fire. Firefighters should be aware that heat propagation is as per the square root of the distance from the source of heat.
- The initial recoil and subsequent force exerted by discharge means that in order to avoid the wastage of dry powder, a second person may be needed to help the operator maintain control of the gun.
- Remain on guard against possible re-ignition. Dry chemicals attack the flame by the absorption of free radicals in the combustion process. The trainees should also be made aware that there is no cooling effect from the use of dry powder, and that re-ignition after a fire has been extinguished is a distinct possibility.

12.7 Basic knowledge of spill containment in relation to firefighting operations (0.5 hours)

Significant pool fires are not likely on liquefied gas tankers decks because the amount of liquid which can be spilled and contained is limited. The arrangement of the tanker's deck, with its camber and open scuppers will allow liquid spillage to flow quickly and freely away over the tanker's side. In case of cargo leakage, open scuppers on liquefied gas tankers are an important feature to allow cold liquids to escape quickly to reduce risk of metal embrittlement and the possibility of small pool fires on a tanker's deck.

12.7.1 Describes spill containment in relation to firefighting operations of a liquefied gas tanker.

It is better to allow a liquid pool fire to burn under controlled conditions. Fire should not be extinguished unless flow of gas can be immediately stopped. Stop leak if it can be done without risk. If a leak or spill has not ignited, use water spray to disperse the vapours and to protect personnel attempting to stop a leak. Prevent from fire or dilution from entering streams, sewers, or drinking water supply. Use water to cool equipment, surfaces and containers exposed to fire and excessive heat. For large fire the use of water curtains or monitor nozzles may be advantageous to further minimize personnel exposure.Direct DCP jets on the spilled pool must be avoided as this will destroy the curtain and prevent smothering of the fire. Also it will allow the liquid and its vapours to spread.

13.0 BASIC KNOWLEDGE OF EMERGENCY PROCEDURES, INCLUDING EMERGENCY SHUTDOWN (0.5 hours)

An emergency shutdown procedure should be agreed between ship and shore, formally recorded and signed by both the ships and terminal representative.

The agreement should designate in which cases the operations have to be stopped immediately.

Due regard should be given to the possible introduction of dangers associated with the emergency shutdown procedure.

13.3 EMERGENCY PROCEDURES

If an incident occurs during cargo operations the duty officer's first action must be to stop cargo handling operations using the 'Emergency shutdown system (ESDS)

- When loading, ships are expected to activate the shore ESD system before activating the ship's ESDS
- Where ship and shore ESD systems are linked, activation of ESD from one end will also activate the ESD at other end.
- Where a Quick Connect Disconnect Coupling (QCDC) is included in the hard-arms, activation of shore ESD 2 will initiate the release process for hard-arms.
- When there is any possibility of liquid going overboard emergency procedures should be complied with.

Ship-specific emergency checklists should be referred to avoid missing out on critical actions during any emergency.

14.0 BASIC KNOWLEDGE OF THE EFFECTS OF POLLUTION ON HUMAN AND MARINE LIFE (0.25 HOURS)

Pollution is a major problem that is affecting the ocean and the rest of the environment. Pollution in the ocean directly affects ocean organisms and indirectly affects human health and resources. Release of toxic gases and wastes, dumping of other harmful materials are all major sources of pollution in our environment.

Pollutants found in the ocean may cause seafood to be dangerous to human health. The effect on humans from contaminated seafood may include birth defects and nervous system damage. Other waste has been known to cause viral and bacterial diseases. This type of pollution can be stopped by watching what pollution we are letting into the environment.

Air Pollution

Air pollution consists of solid particles and gases. Many pollutants are carcinogens. People who breathe in these poisons are at a higher risk for asthma and reproductive-system damage. According the U.S. Environmental Protection Agency, birth defects can also be caused by air pollution. A 1995 study found a link between air pollution and increased deaths from cardiovascular and respiratory problems. Humans are not the only living creatures affected by toxic air pollutants. Some toxins, settle onto plants and into water sources that are then consumed by animals. The health effects of these poisons are then magnified up the food chain. Animals that are at the top of the food chain end up with the largest concentrations of toxins in their bodies.

15.0 BASIC KNOWLEDGE OF SHIPBOARD PROCEDURES TO PREVENT POLLUTION (0.25 HOURS)

It is the responsibility of the master or those in charge of transfer operations involving cargo or bunkers to know the applicable pollution prevention regulations and to ensure that they are not violated. Exercises should be held to train personnel in accordance with the Shipboard Marine Pollution Emergency Response Plan and recorded.

There is a danger of violating regulations if ballast taken in different waters is discharged in another port. If ballast has to be taken it may be necessary to exchange it in deep waters during the passage. Some terminals have specific requirements in this respect, and the master should ensure that they are observed.

16.0 BASIC KNOWLEDGE OF MEASURES TO BE TAKEN IN THE EVENT OF SPILLAGE (0.5 HOURS)

CARGO SPILLAGE (HOSE BURST OR PIPEWORK FRACTURE)

The following action should be taken immediately:

- The alarm should be raised and the terminal informed immediately.
- All cargo operations should be stopped, ESD should be activated and all valves closed.
- All accommodation access doors should be shut and all ventilation (except closed-circuit systems) shut down.
- Smoking and naked lights should be prohibited everywhere on the ship, and electrical switches used as little as possible.
- Appropriate firefighting equipment should be deployed and breathing apparatus sets assembled for immediate use. The emergency squad should wear breathing apparatus and protective clothing.
- If liquid spillage occurs, fire hoses or water sprays should be played along the deck to disperse the liquid overboard and to maintain steel temperatures so that brittle fracture is avoided. Water spray from hoses can also be used to deflect a gas cloud.

If the spillage is contained in a drip tray, the contents should be covered or protected to prevent accidental contact and allowed to evaporate unless the drip tray is fitted with a drain when the liquid should be drained off. Liquefied gases quickly reach equilibrium and visible boiling ceases; this quiescent liquid could be mistaken for water and carelessness could be dangerous. Water jet should never be directed onto the contents of a drip tray.

If liquefied gases spill on to the sea, large quantities of vapour will be generated by the heating effect of the water. This vapour may create a fire or health hazard, or both. Great care should be taken to ensure that such spillage does not occur especially when disconnecting cargo hoses.

17.0 DISCUSSES CASE STUDIES ON GAS TANKER EMERGENCIES (1.0 HOURS)

The trainer may use the case studies appended in this IMO model course.

APPENDIX 1

DIAGRAMS FOR USE BY THE INSTRUCTOR
PRINT OFF AS HANDOUTS
OR
USE THROUGH OVERHEAD PROJECTORS
IF SUITABLY ENLARGED

Figure 1.1 (A) LPG SHIP

Figure 1.1 (B) LNG SHIP

Figure 1.1 (C) GENERAL ARRANGEMENT ON LPG/CHEMICAL SHIP

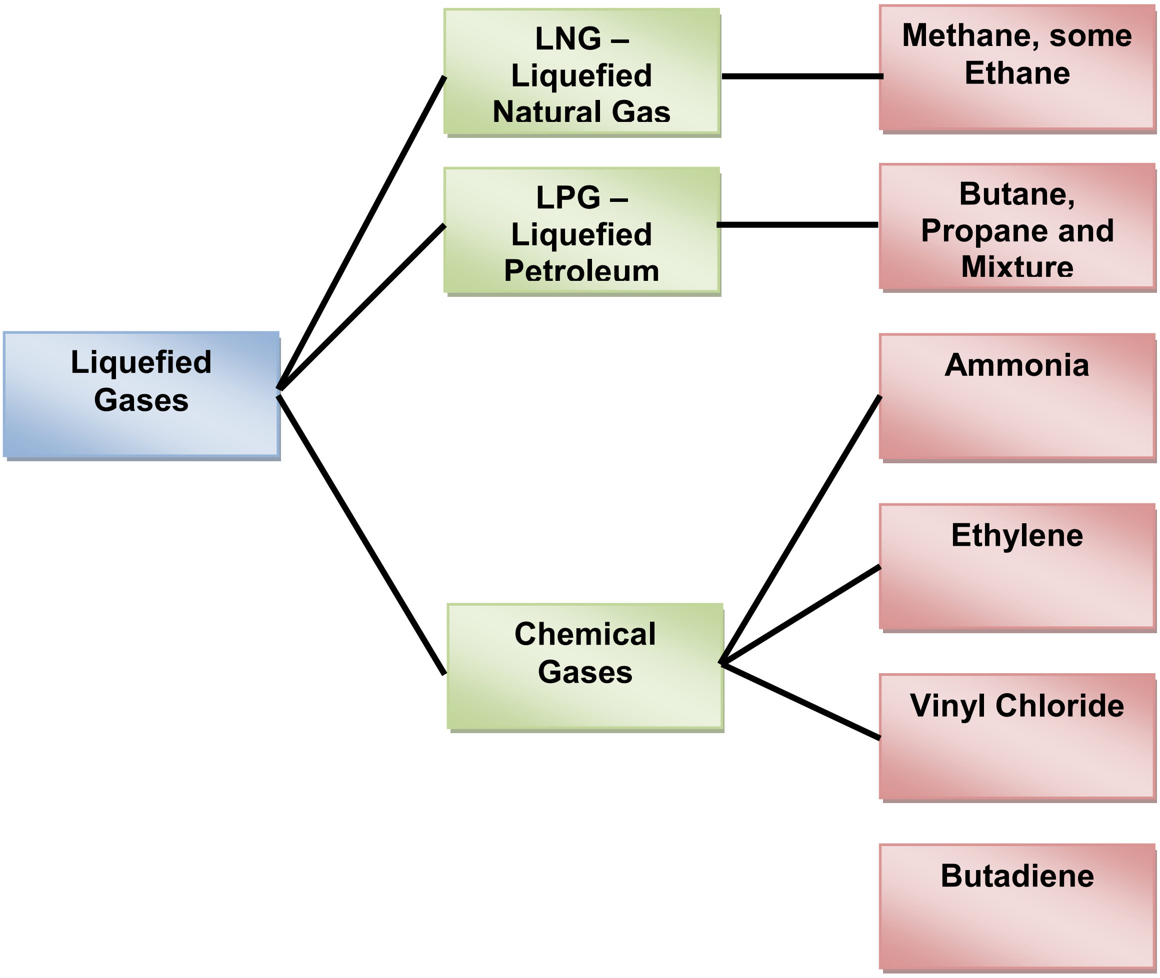


Figure 1.1 (D) TYPES OF LIQUEFIED GASES

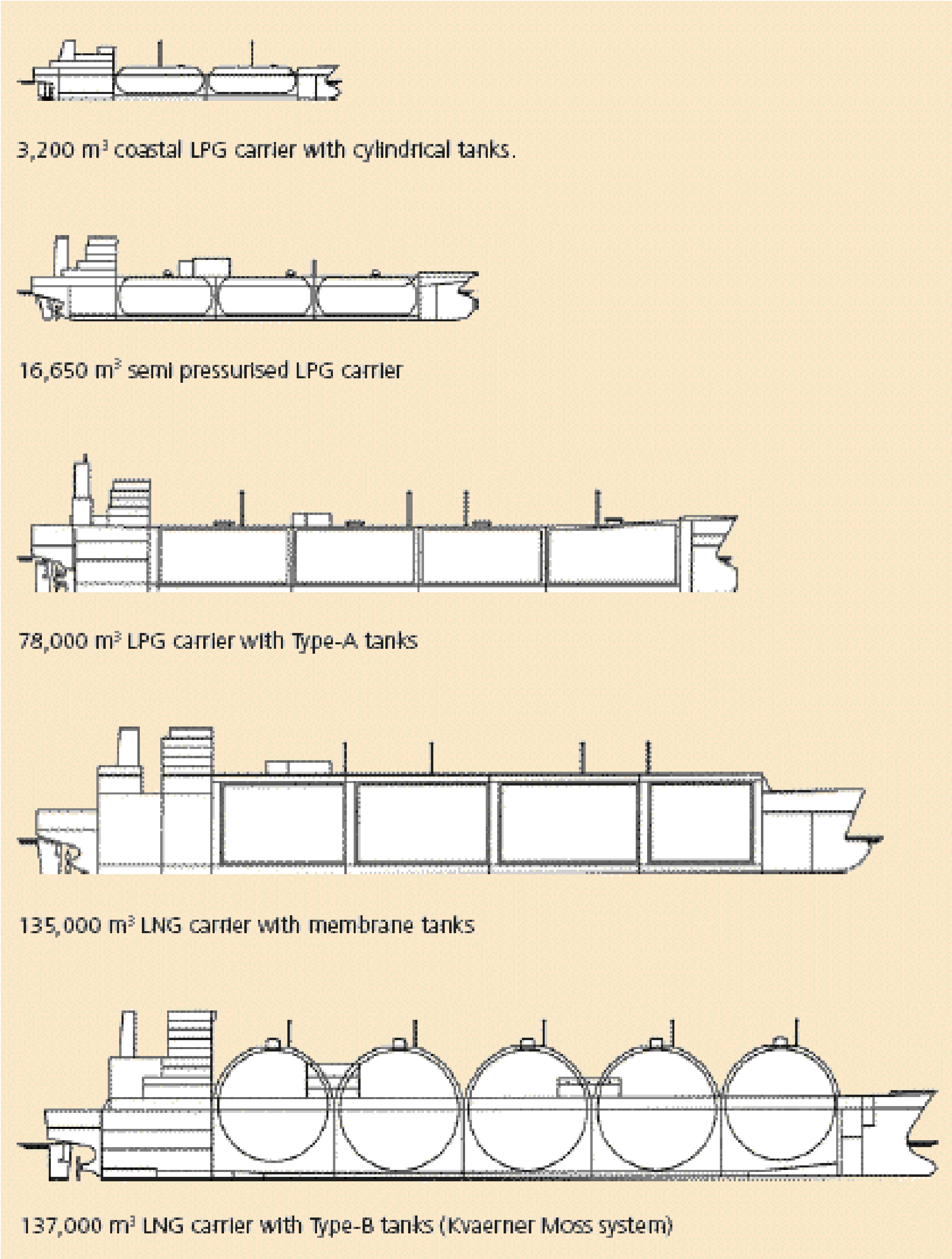
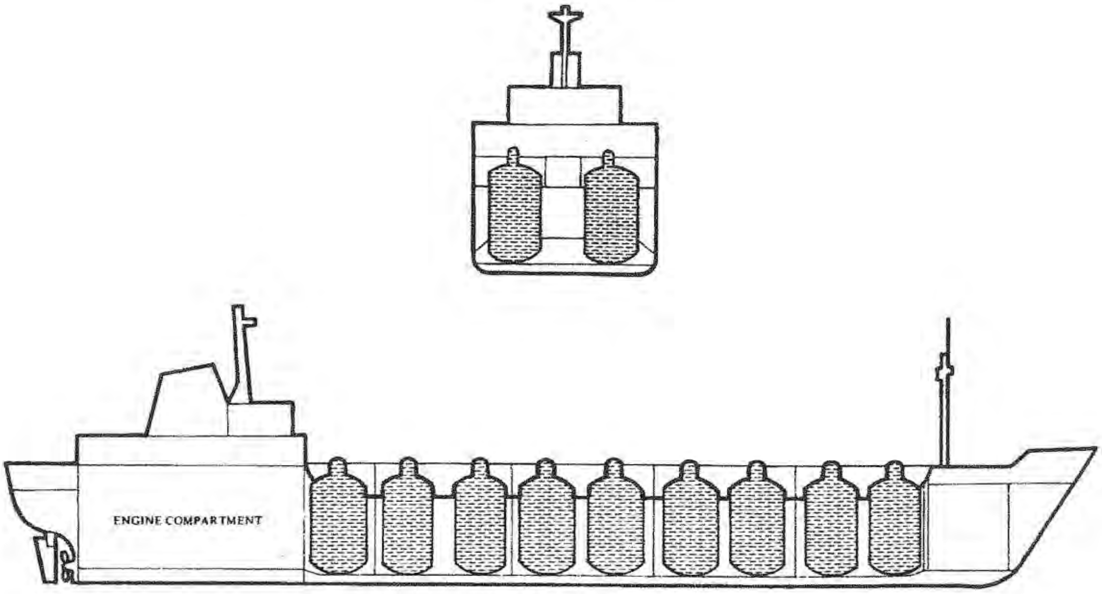
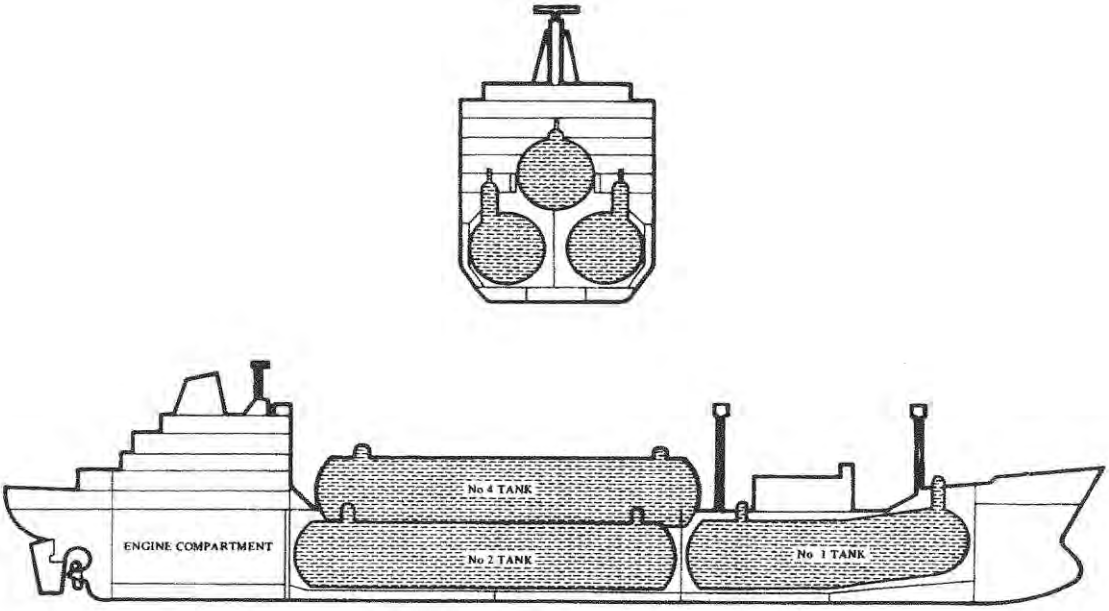


Figure 1.1 (E) TYPES OF GAS TANKERS

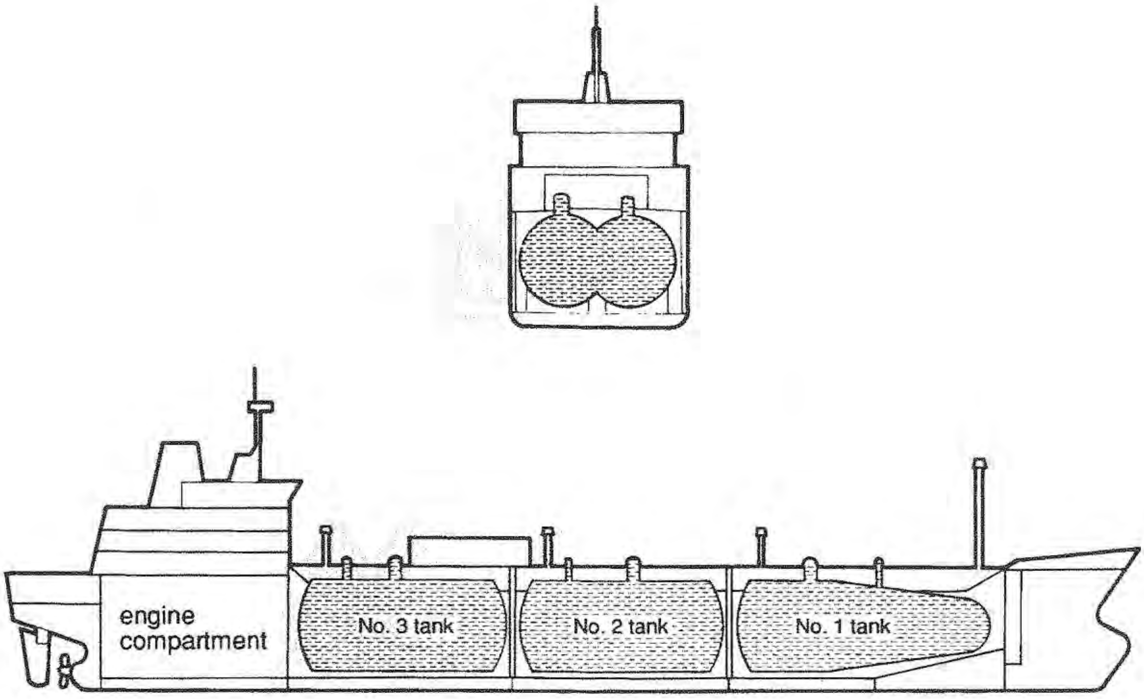


A fully pressurized LPG carrier



A semi-pressurized/fully refrigerated LPG/NH_3 carrier

Figure 1.1 (F) GAS TANKERS (1)



A semi-pressurized/fully refrigerated LPG/NH_3 carrier

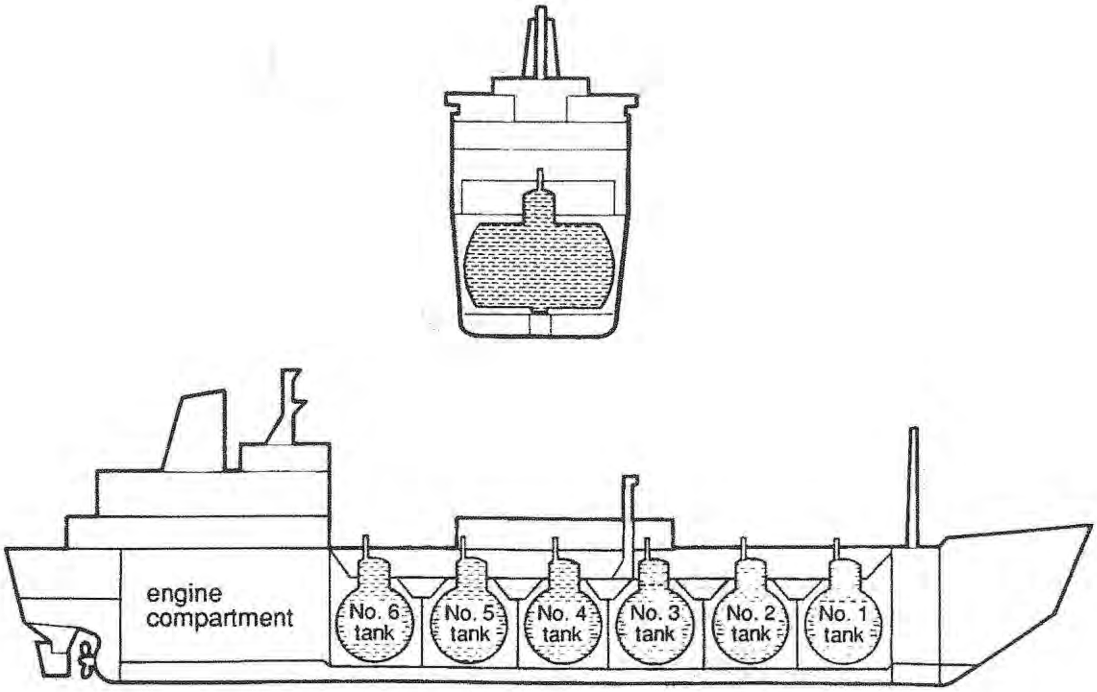


Figure 1.1 (G) A SEMI – PRESSURIZED FULLY REFRIGERATED LPG / ETHYLENE CARRIER

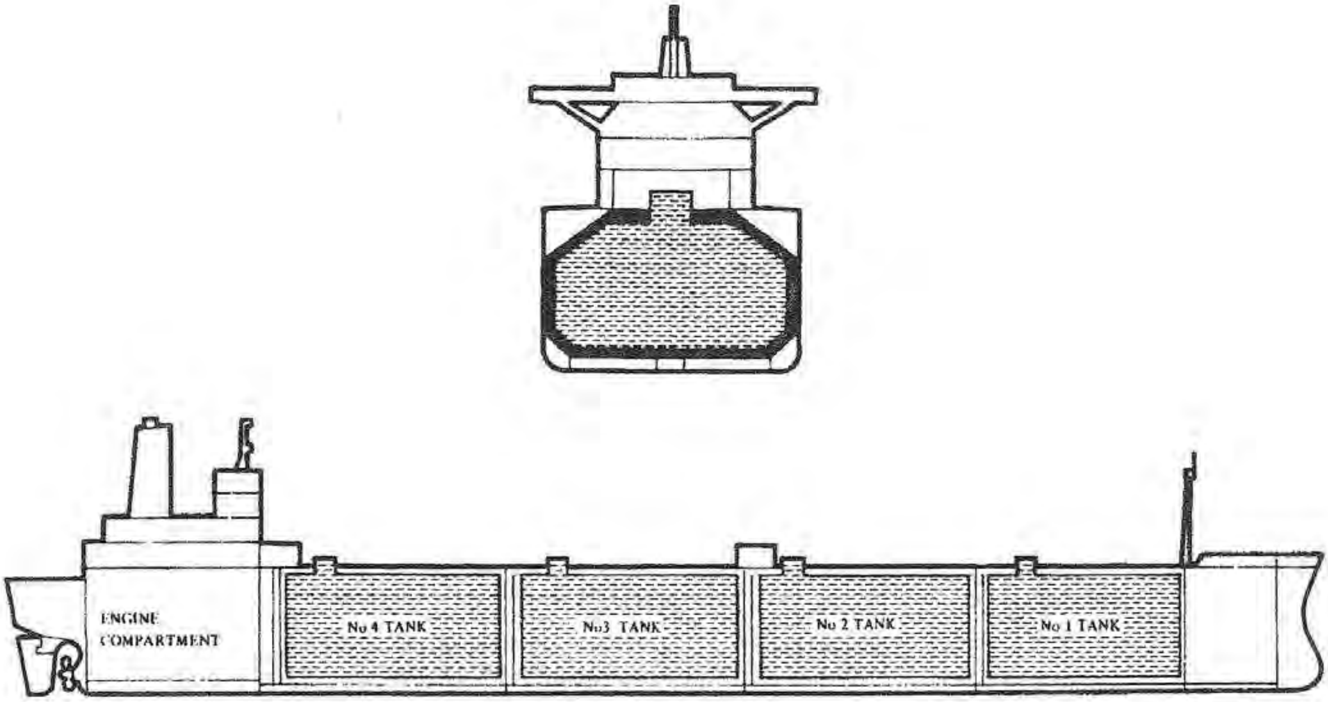


Figure 1.1 (H) A FULLY REFRIGERATED LPG CARRIER

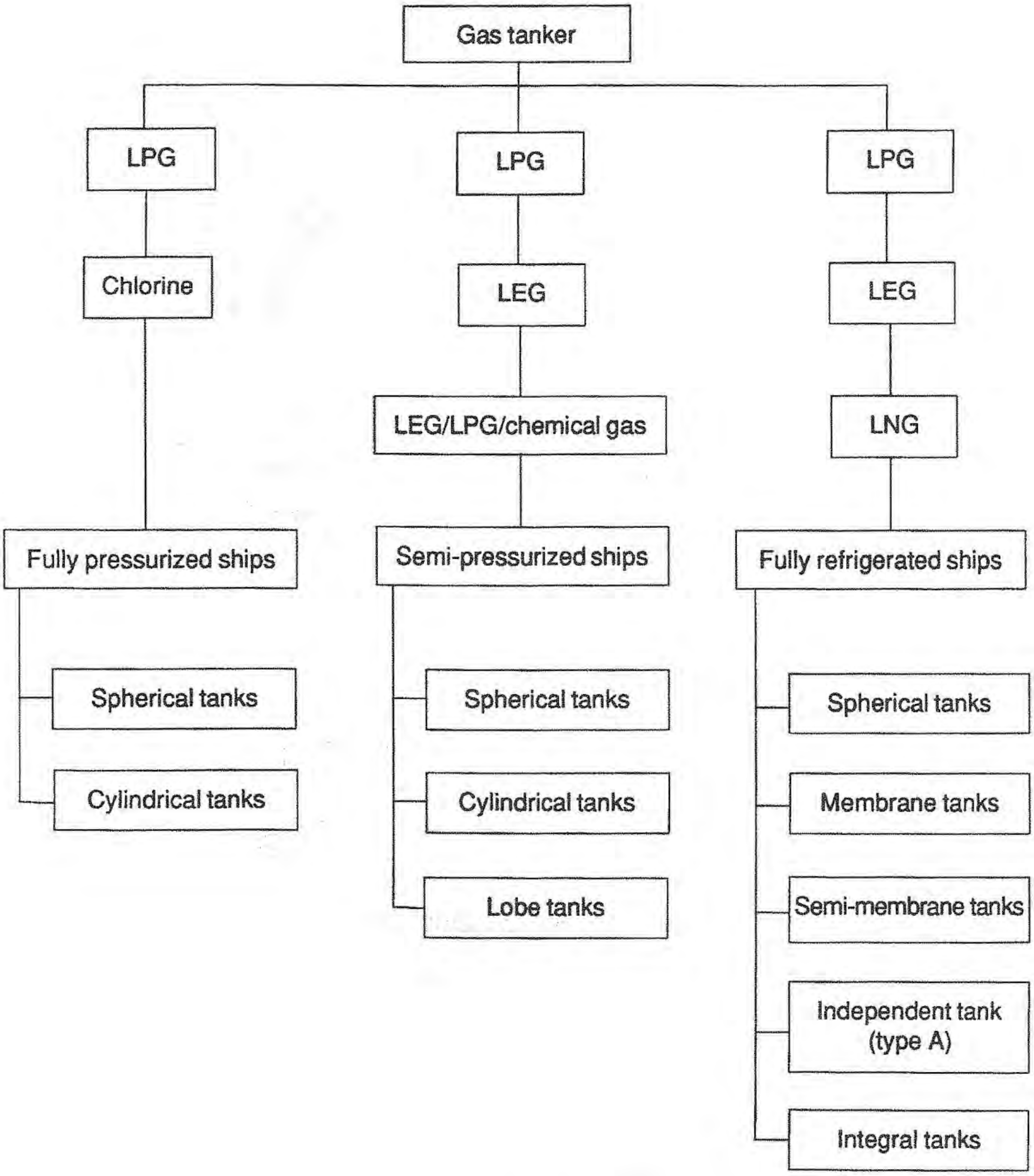


Figure 1.1 (I) BLOCK DIAGRAM DESCRIBING GAS TANKER TYPES AND THE RELATIONSHIP BETWEEN THE CARGO CARRIED, CARRIAGE CONDITION AND THE CARGO – CONTAINEMENT SYSTEM NORMALLY USED.

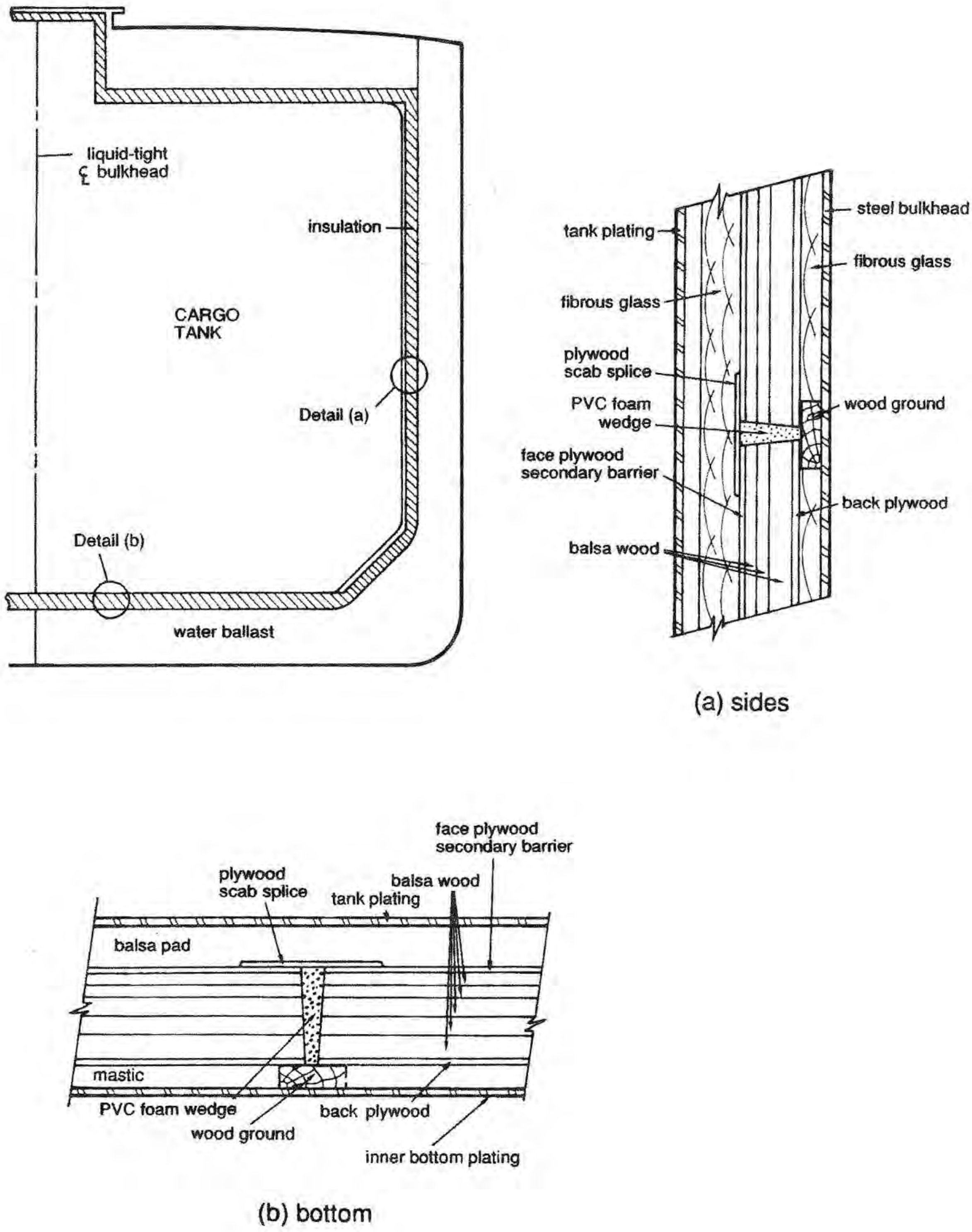


Figure 1.1 (J) AN INDEPENDENT TANK OF TYPE A

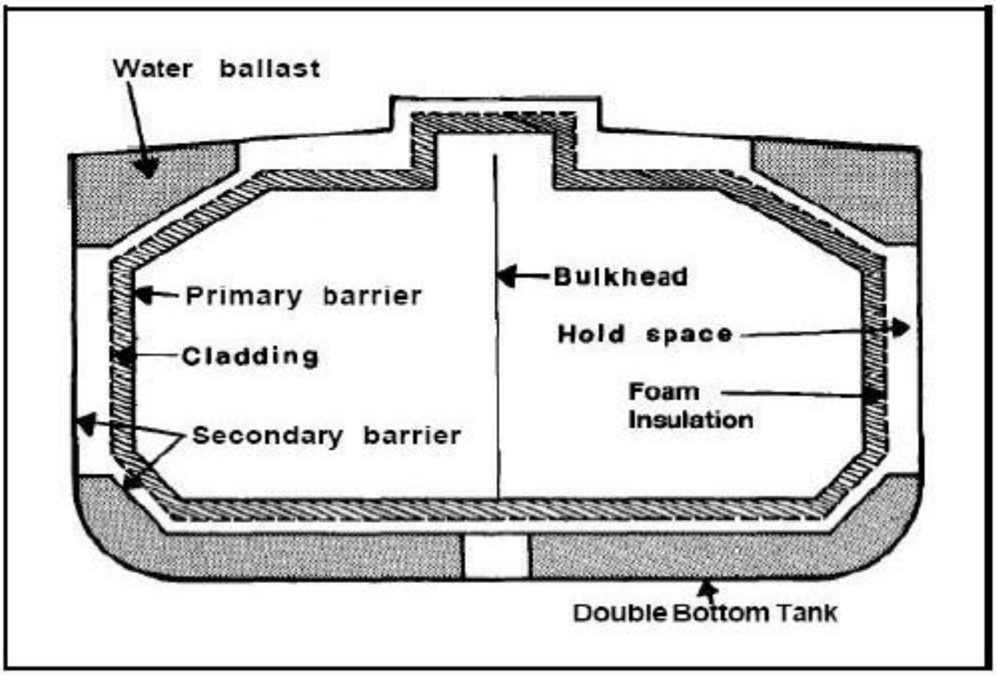


Figure 1.1.8 (A) CONTAINMENT SYSTEM LPG TANK

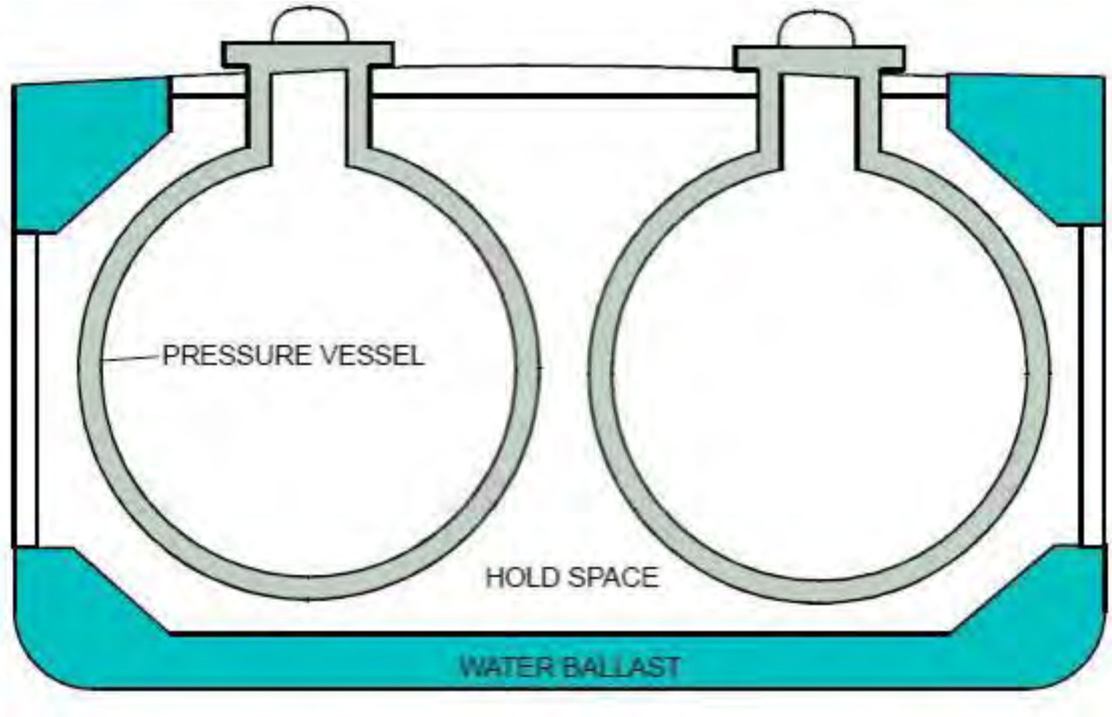


Figure 1.1.8 (B) FULLY PRESSURED CONTAINMENT SYSTEM

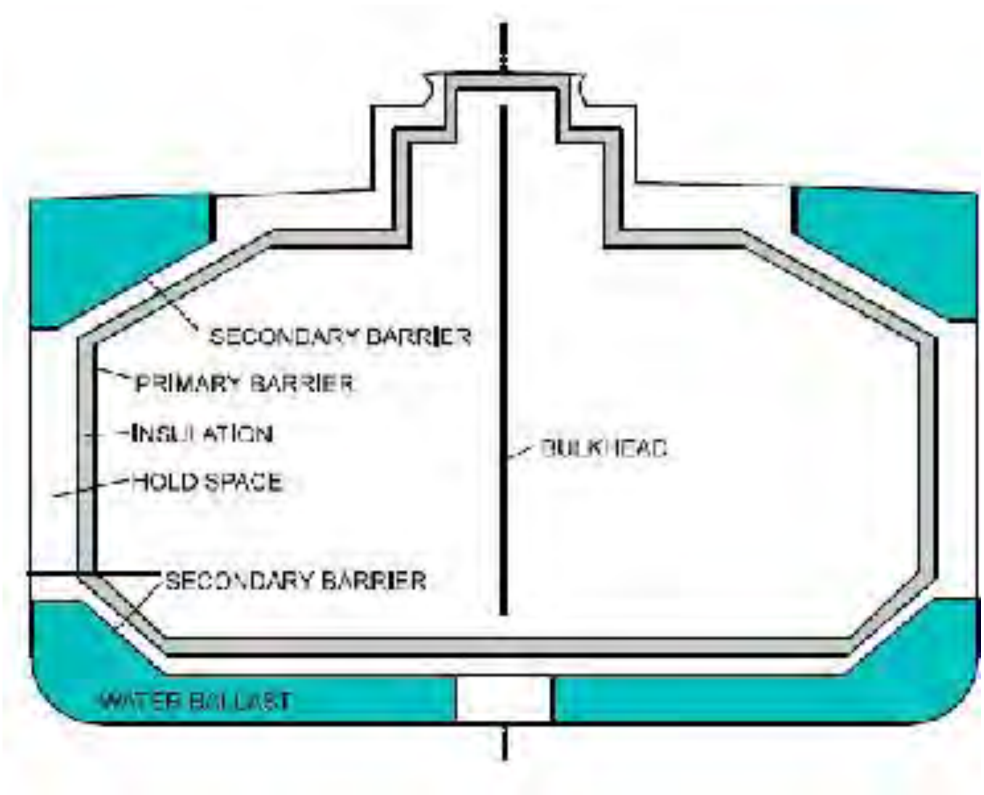


Figure 1.1.8 (C) CONTAINMENT SYSTEM

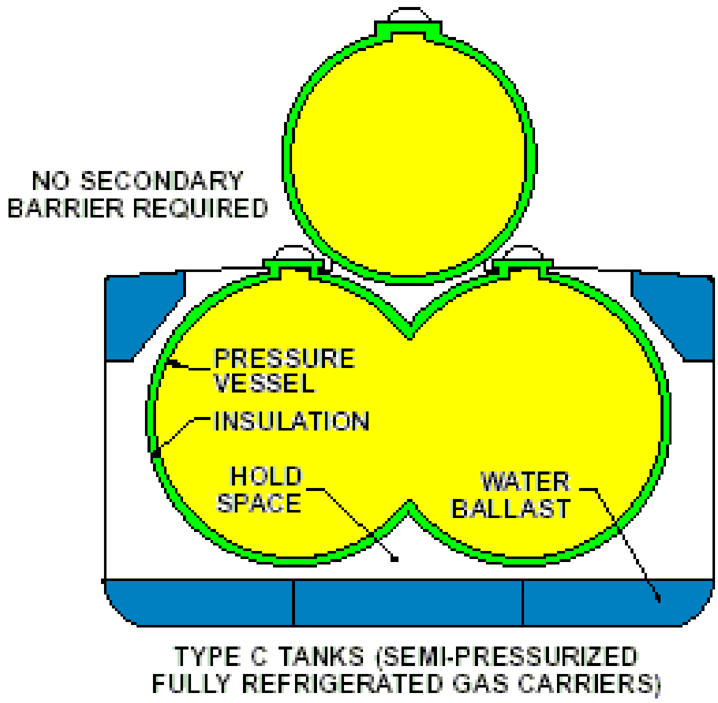


Figure 1.1.8 (D) SEMI PRESSURISED LPG SHIP

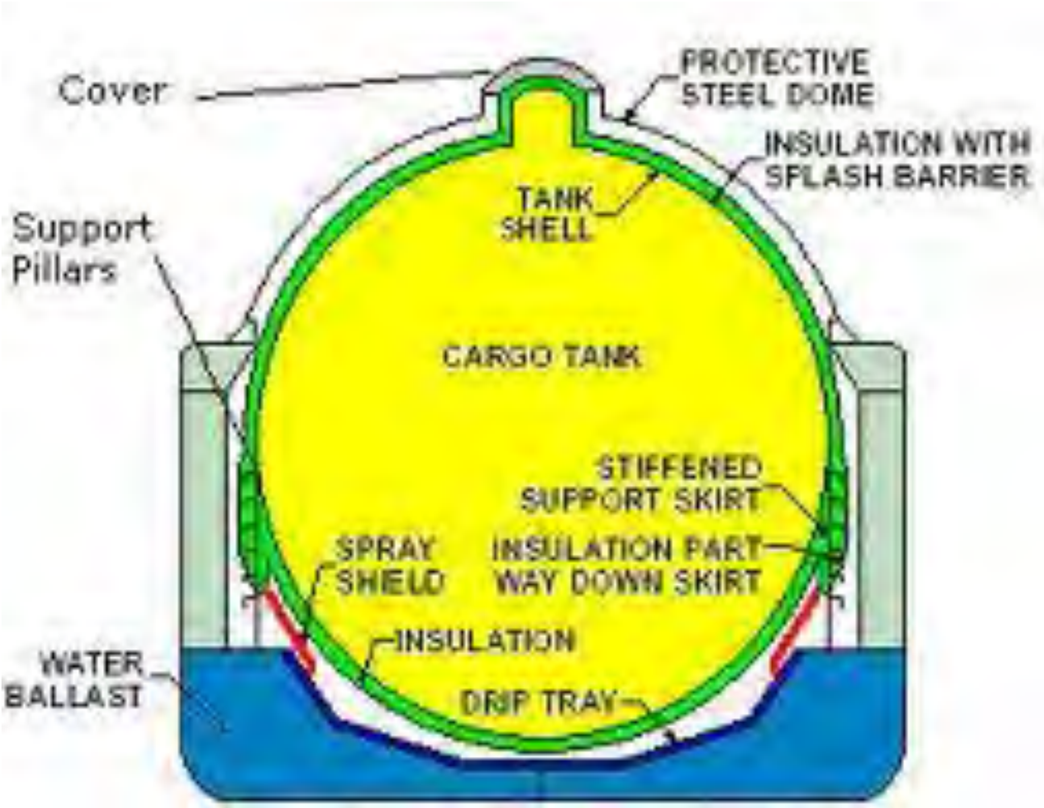


Figure 1.1.8 (E) SELF-SUPPORTING SPHERICAL TYPE B TANK

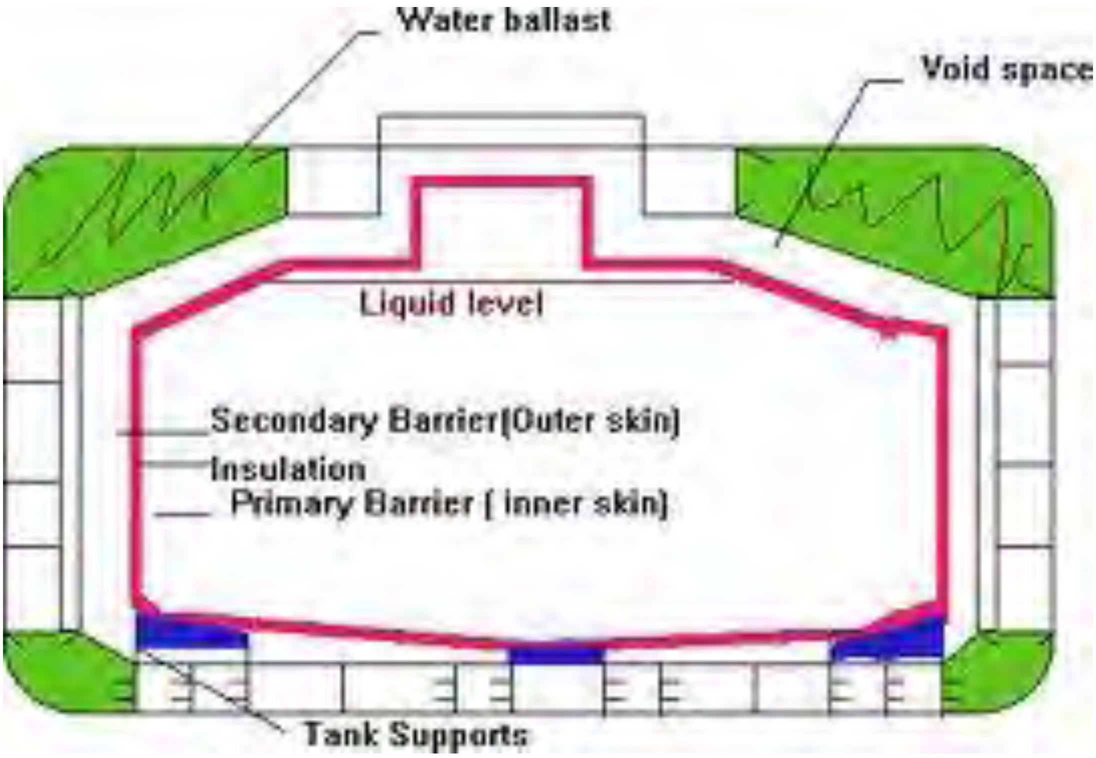
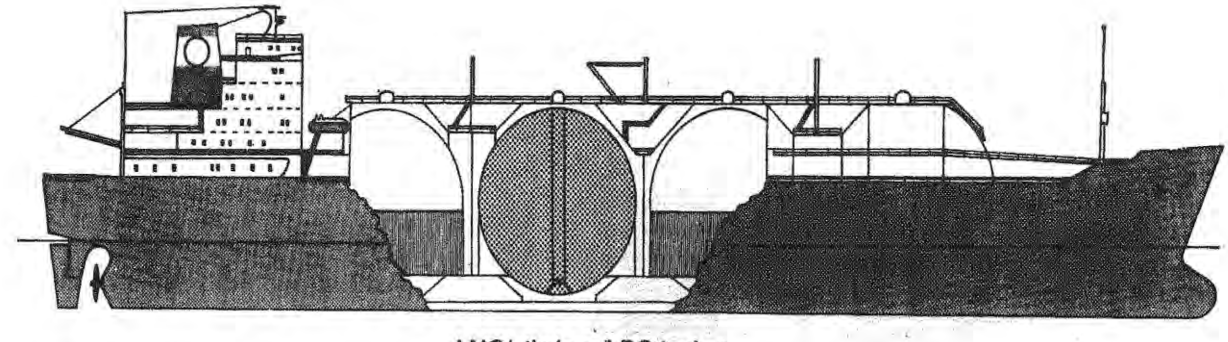
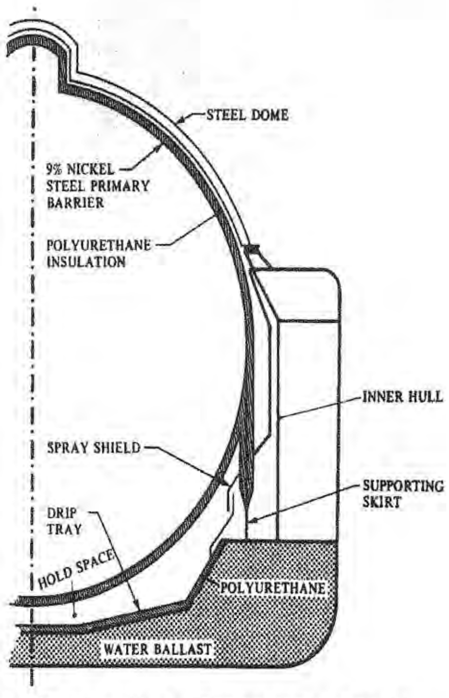


Figure 1.1.8 (F) LPG Tank



LNG/ethylene/LPG tanker



Independent self-supporting spherical tank (type B)

Figure 1.1.8 (G) LNG CARRIER

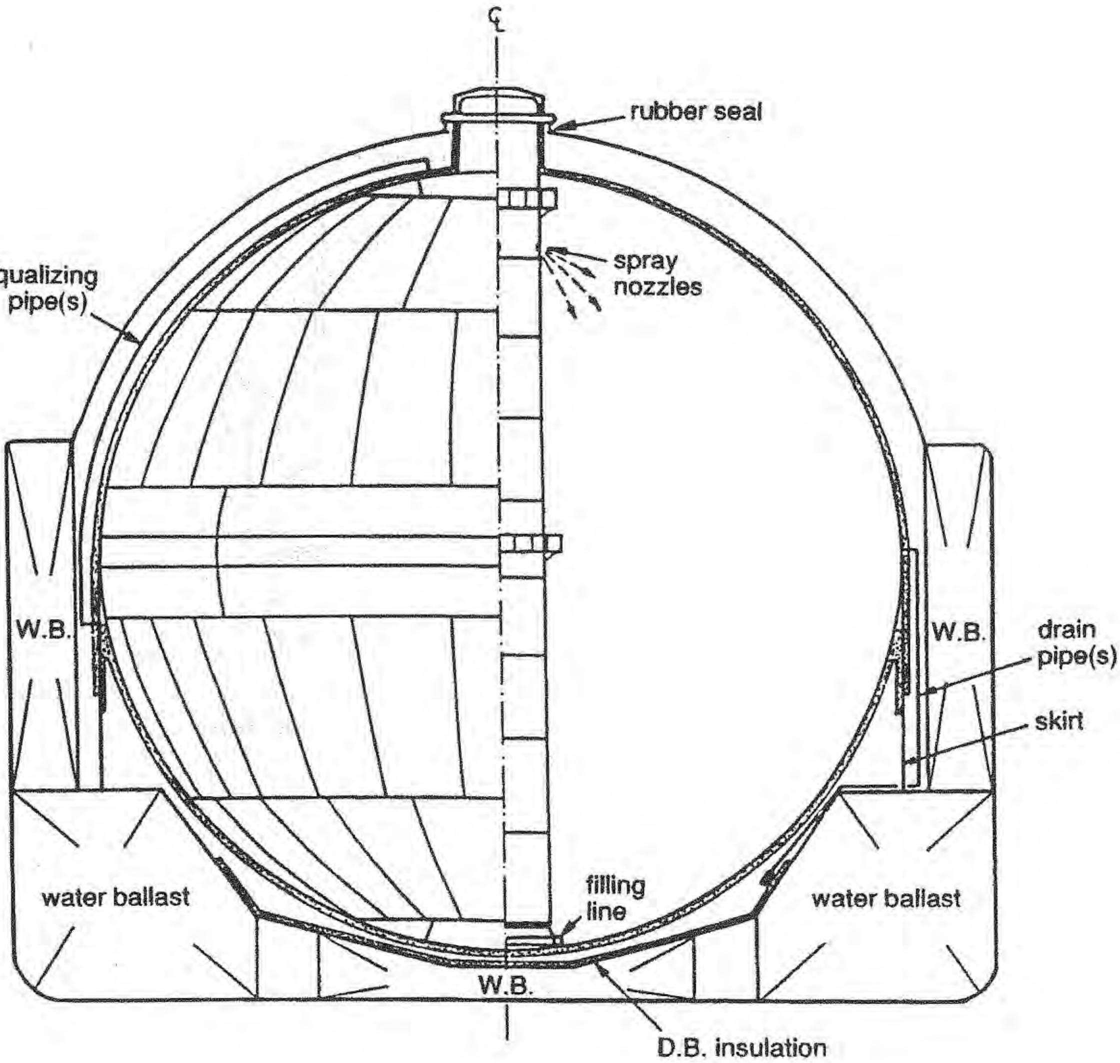


Figure 1.1.8 (H) AN INDEPENDENT TANK OF TYPE B

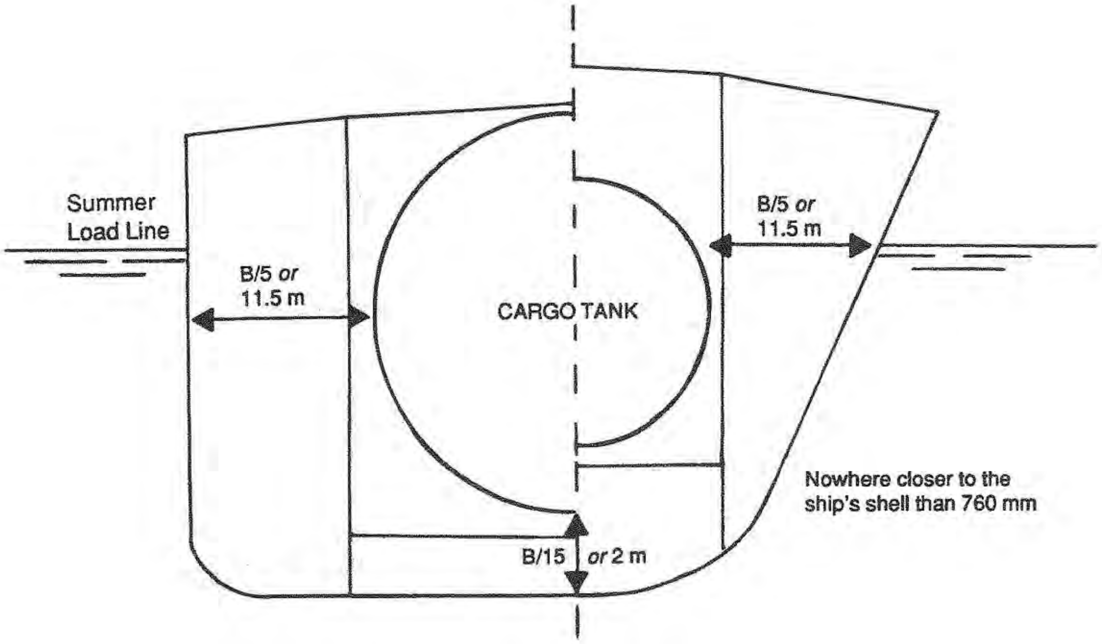


Figure 1.1.8 (I) LOCATION OF CARGO TANKS IN A SHIP OF TYPE 1 G

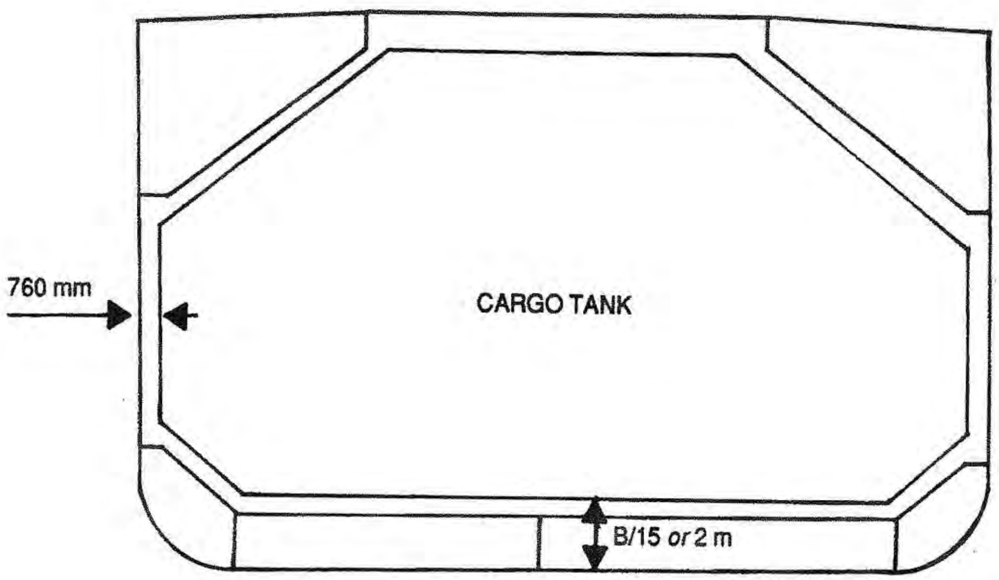


Figure 1.1.8(J) LOCATION OF CARGO TANKS IN SHIPS OF TYPES 2G, 2PG AND 3G

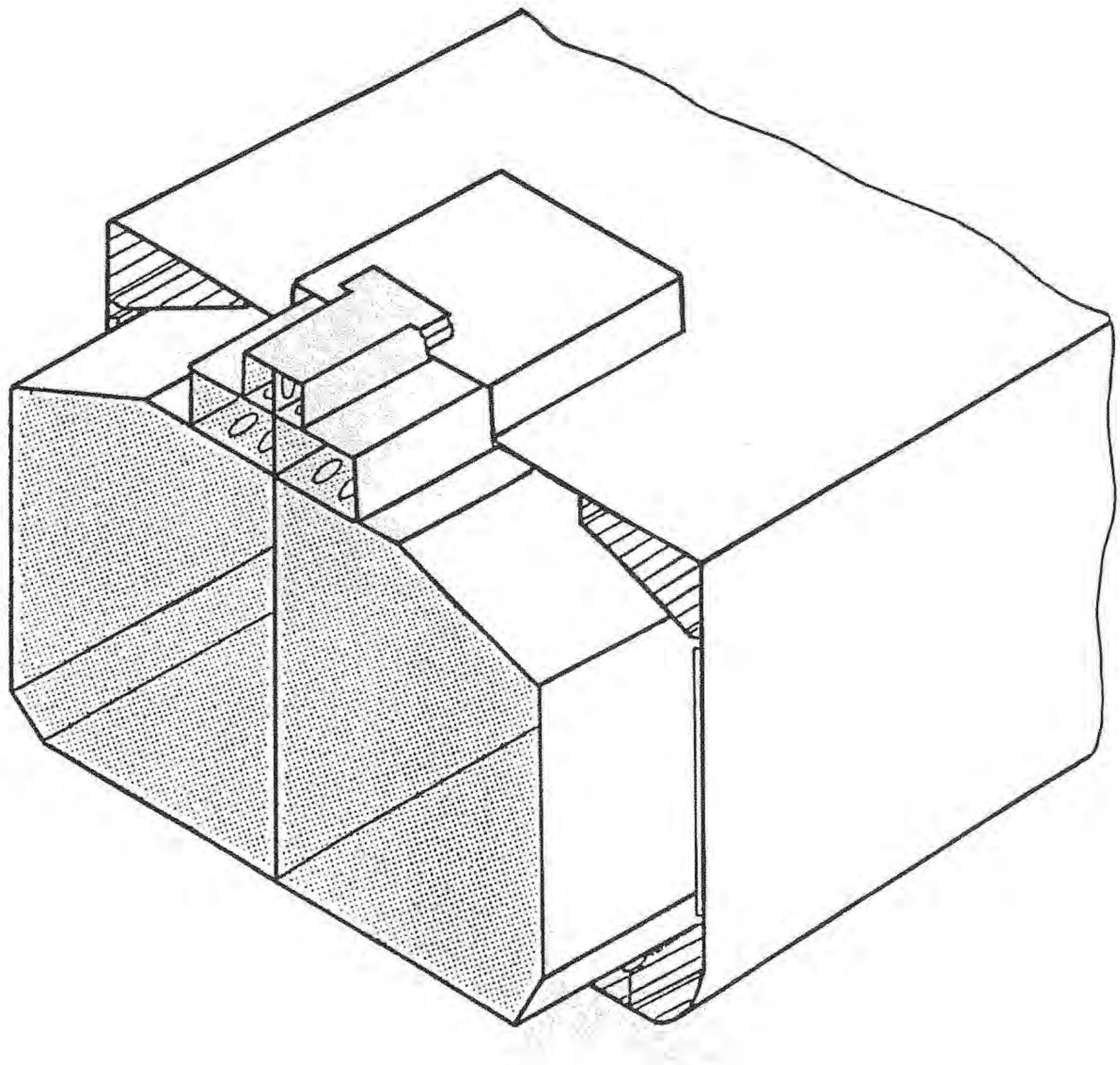


Figure 1.1.8 (K) AN INDEPENDENT TANK OF TYPE A (FOR LPG)

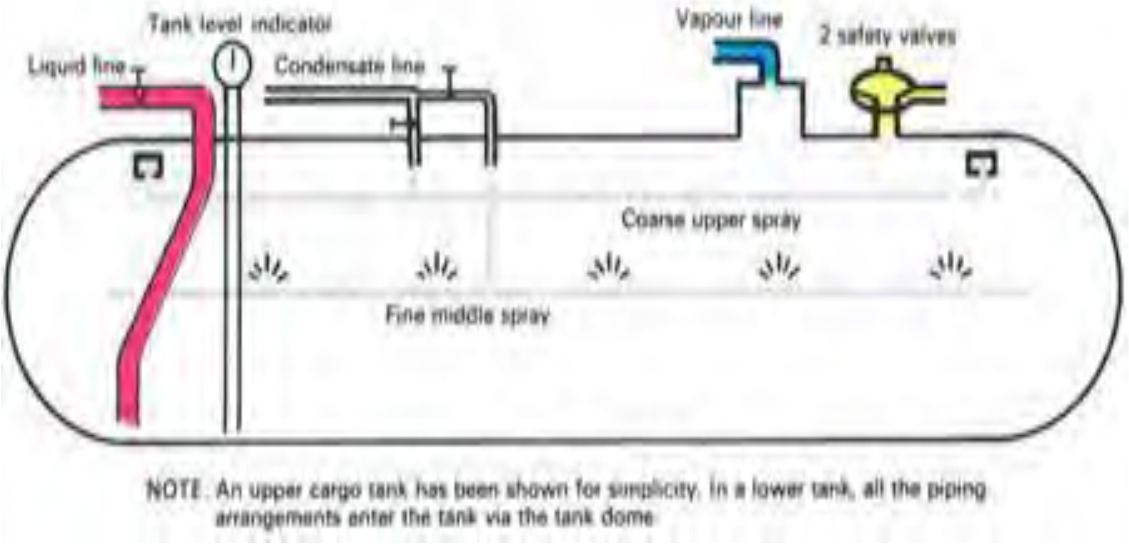


Figure 1.2 (A) CARGO TANK SHOWING PIPE ARRANGEMENTS

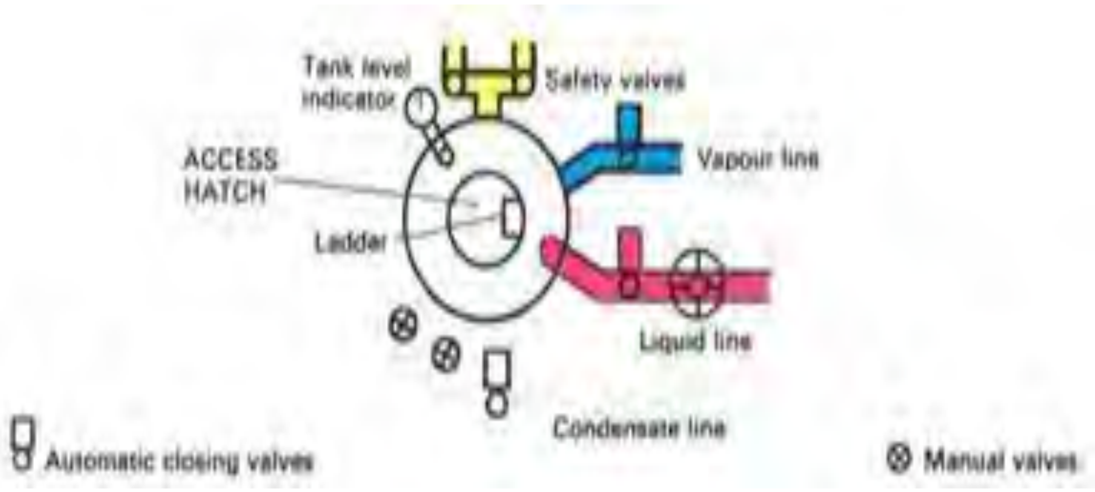


Figure 1.2 (B) TANK DOME PENETRATION

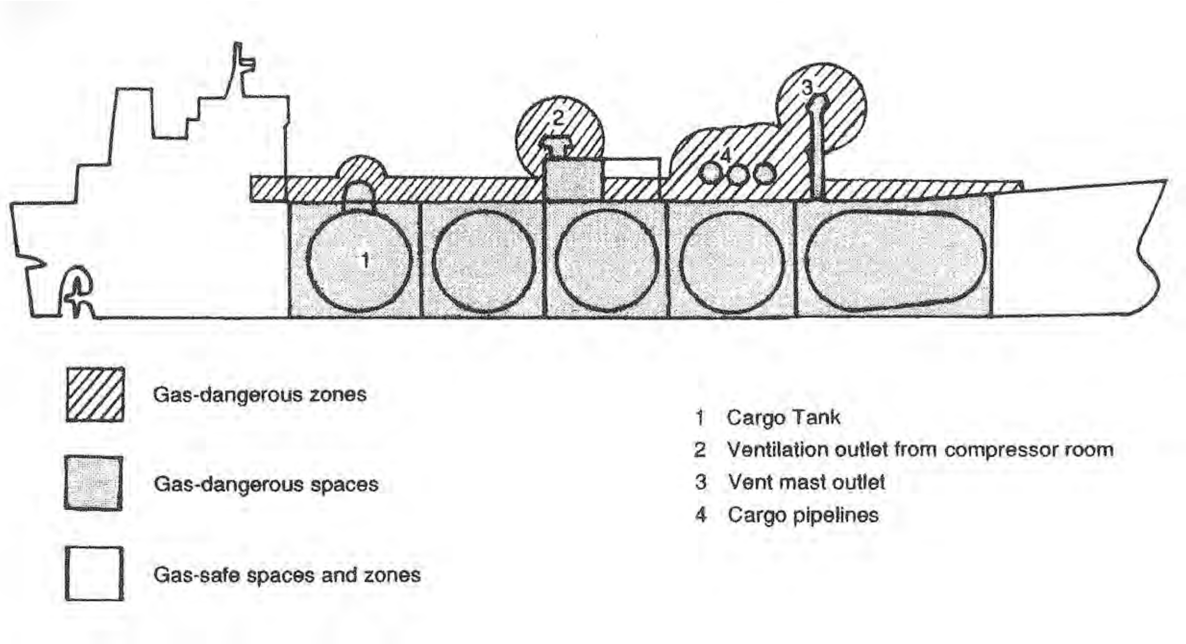


Figure 1.2.2 GAS – DANGEROUS SPACES AND ZONES

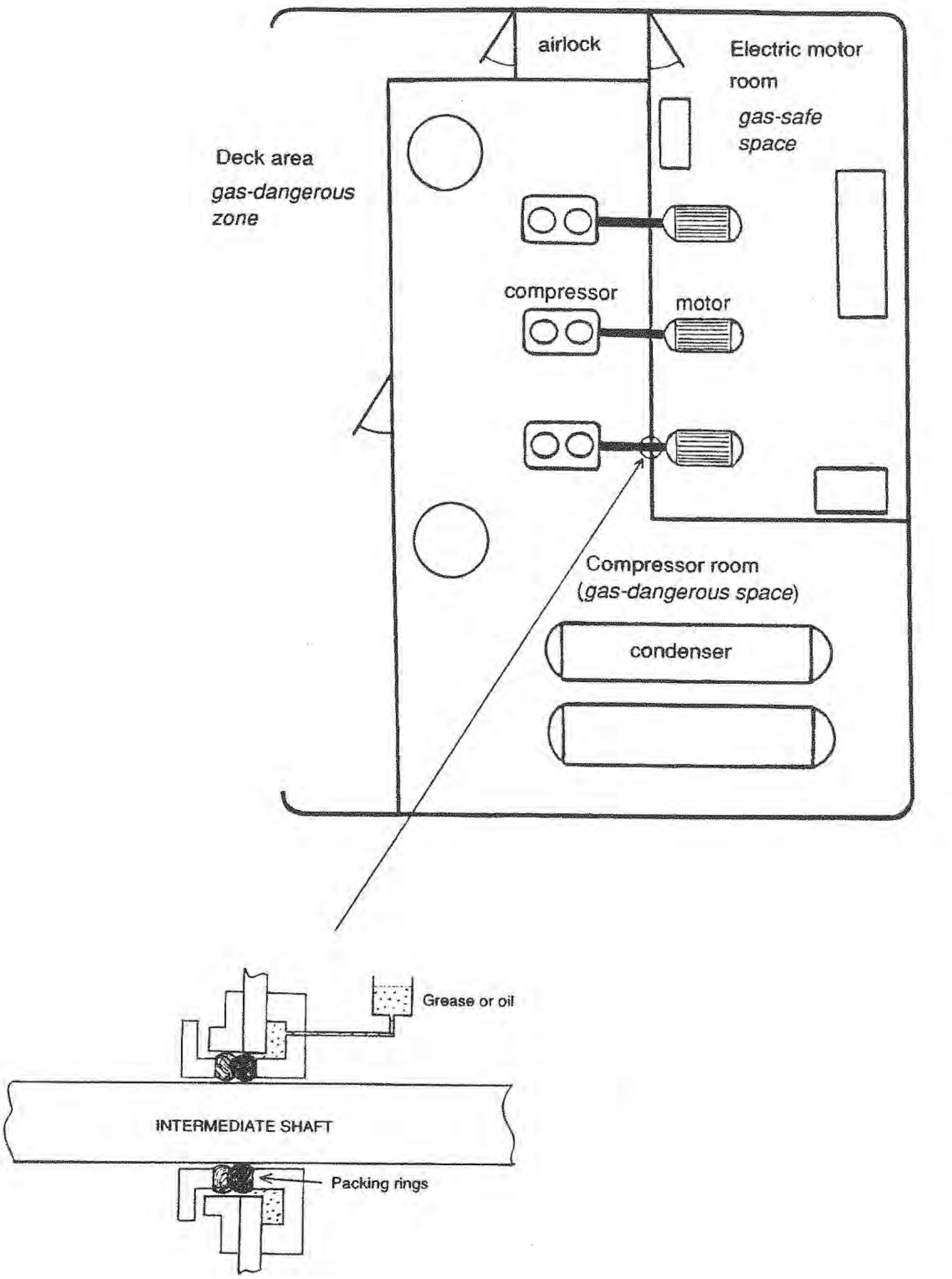


Figure 1.2.7 AIR LOCKS WITH DOUBLE DOORS

Figure 2.1 (A) GAS CARGO PIPING ARRANGEMENT

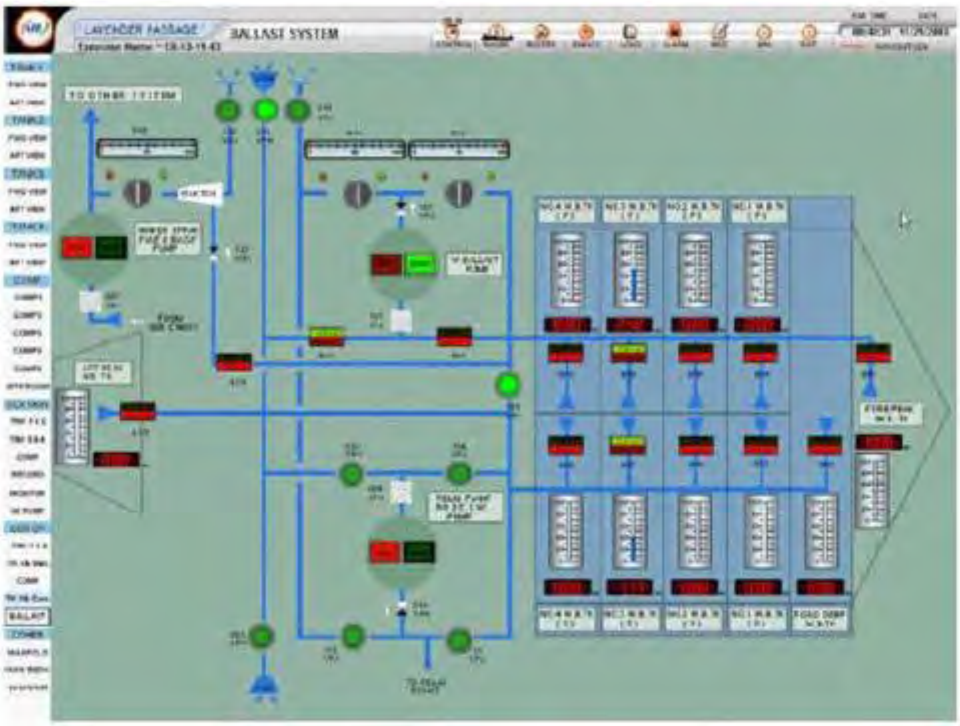


Figure 2.1 (B) PIPING AND PUMPING ARRANGEMENT

**Figure 2.1 (C) VAPOUR HEADERS and CONDENSATE HEADERS
LIQUID CARGO HANDLING SIMULATOR – LPG**

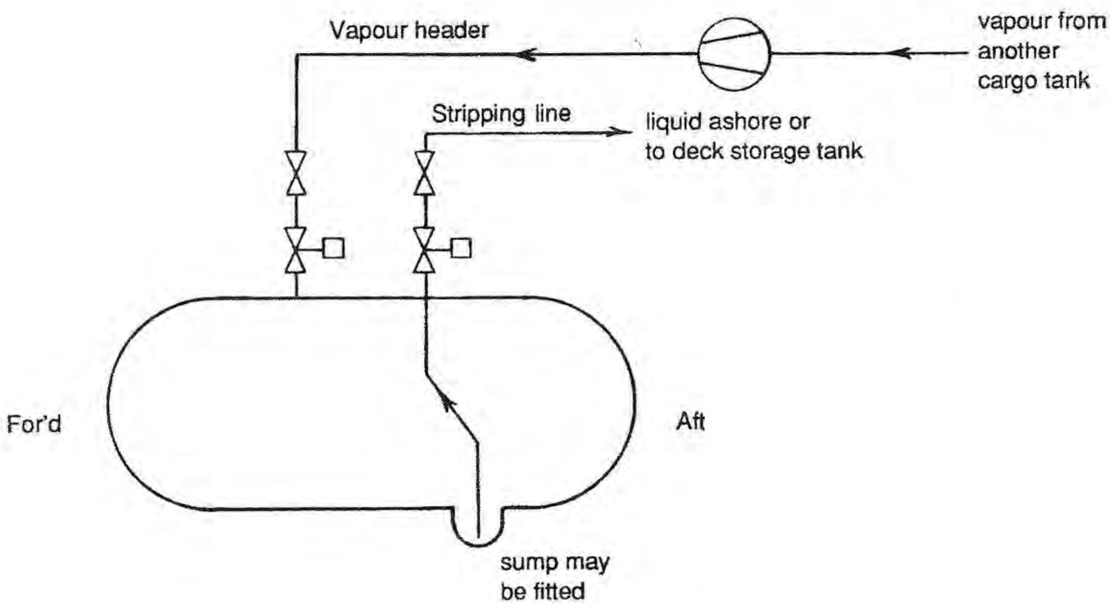


Figure 2.1.10 REMOVAL OF RESIDUAL CARGO LIQUID BY PRESSURIZATION

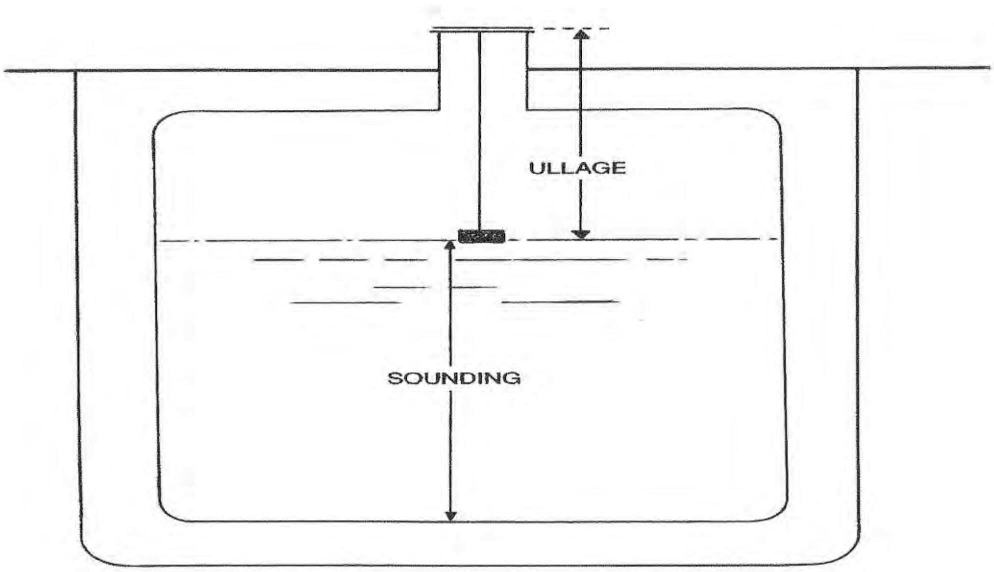


Figure 2.2.1.3 EXPLANATION OF ULLAGE / SOUNDING

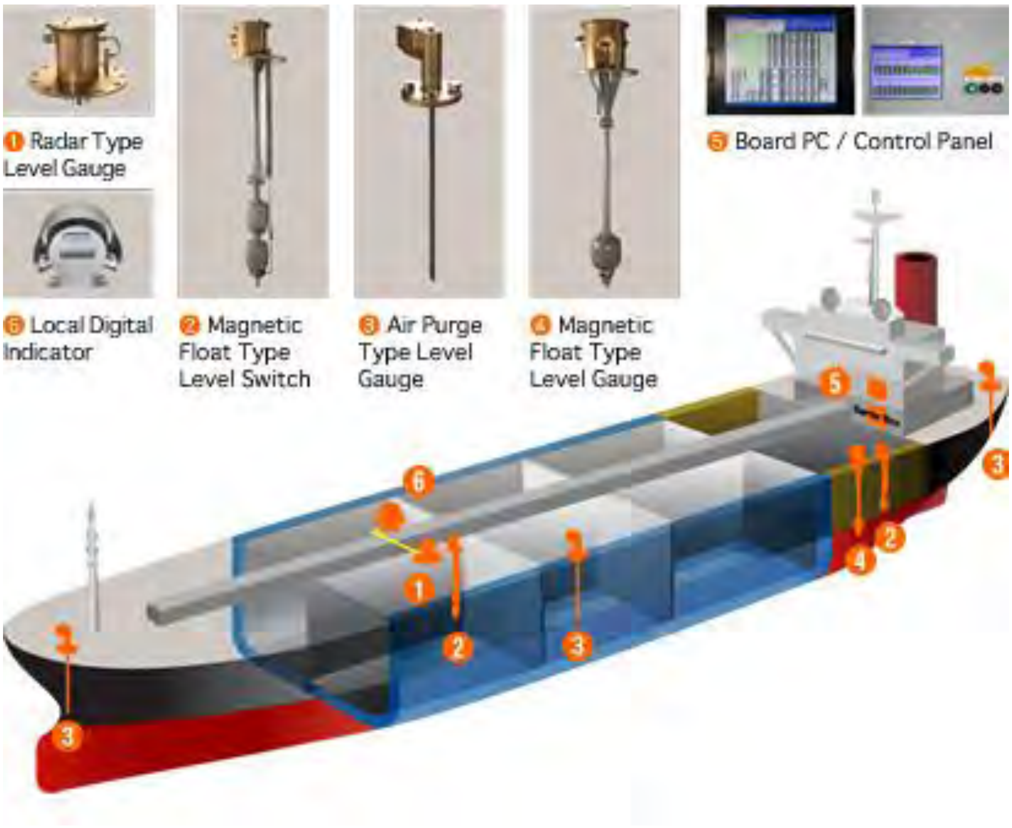


Figure 2.2.1.4 CARGO HANDLING EQUIPMENT- GAUGES

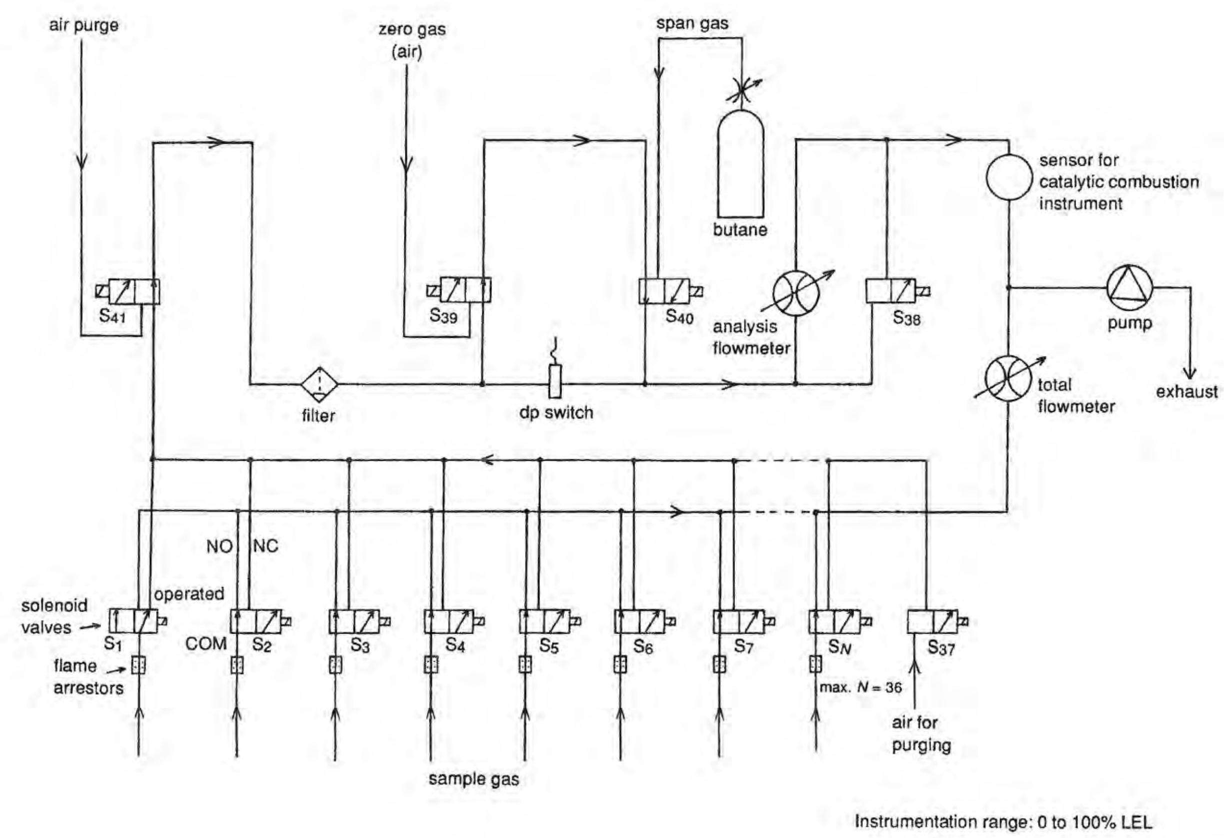


Figure 2.2.1.10(A) FLOW DIAGRAM OF A FIXED GAS – DETECTING SYSTEM

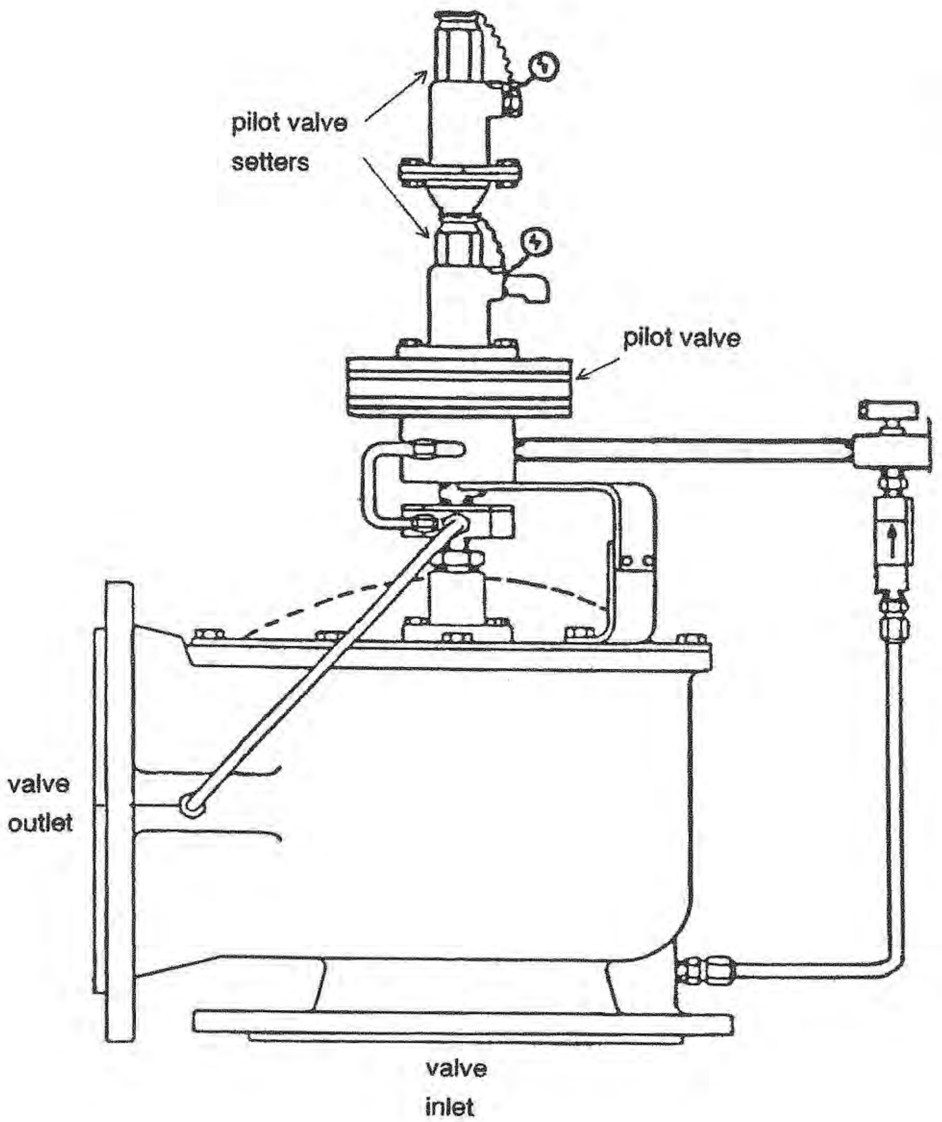
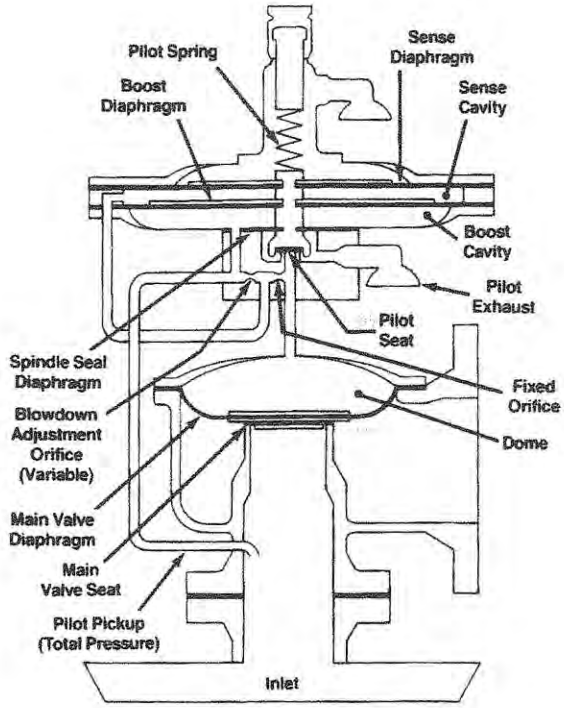
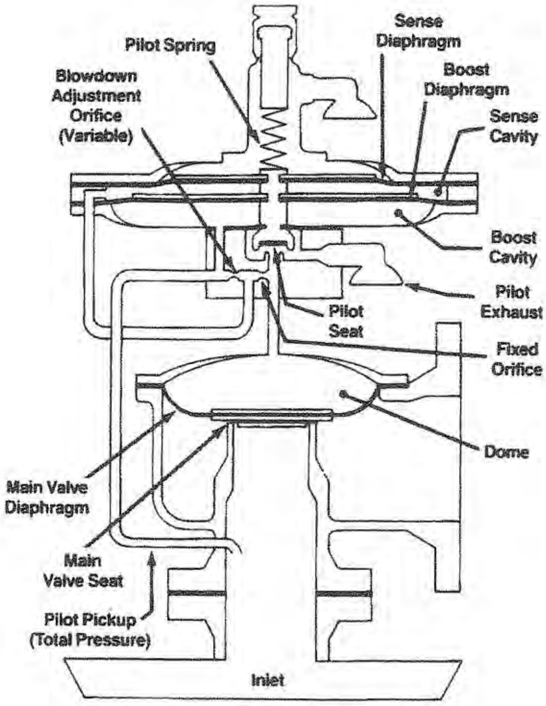


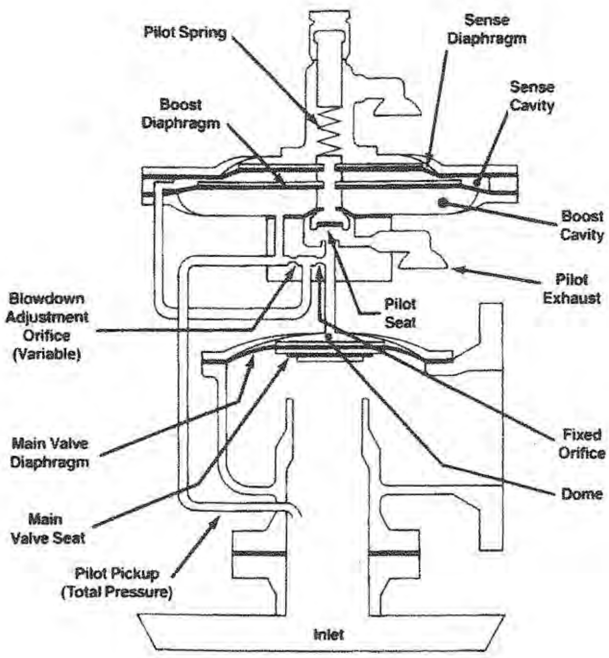
Figure 2.2.2(A) A CARGO TANK SAFETY RELIEF VALVE



(Closed)
Positive Pressure Relief



(Pilot Open)
Positive Pressure Relief



(Open and Flowing)
Positive Pressure Relief

Figure 2.2.2 (B) OPERATIONAL PRINCIPLE OF A TANK SAFETY RELIEF VALVE

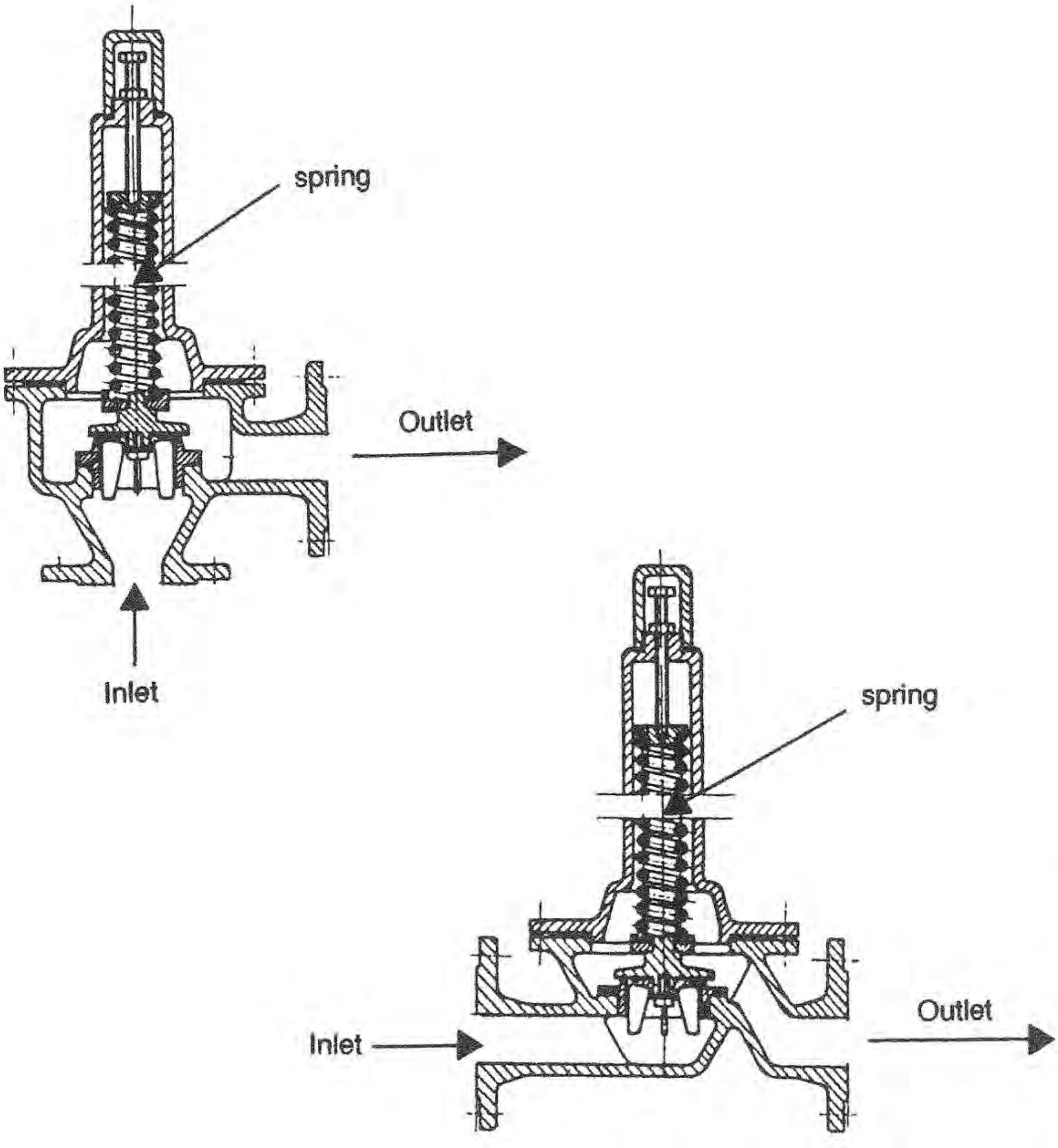


Figure 2.2.2 (C) SPRING – LOADED RELIEF VALVES

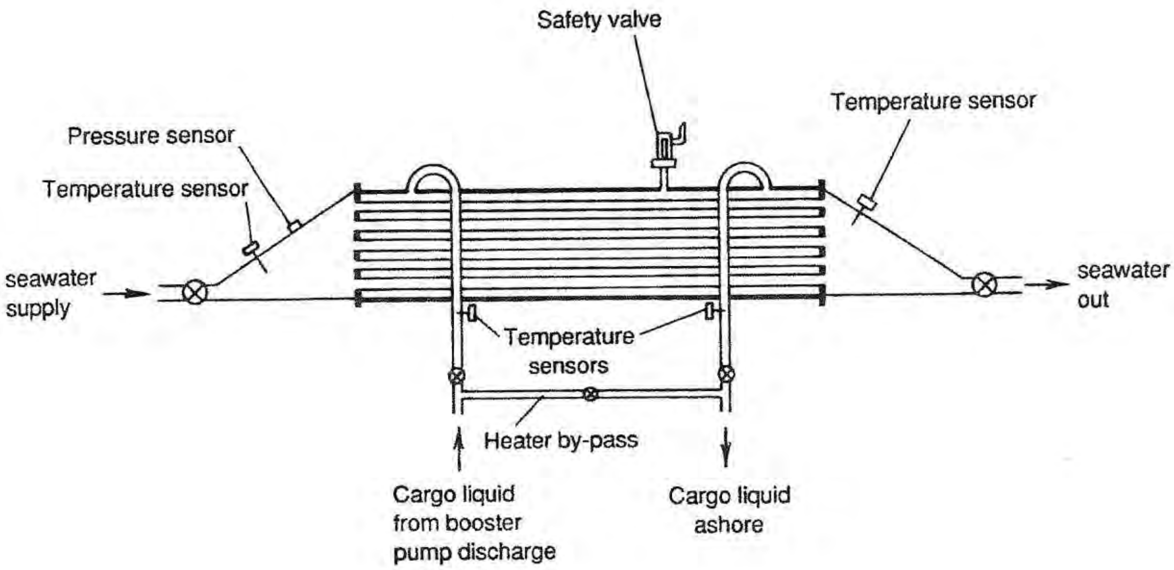


Figure 2.2.3 (A) A CARGO HEATER

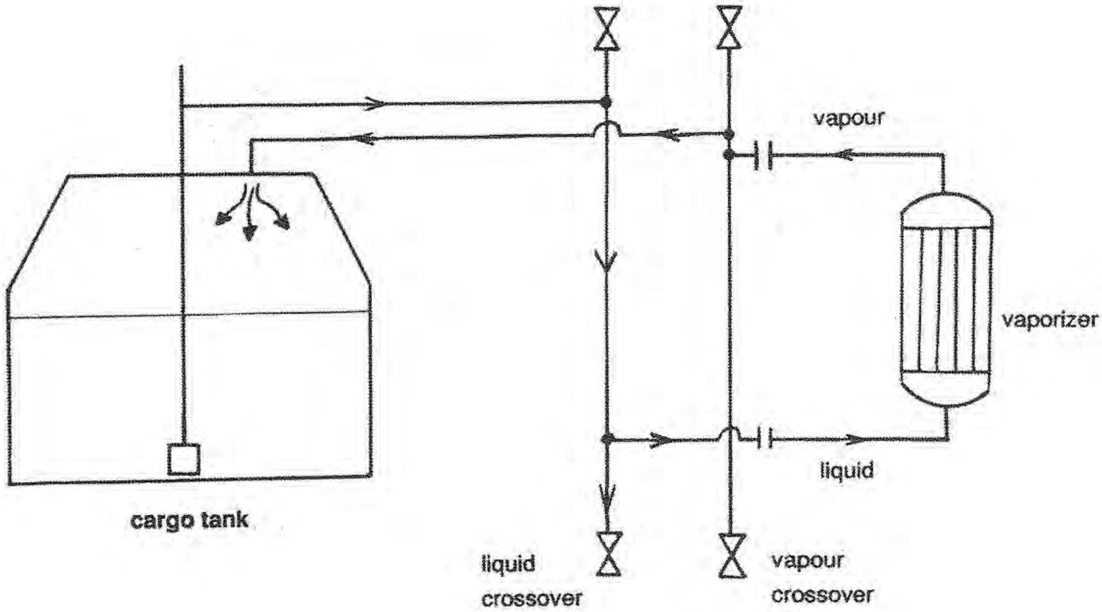


Figure 2.2.3(B) SCHEMATIC DIAGRAM OF A VAPORIZER ARRANGEMENT

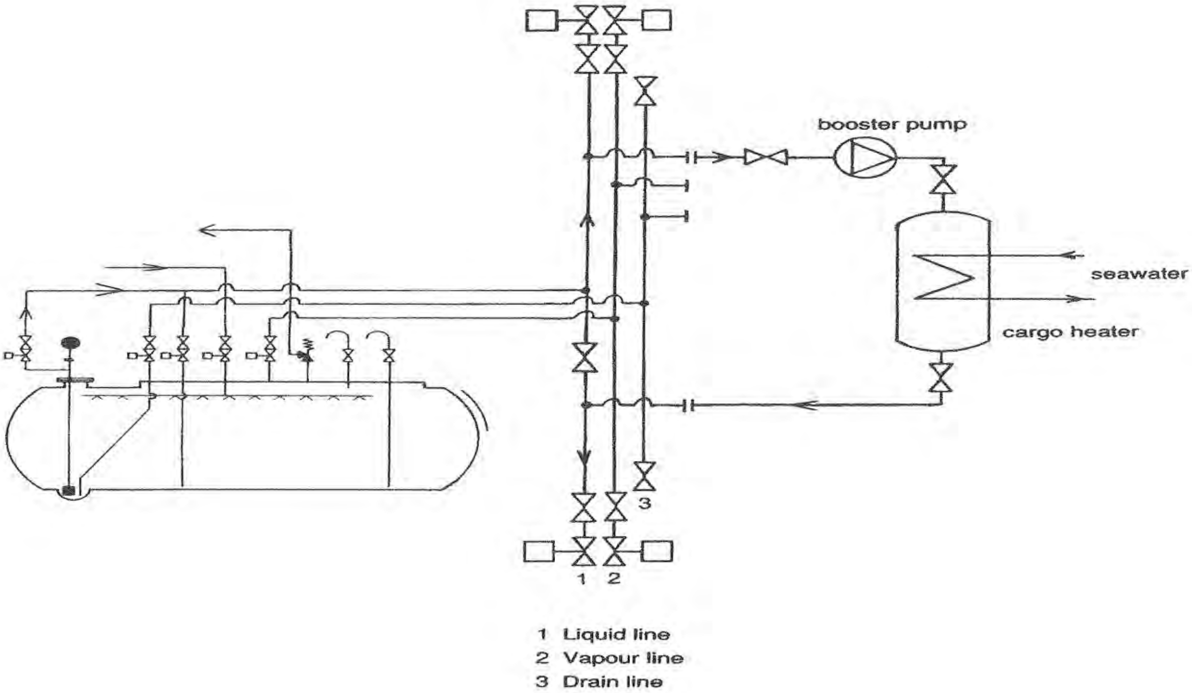


Figure 2.2.3(C) SCHEMATIC DIAGRAM OF A CARGO HEATER ARRANGEMENT

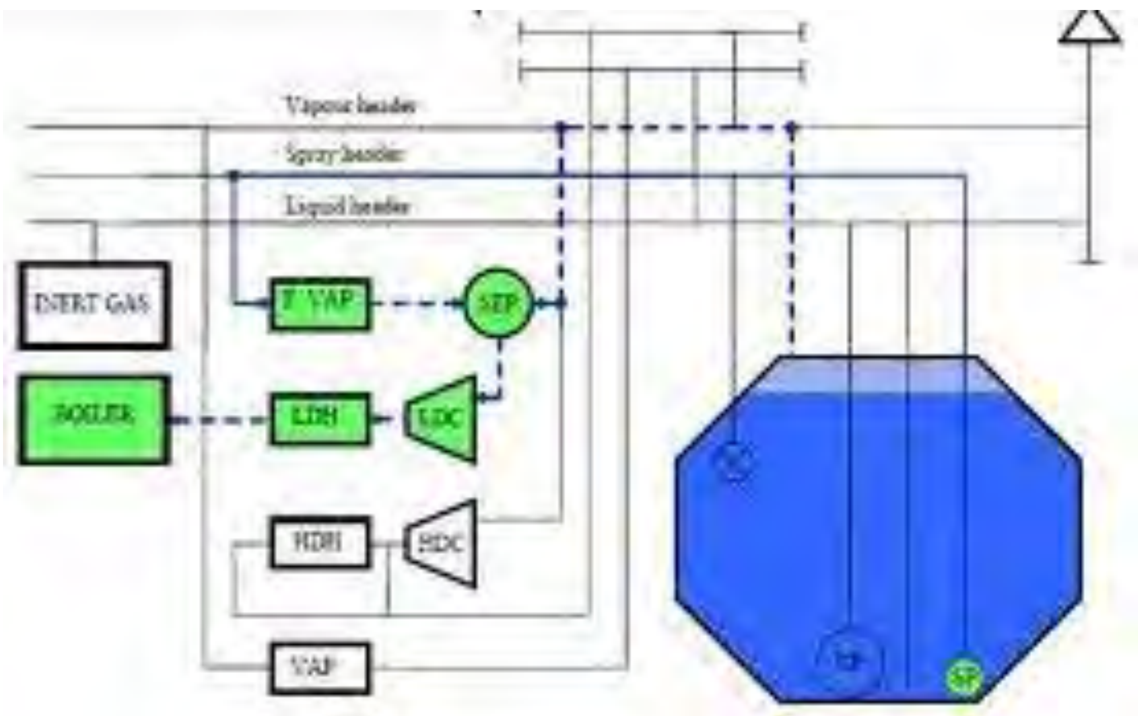


Figure 2.2.3 (D) LOADED VOYAGE WITH FORCED VAPORIZER

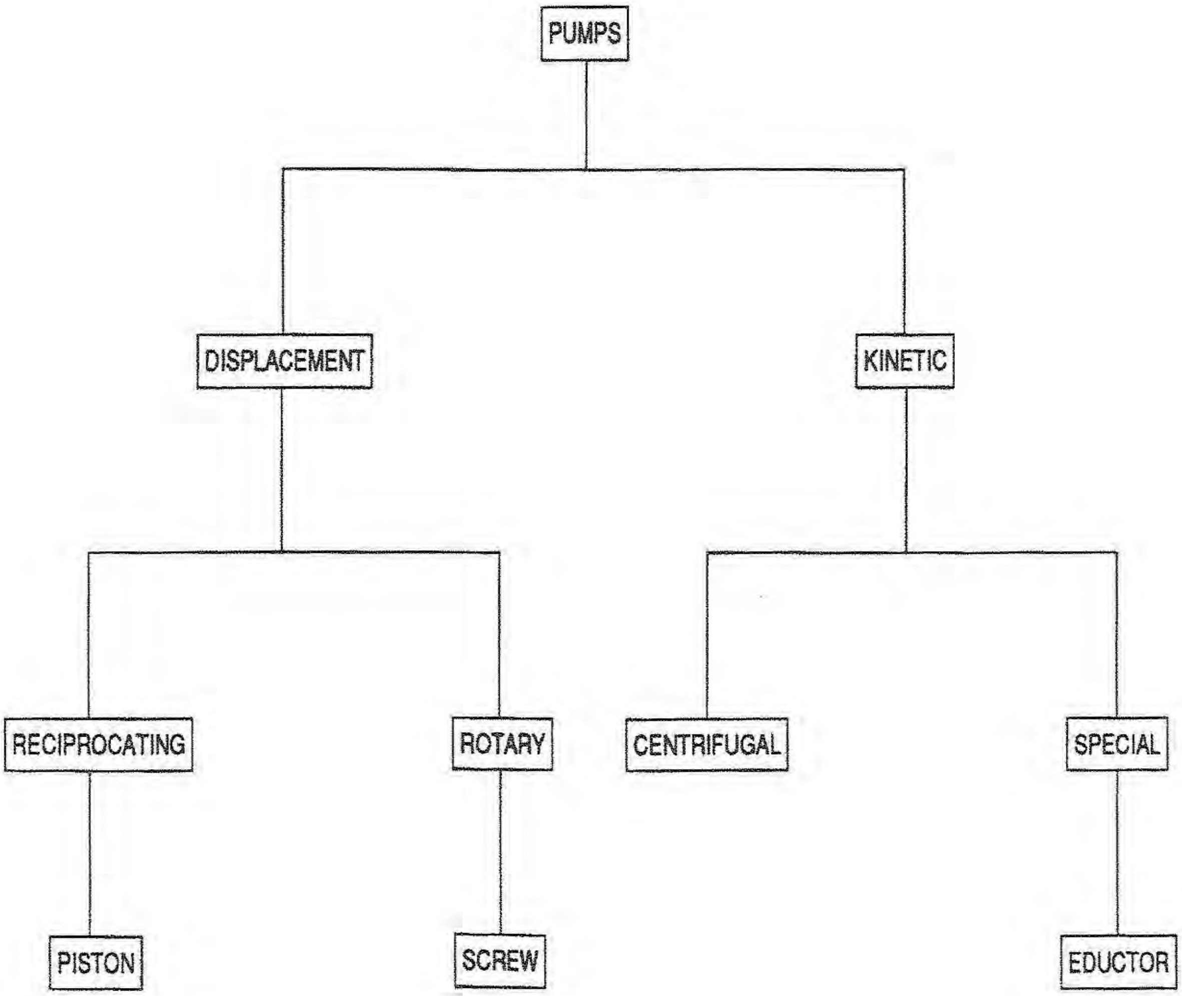


Figure 2.3 (A) PUMP TYPES

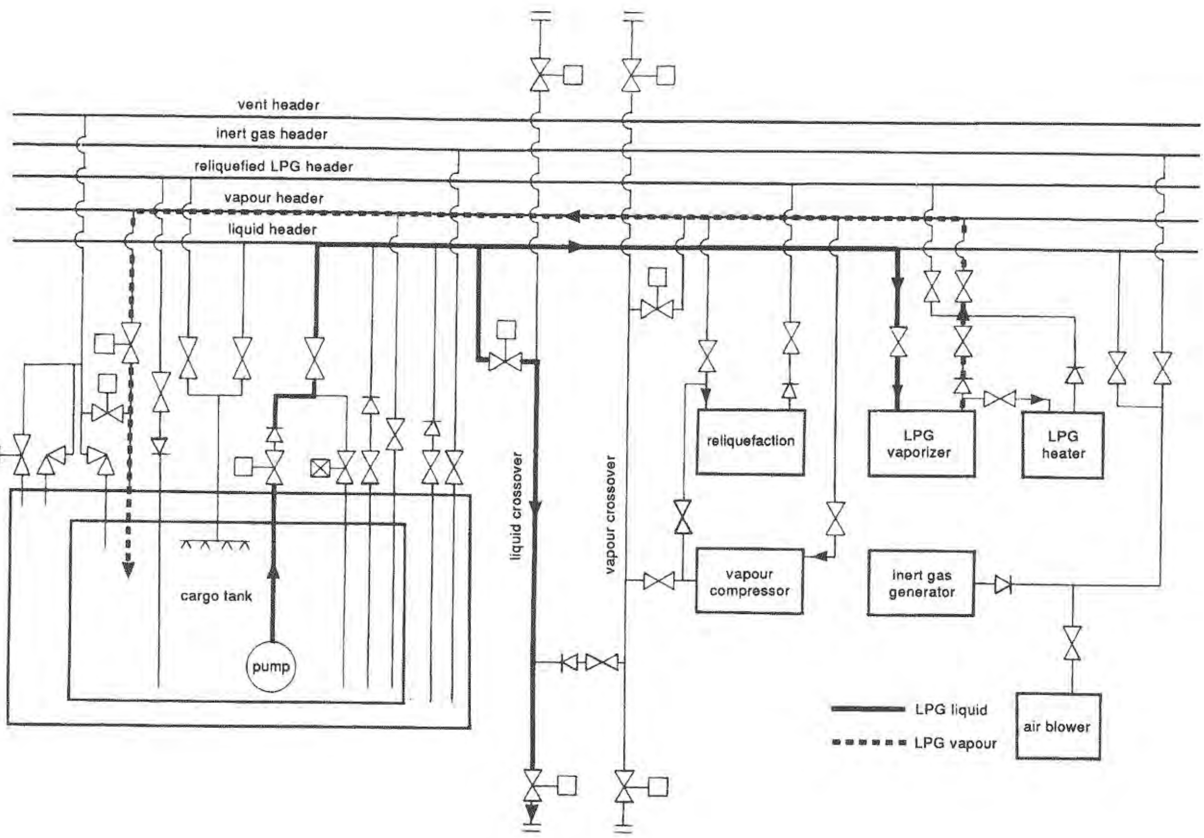


Figure 2.3 (B) CARGO DISCHARGING, WITHOUT VAPOUR RETURN

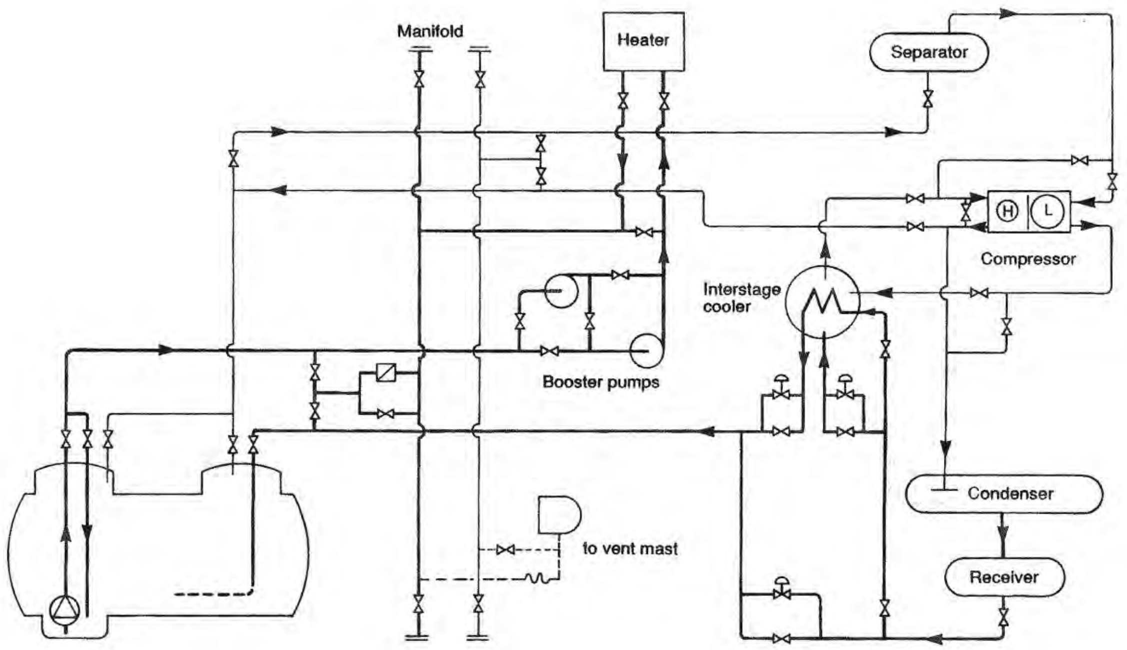


Figure 2.3(C) CARGO HANDLING ARRANGEMENT LOADING UNLOADING AND CARE IN TRANSIT WITH BOOSTER AND HEATER

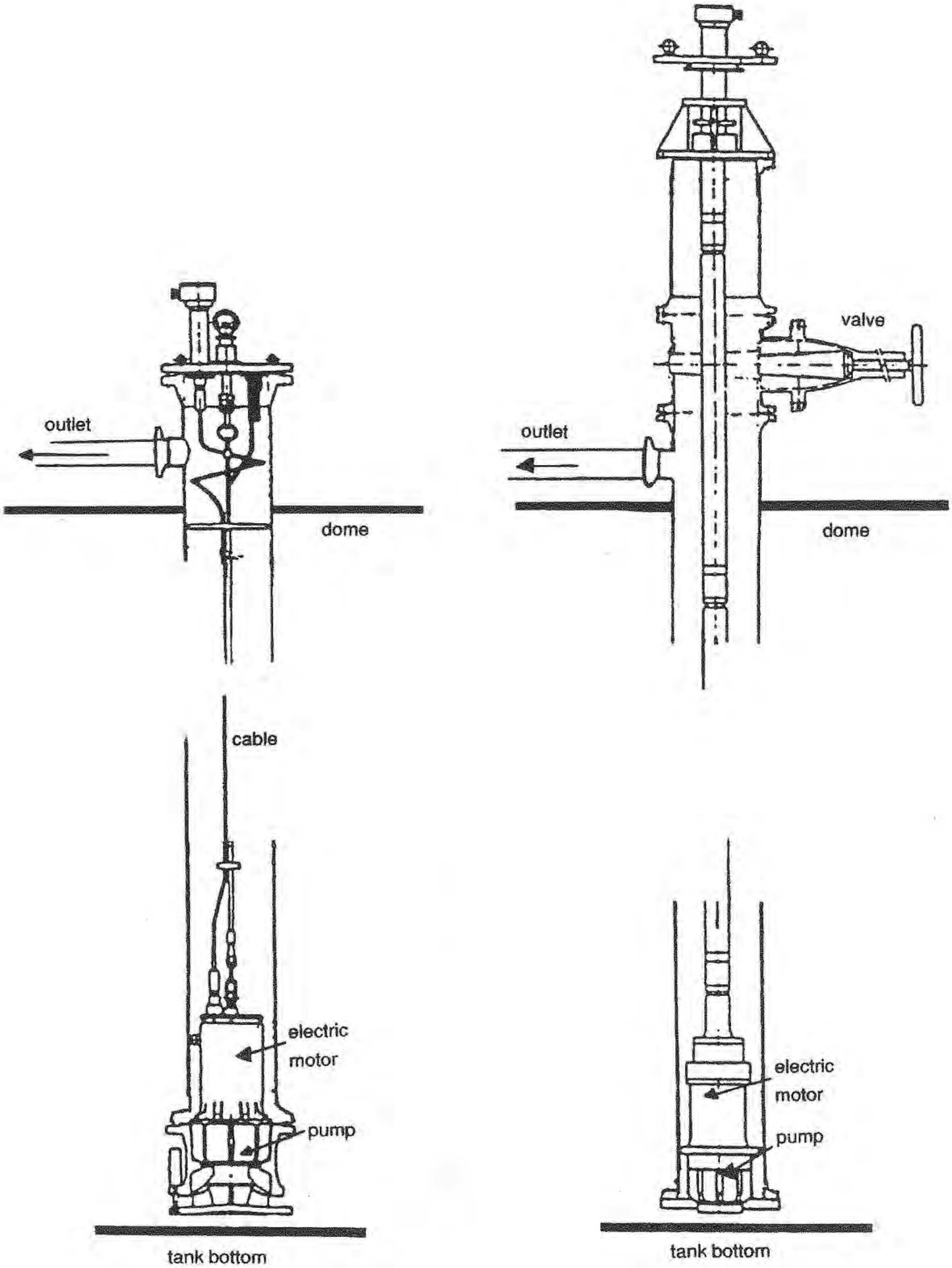


Figure 2.3 (D) EXAMPLES OF ELECTRICAL SUBMERGED PUMPS

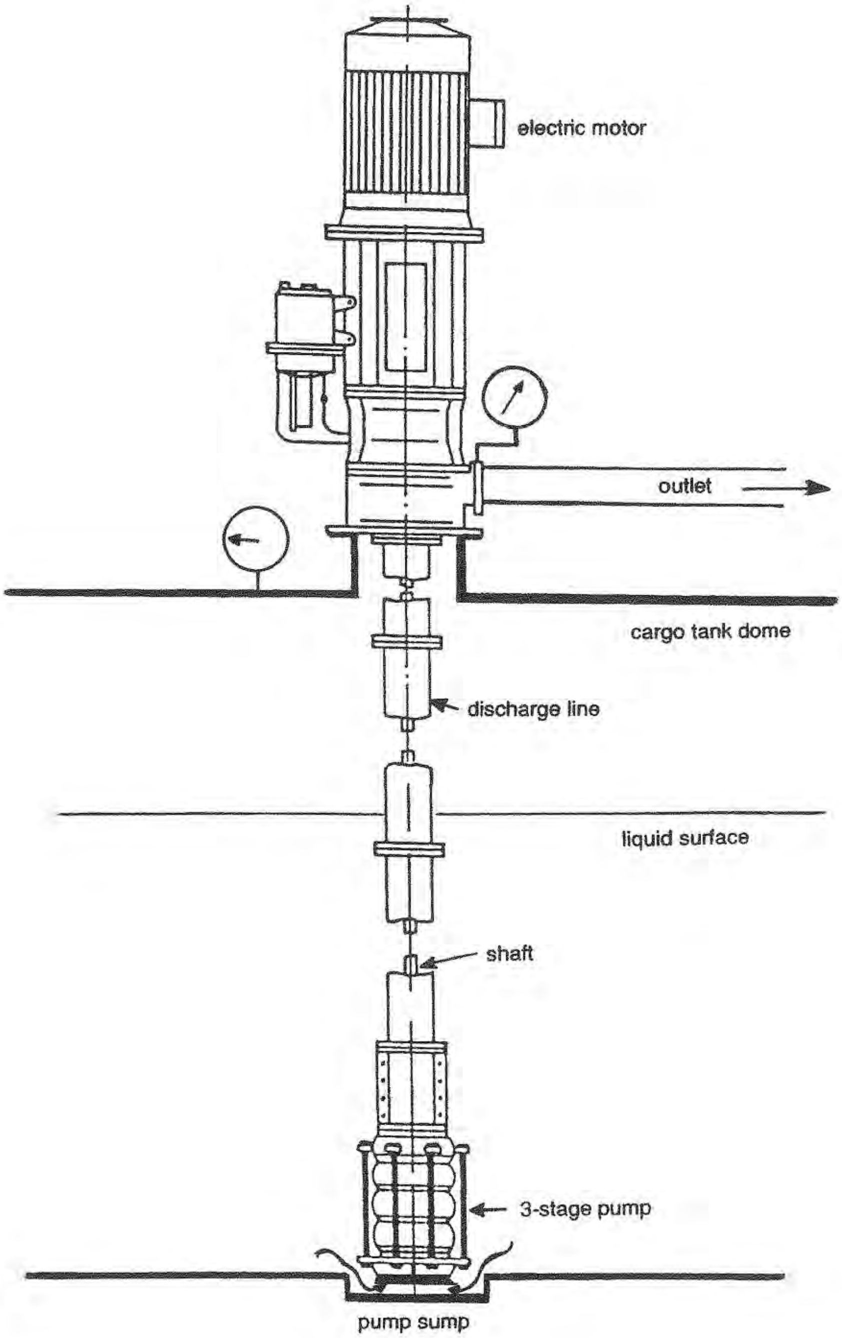


Figure 2.3 (E) DEEPWELL PUMP

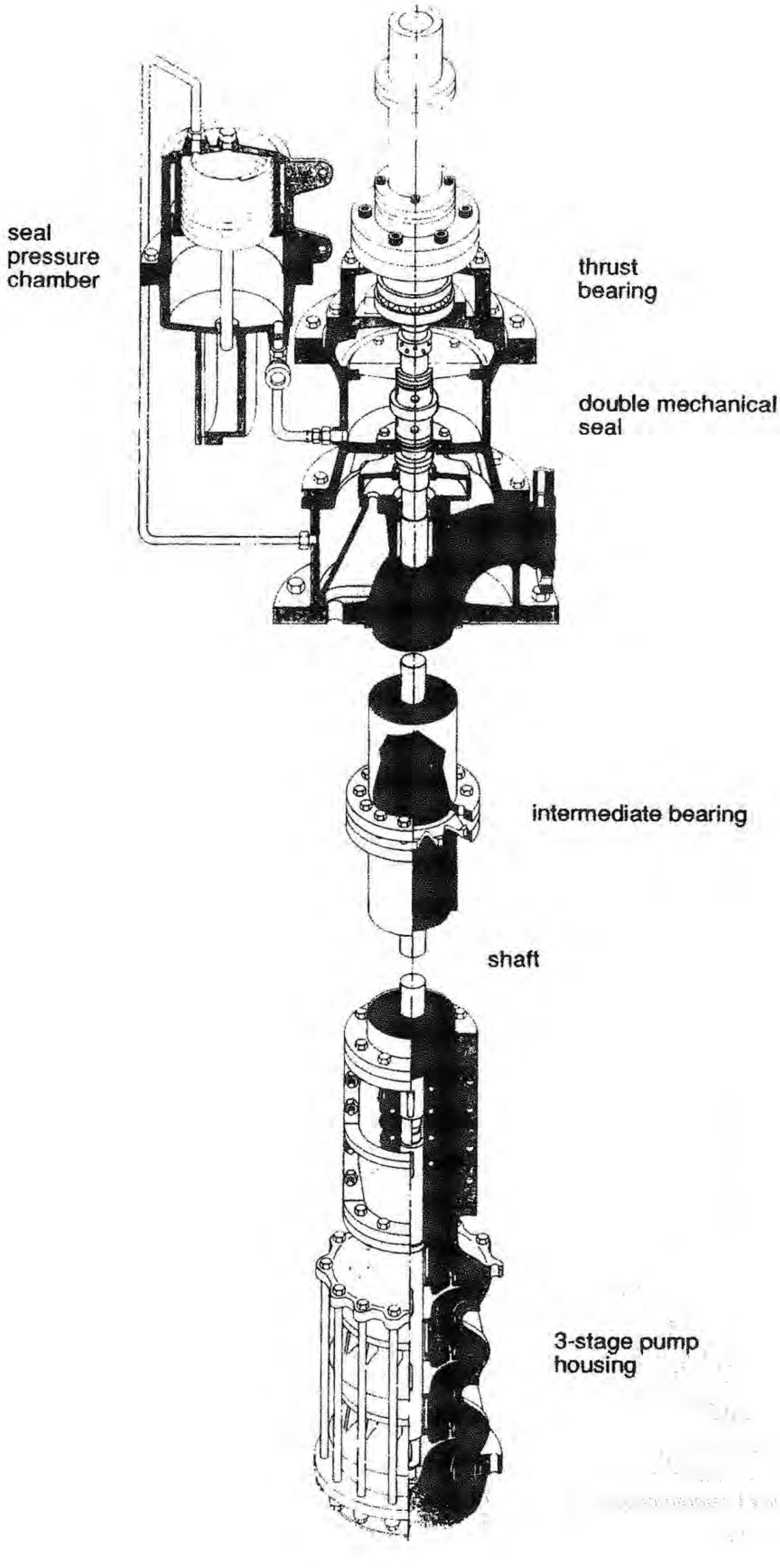


Figure 2.3. (F) DEEPWELL PUMP

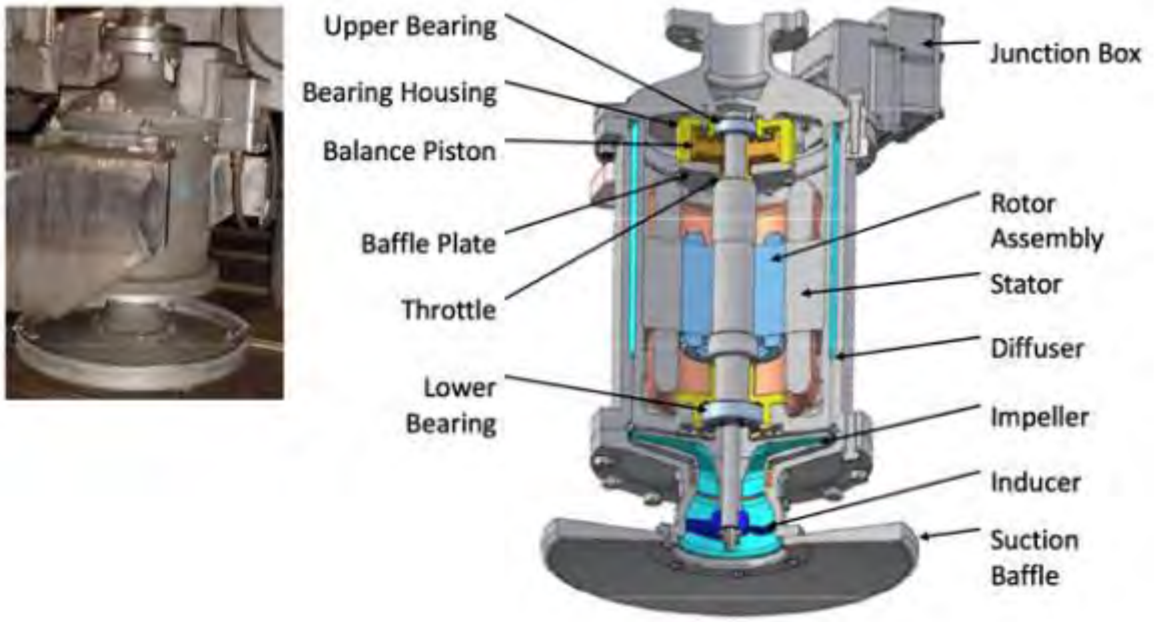


Figure 2.3 (G) SUBMERGED PUMP

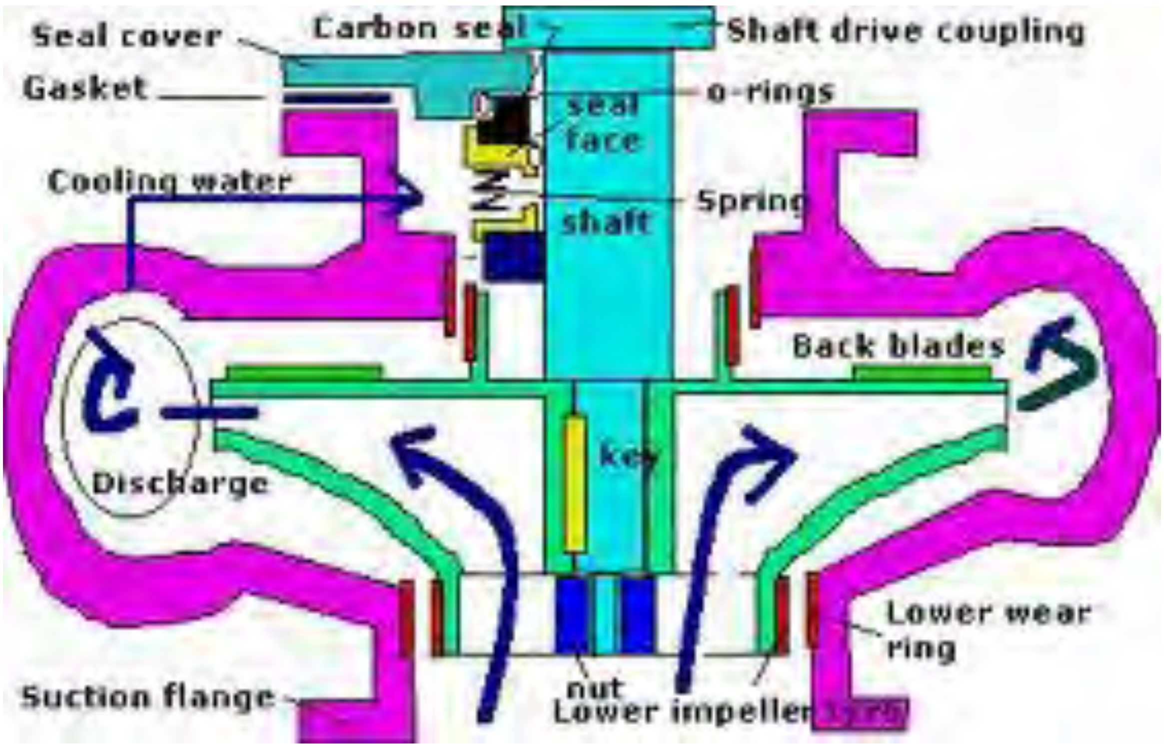


Figure 2.3 (H) CENTRIFUGAL PUMP

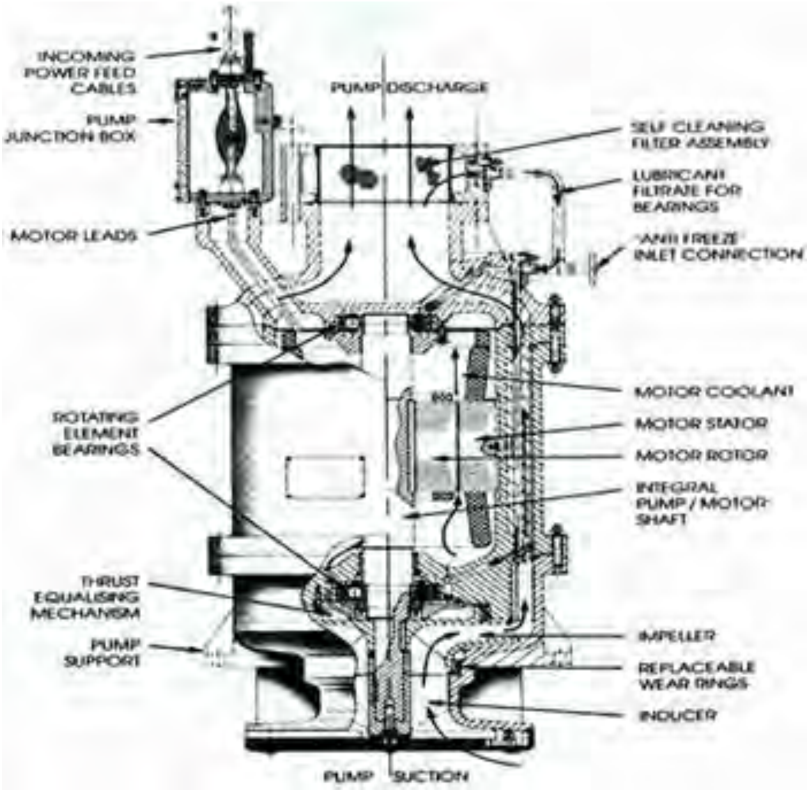


Figure 2.3(I) SUBMERGED MOTOR PUMP FOR LPG

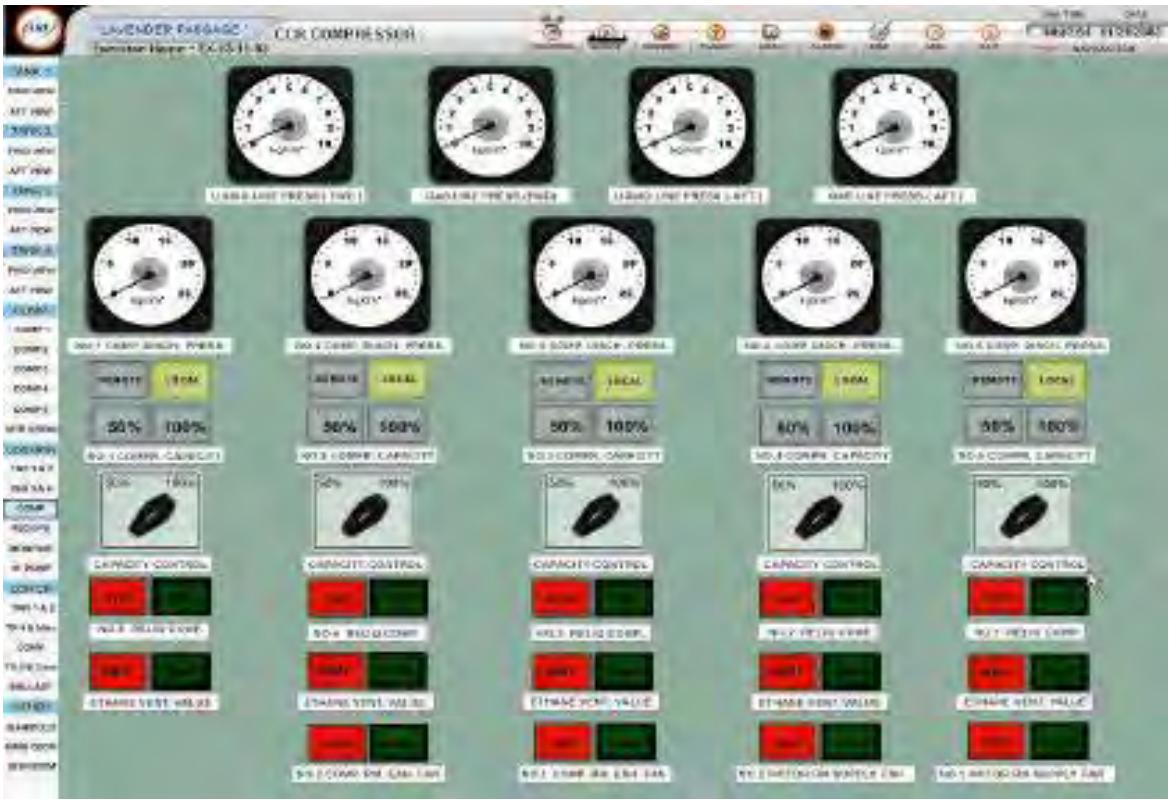


Figure 2.3.2 (A) CARGO RELIQUEFACTION SYSTEM

LIQUID CARGO HANDLING SIMULATOR – LPG

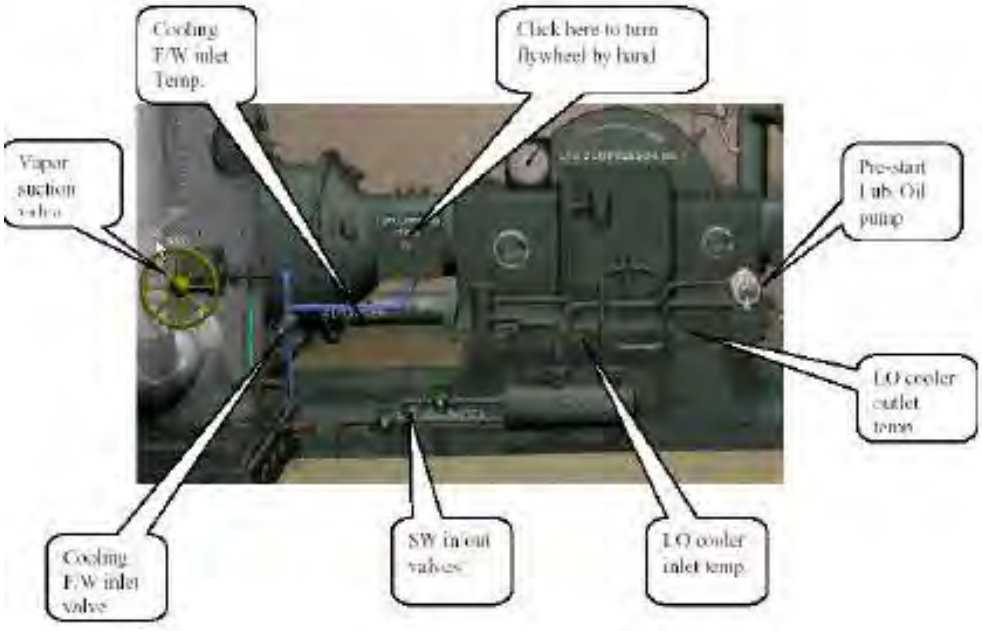


Figure 2.3.2 (B) RELIQUEFACTION COMPRESSOR SET –UP
LIQUID CARGO HANDLING SIMULATOR – LPG

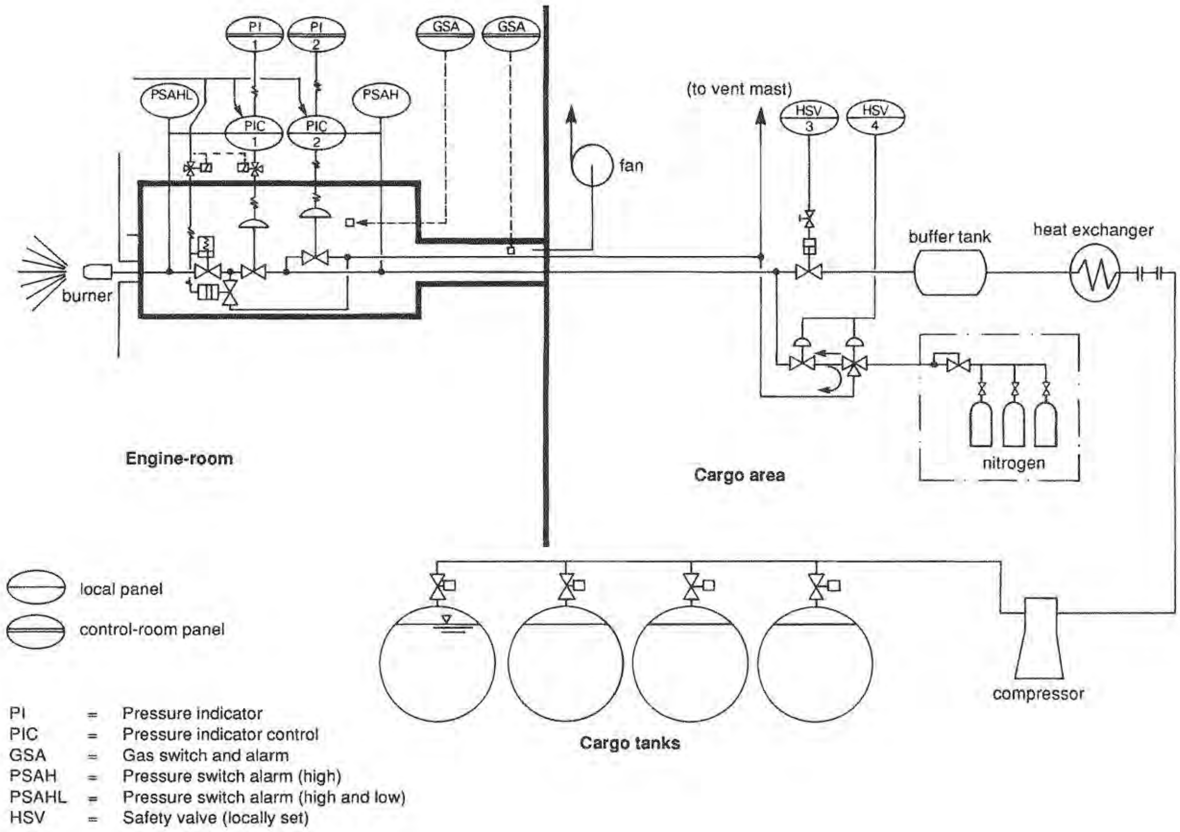


Figure 2.3.2 (C) SCHEMATIC DIAGRAM OF HANDLING OF LNG BOIL-OFF

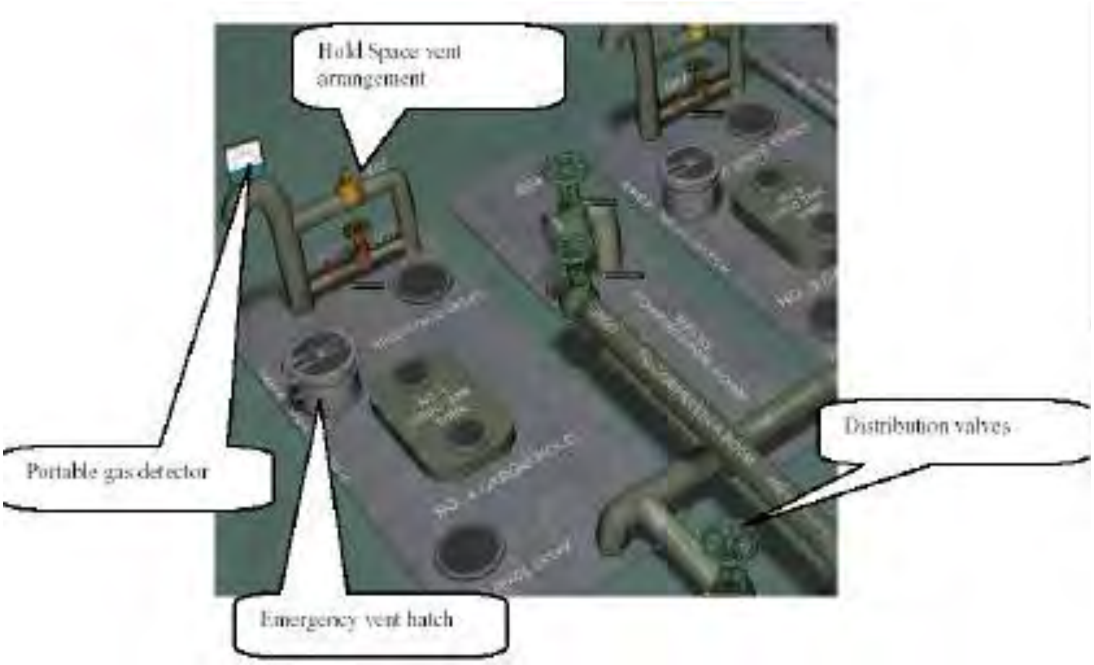


**Figure 2.3.2 (D) INERT / VENTING CONTROL
LIQUID CARGO HANDLING SIMULATOR – LPG**

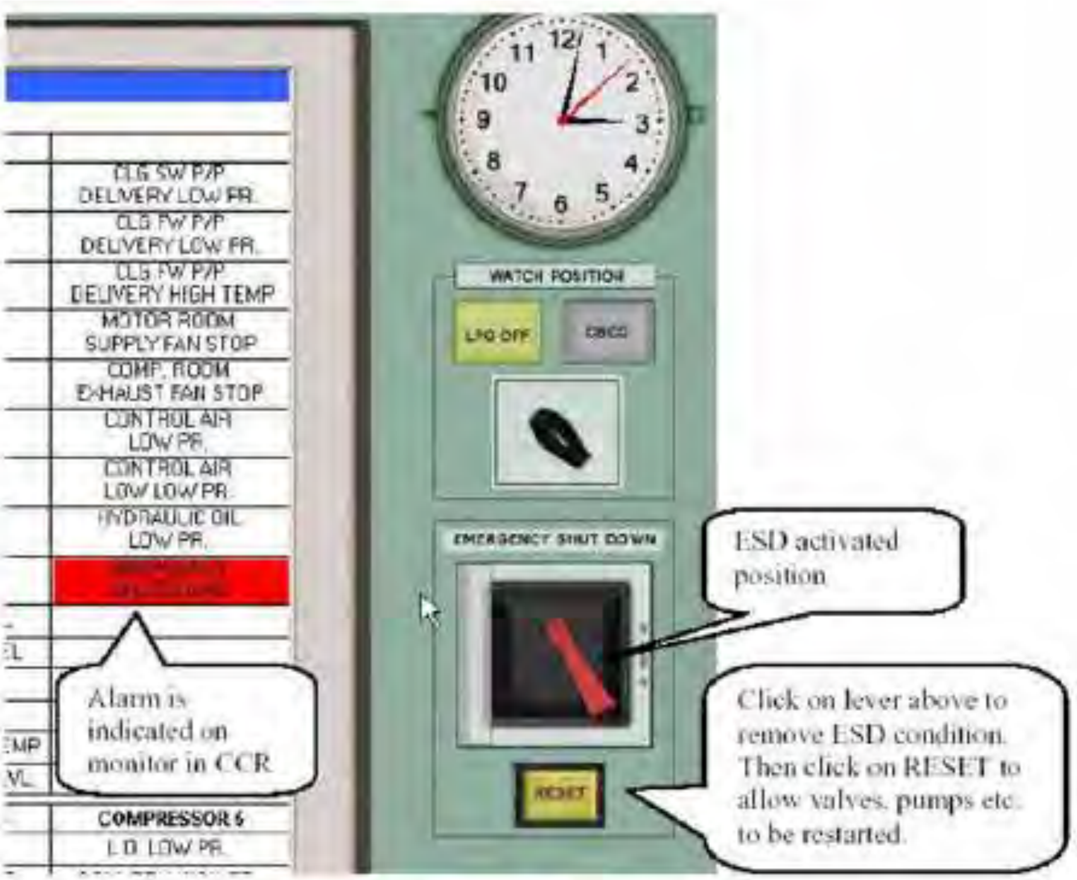


Figure 2.4 (A) ESD Reset LIQUID CARGO HANDLING SIMULATOR – LPG

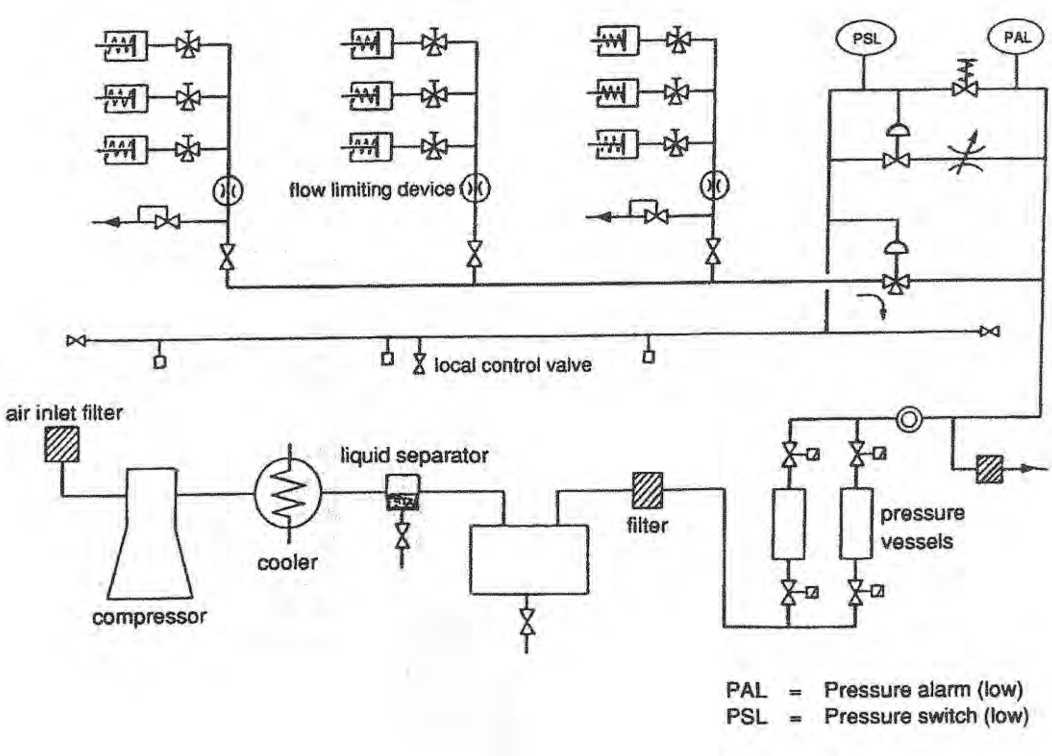


Figure 2.4(B) A PNEUMATIC EMERGENCY SHUTDOWN SYSTEM

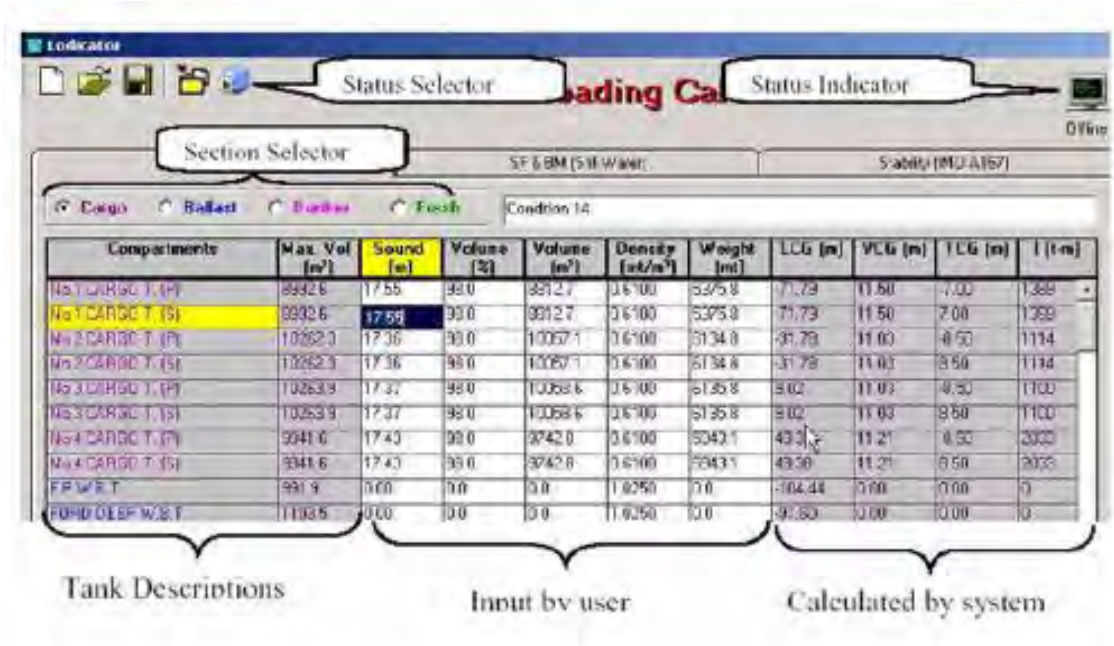


Figure 2.4(C) LOADICATORLIQUID CARGO HANDLING SIMULATOR – LPG

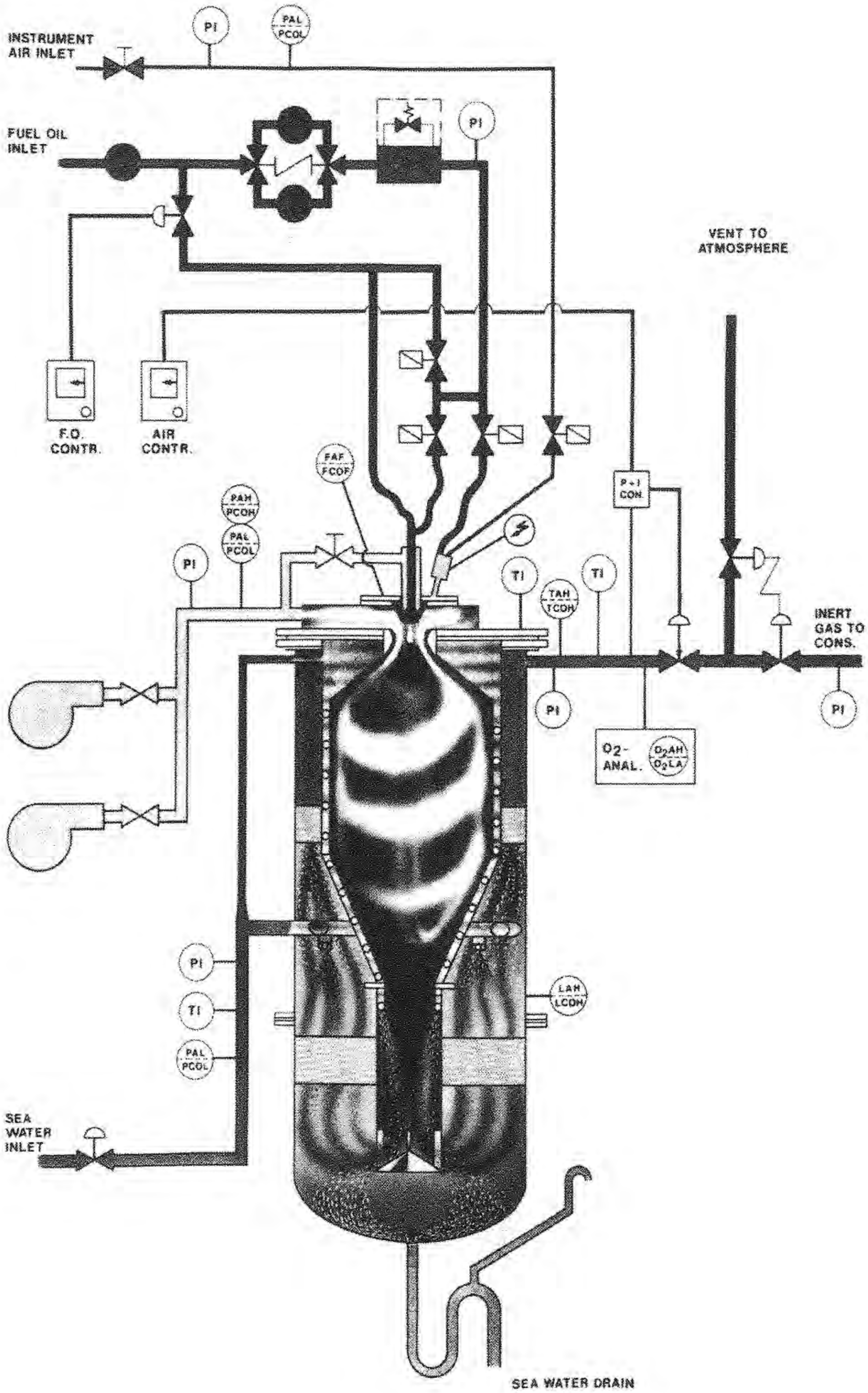


Figure 2.5 (A) AN INERT GAS GENERATOR

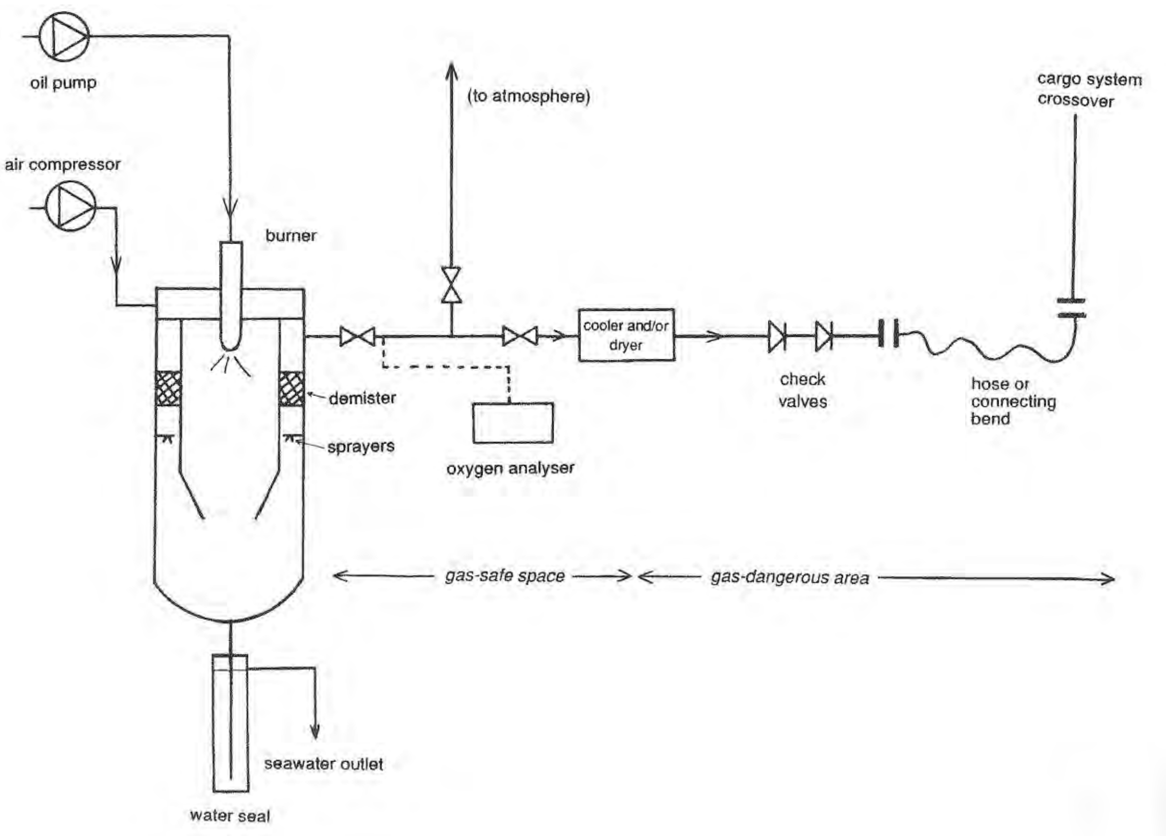


Figure 2.5 (B) SCHEMATIC DIAGRAM OF AN INERT GAS GENERATOR SYSTEM

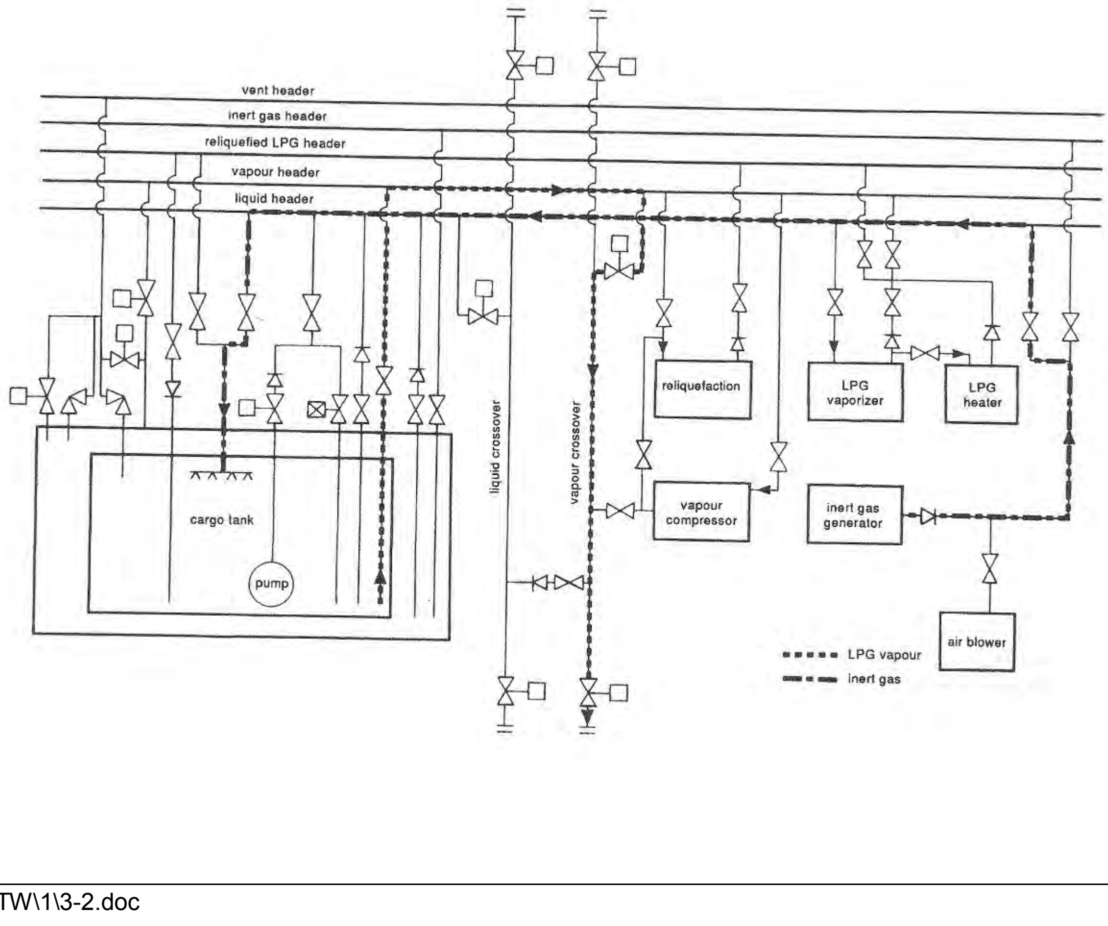


Figure 2.5 (C) INERTING/PURGING OPERATION

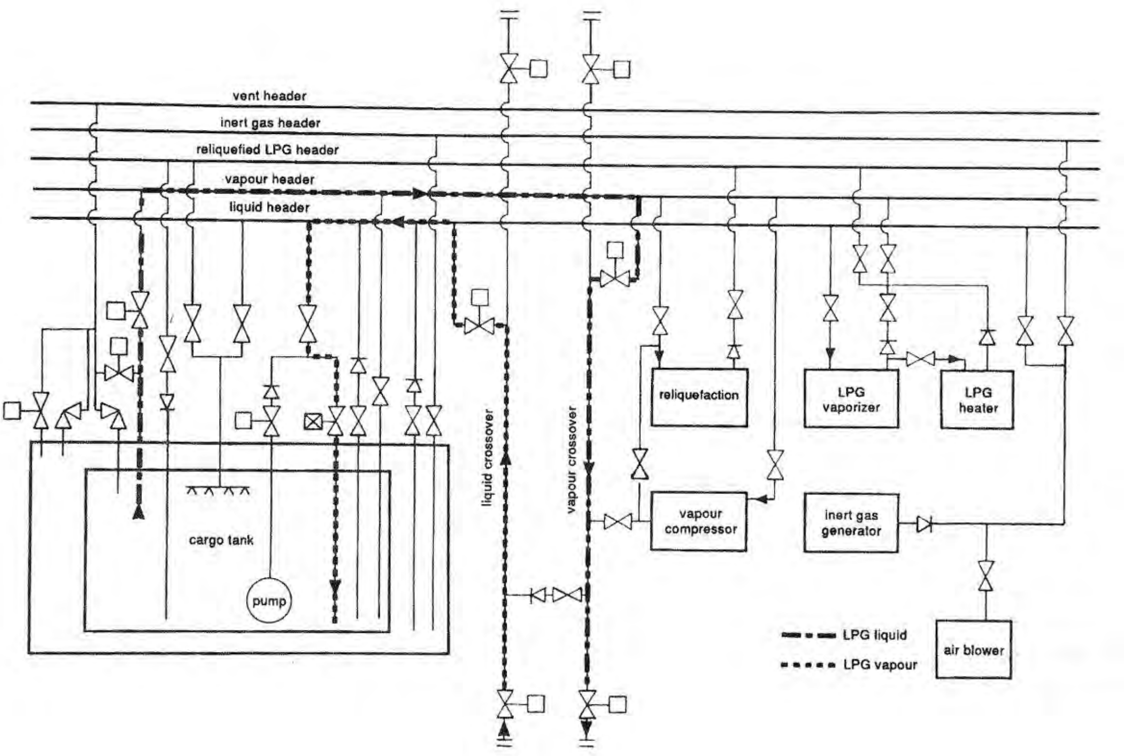


Figure 2.5(D) PURGING OF A CARGO TANK, USING VAPOUR FROM SHORE

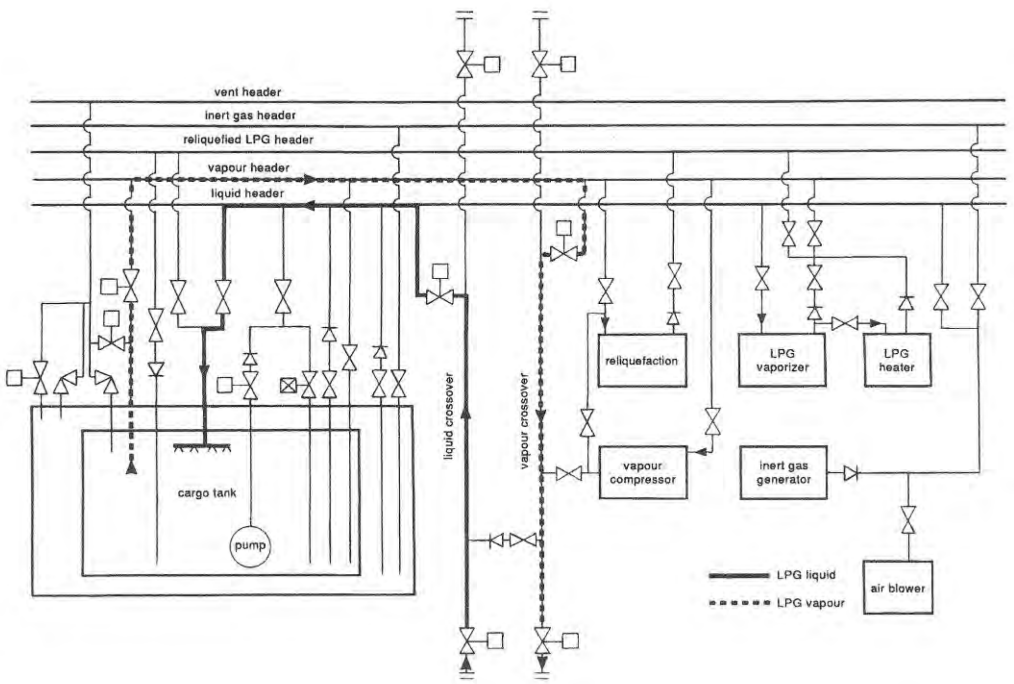


Figure 2.5(E) COOLING DOWN OF A CARGO TANK, USING LIQUID FROM SHORE AND VAPOUR RETURN

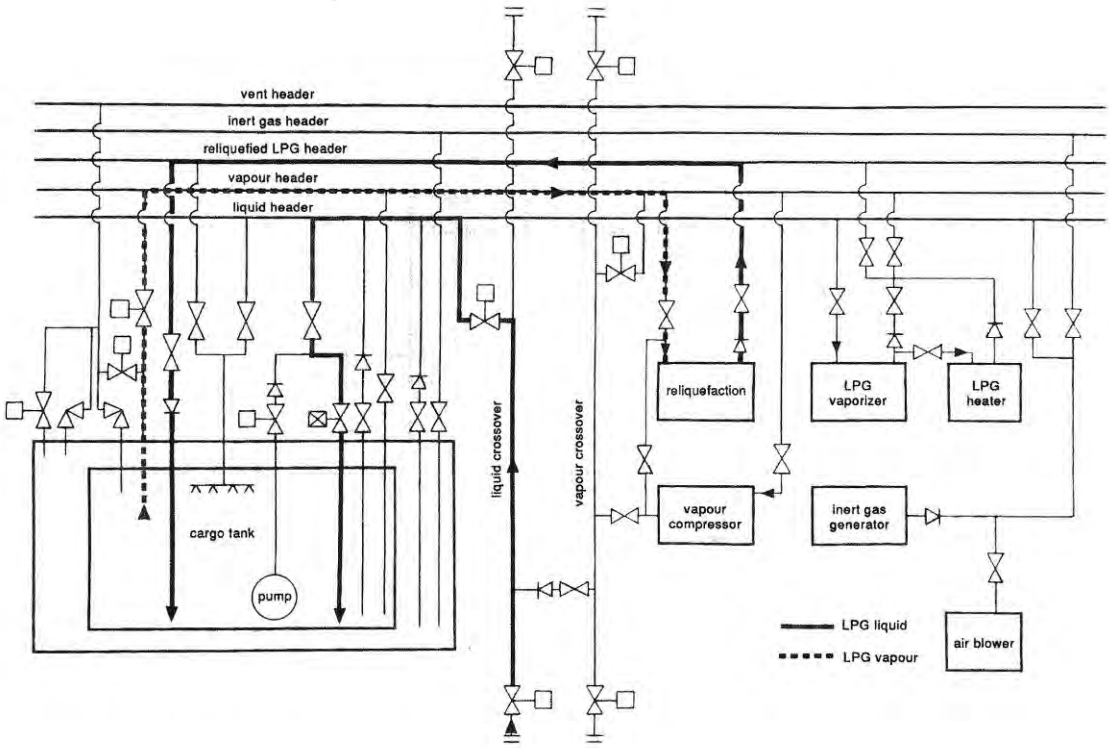


Figure 2.5(F) LOADING, WITHOUT VAPOUR RETURN

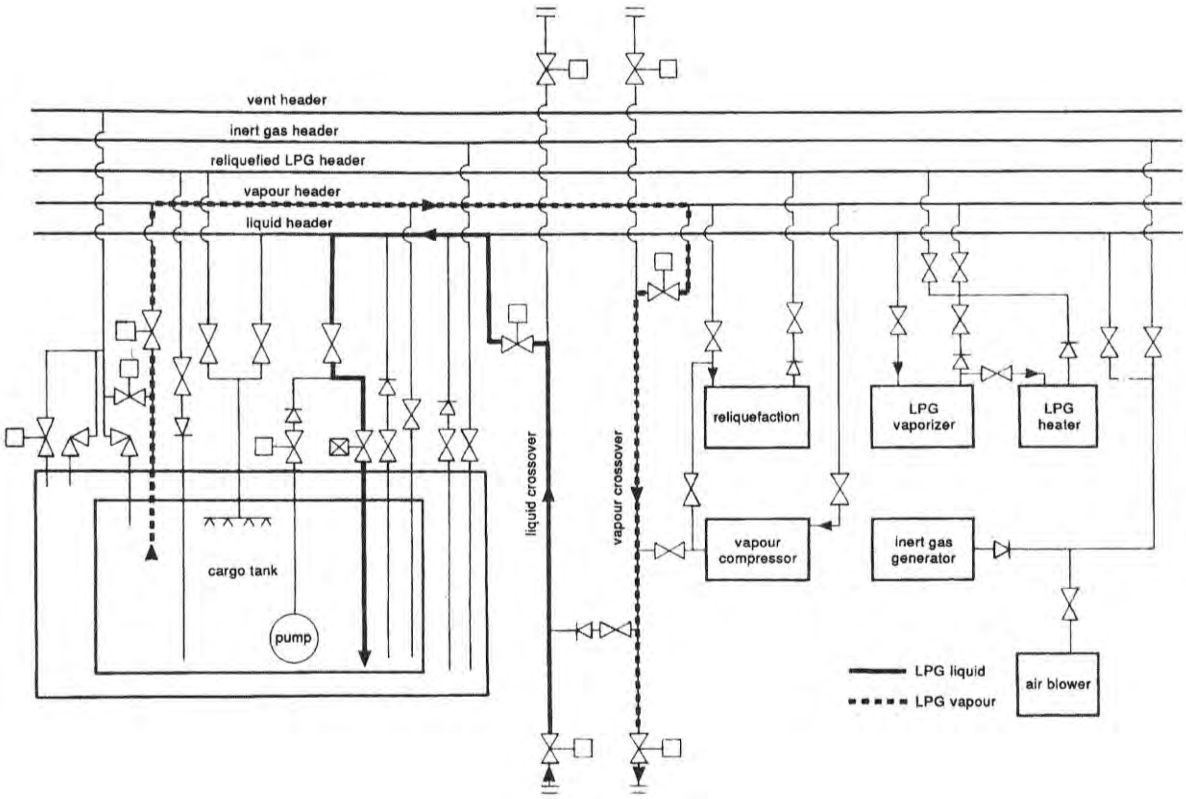


Figure 2.5(G) LOADING, WITH VAPOUR RETURN

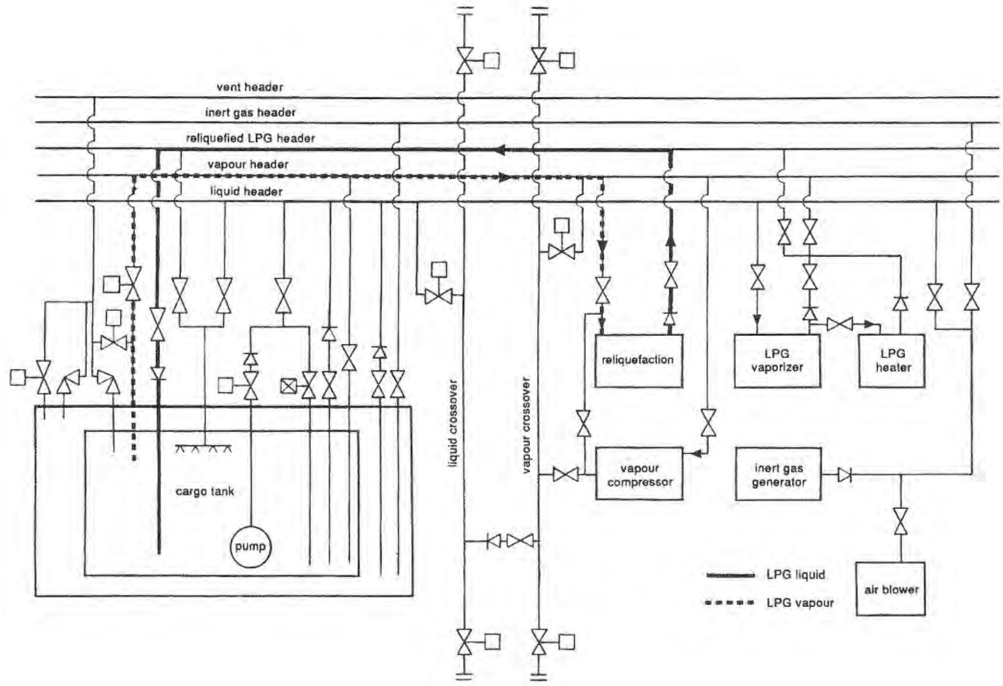


Figure 2.5(H) COOLING DOWN OF TANKS DURING LOADED PASSAGE

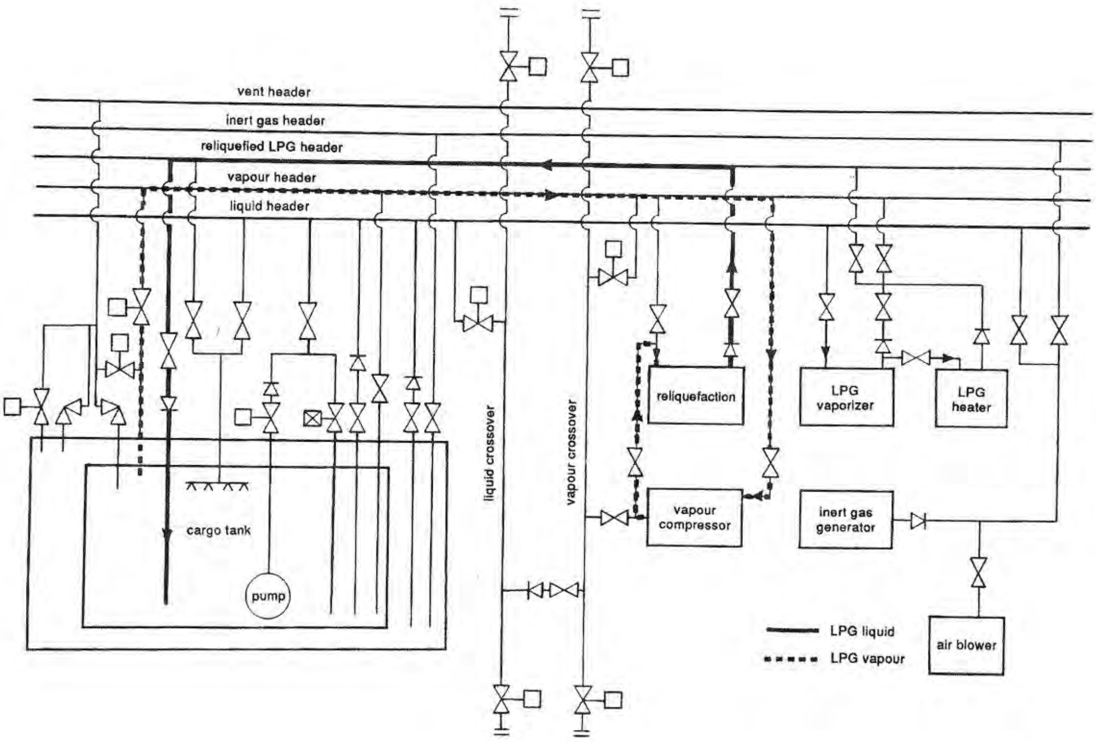


Figure 2.5(I) CARGO CONDITIONING DURING LOADED PASSAGE

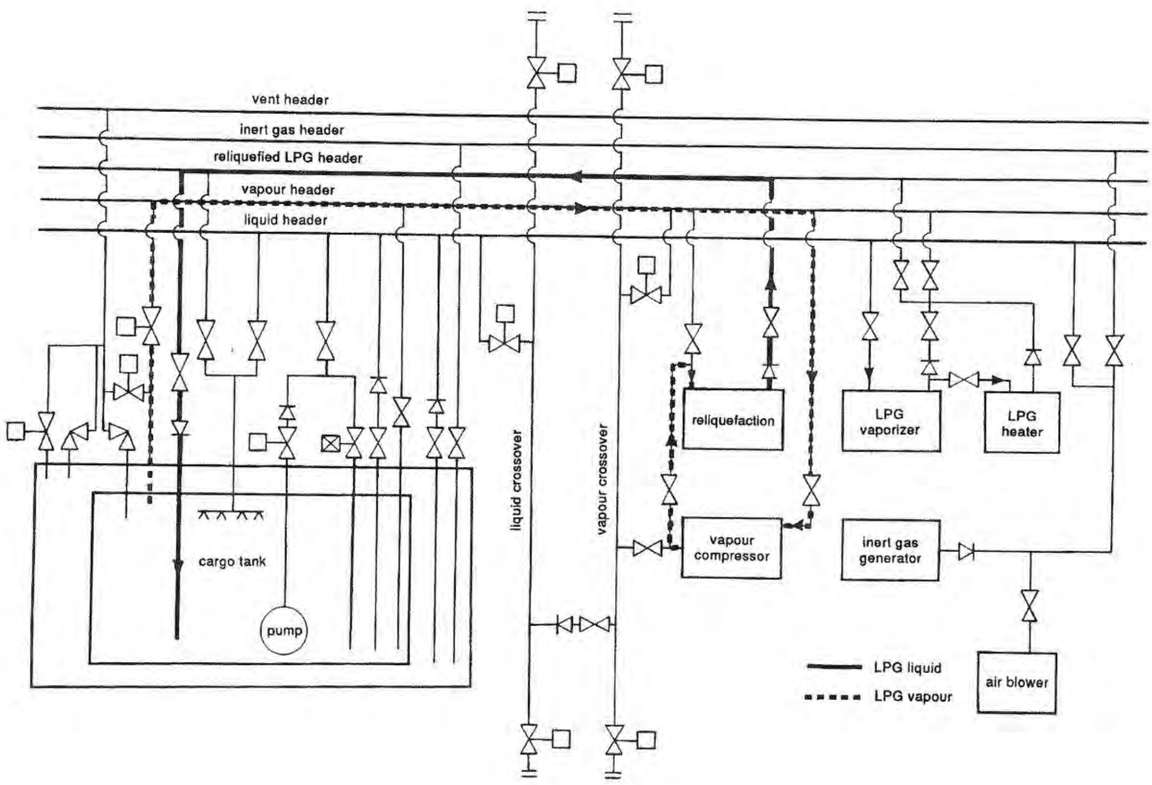


Figure 2.5(J) CARGO CONDITIONING DURING LOADED PASSAGE

Cargo	Ship type
Acetaldehyde	2G/2PG
Ammonia, anhydrous	2G/2PG
Butadiene	2G/2PG
Butane	2G/2PG
Butane/propane mixtures	2G/2PG
Butylenes	2G/2PG
Chlorine	1G
Diethyl ether	2G/2PG
Dimethylamine	2G/2PG
Ethane	2G
Ethyl chloride	2G/2PG
Ethylene	2G
Ethylene oxide	1G
Ethylene oxide/propylene oxide mixture with ethylene oxide content less than 30% by weight	2G/2PG
Isoprene	2G/2PG
Isopropylamine	2G/2PG
Methane	2G
Methylacetylene/propadiene mixture	2G/2PG
Methyl bromide	1G
Methyl chloride	2G/2PG
Monoethylamine	2G/2PG
Nitrogen	3G
Propane	2G/2PG
Propylene	2G/2PG
Propylene oxide	2G/2PG
Refrigerant gases	3G
Sulphur dioxide	1G
Vinyl chloride	2G/2PG
Vinyl ethyl ether	2G/2PG
Vinylidene chloride	2G/2PG

Figure 3.1 (A) LIST OF LIQUEFIED GASES SUITABLE FOR TRANSPORT IN DIFFERENT SHIP TYPE - LIQUEFIED GAS TANKER(AS LISTED IN IMO GAS CARRIER CODES)

a Product name	b UN number	c Ship type	d Independent tank type C required	e Control of vapour space within cargo tanks	f Vapour detection	g Gauging	h MFAG table no.	i Special requirements
Isoprene*	1218	2G/ 2PG	–	–	F	R	310	14.4.3, 17.8, 17.10, 17.12
Isopropylamine*	1221	2G/ 2PG	–	–	F+T	C	320	14.4.2, 14.4.3, 17.2.4, 17.10, 17.11, 17.12, 17.17
Methane (LNG)	1972	2G	–	–	F	C	620	
Methyl acetylene-propadiene mixtures	1060	2G/ 2PG	–	–	F	R	310	17.18
Methyl bromide	1062	1G	Yes	–	F+T	C	345	14.4, 17.2.3, 17.3.2, 17.4.1, 17.5, 17.9
Methyl chloride	1063	2G/ 2PG	–	–	F+T	C	340	17.2.3
Monoethylamine*	1036	2G/ 2PG	–	–	F+T	C	320	14.4.2, 14.4.3, 14.4.4, 17.2.1, 17.3.1, 17.10, 17.11, 17.12, 17.17
Nitrogen	2040	3G	–	–	O	C	620	17.19

Figure 3.1.2 (A) CHAPTER 19 OF IGC CODE

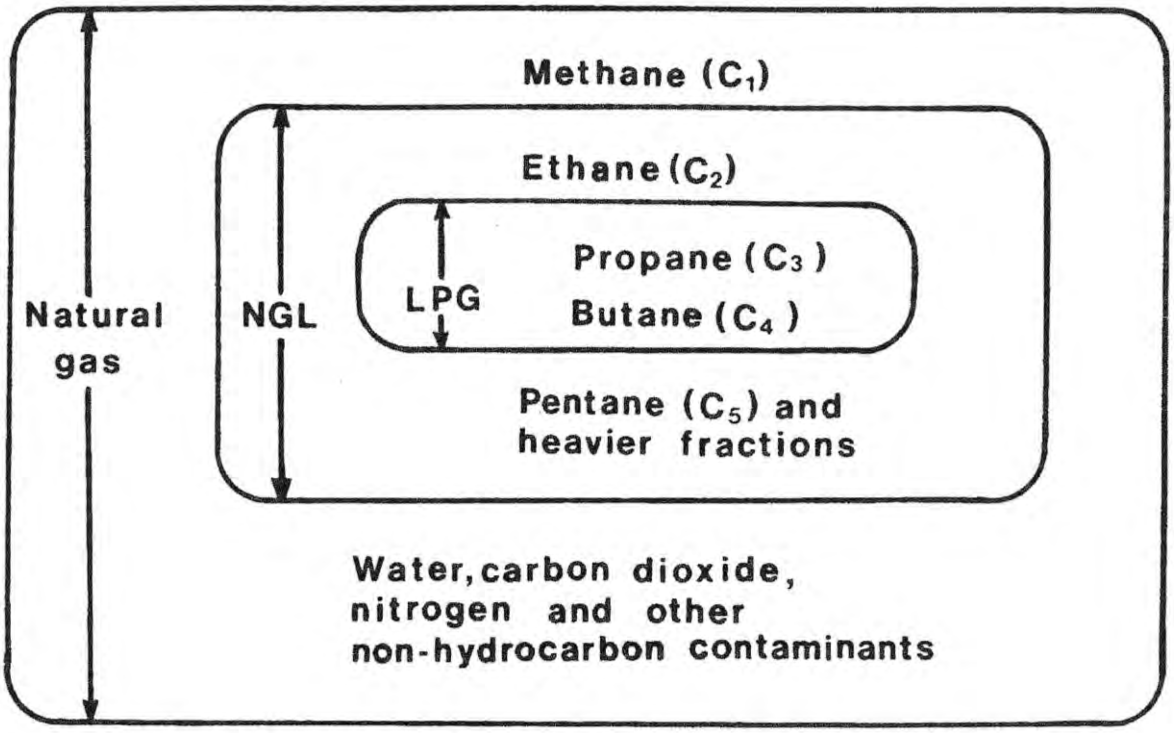


Figure 3.1.5 THE CONSTITUENTS OF NATURAL GAS FROM A WELL

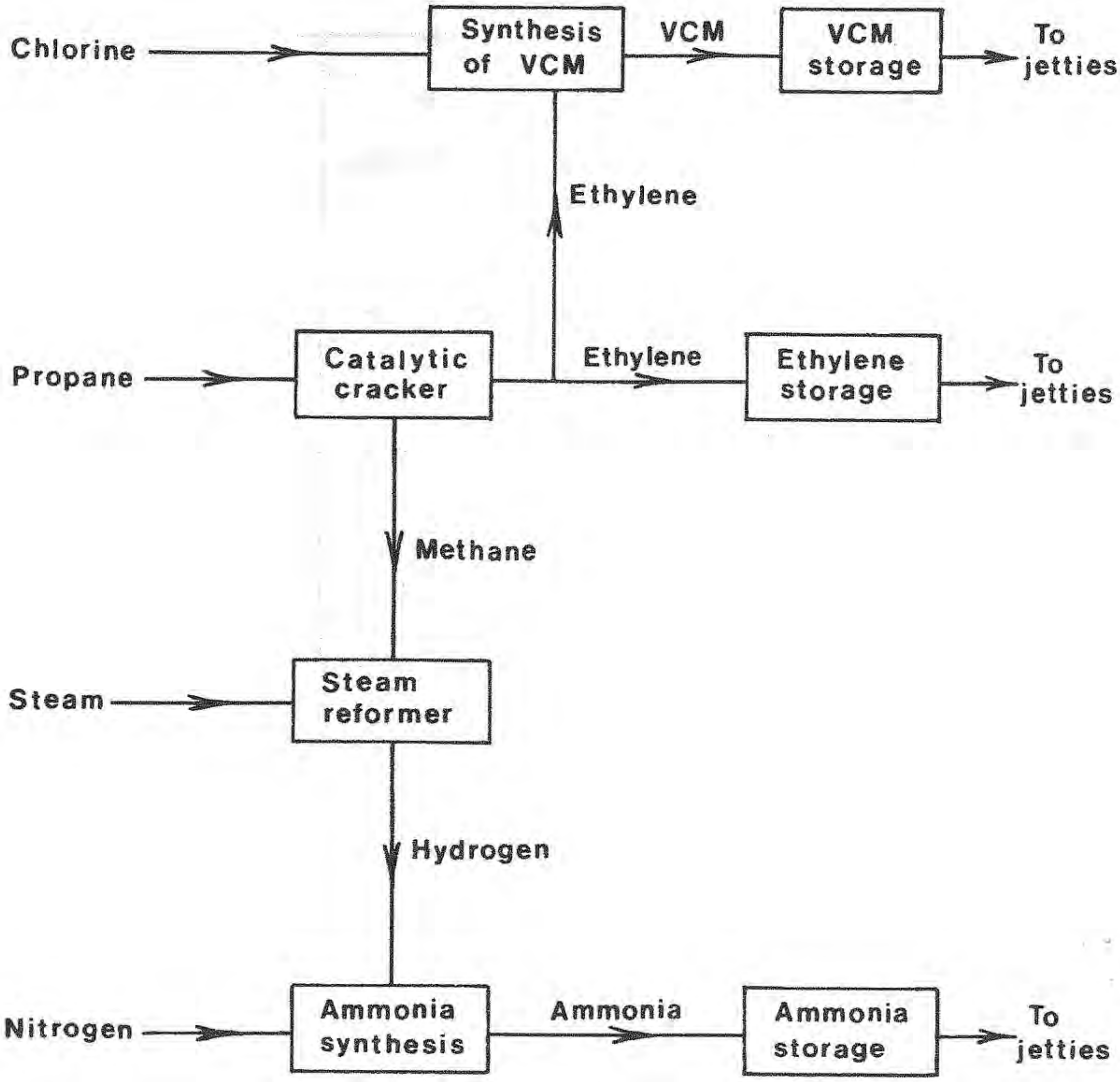


Figure 3.1.10 FLOW DIAGRAM FOR TYPICAL PRODUCTION OF CHEMICAL GASES

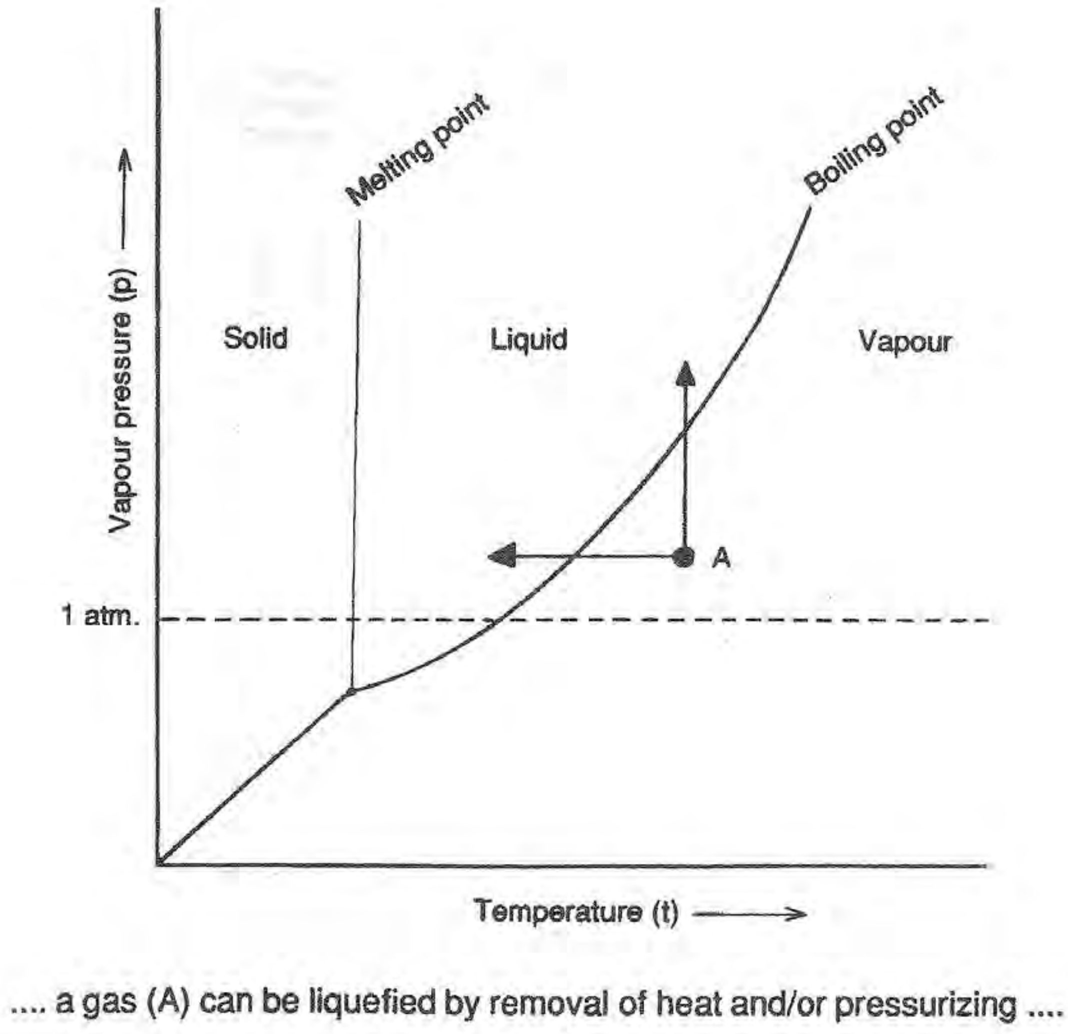


Figure 3.2.1 (A) STATES OF AGGREGATION (PRESSURE / TEMPERATURE)

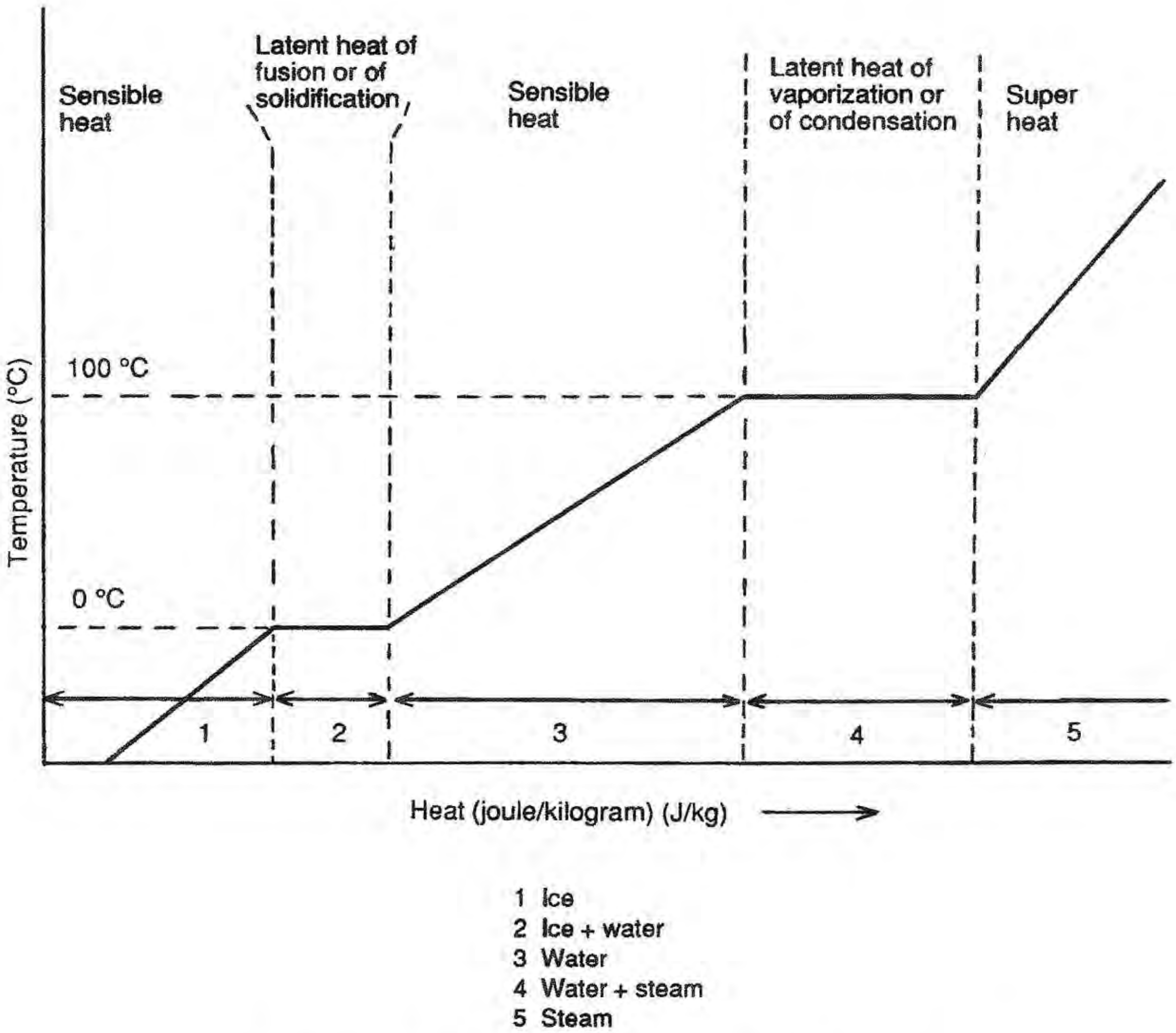


Illustration of the behaviour of water when heated.

In the reverse process, water vapour (steam) can be liquefied and subsequently solidified by removal of heat.

Figure 3.2.1 (B) STATES OF AGGREGATION (TEMPERATURE / HEAT)

Figure 3.2.2.6 (A) TOXIC GASES

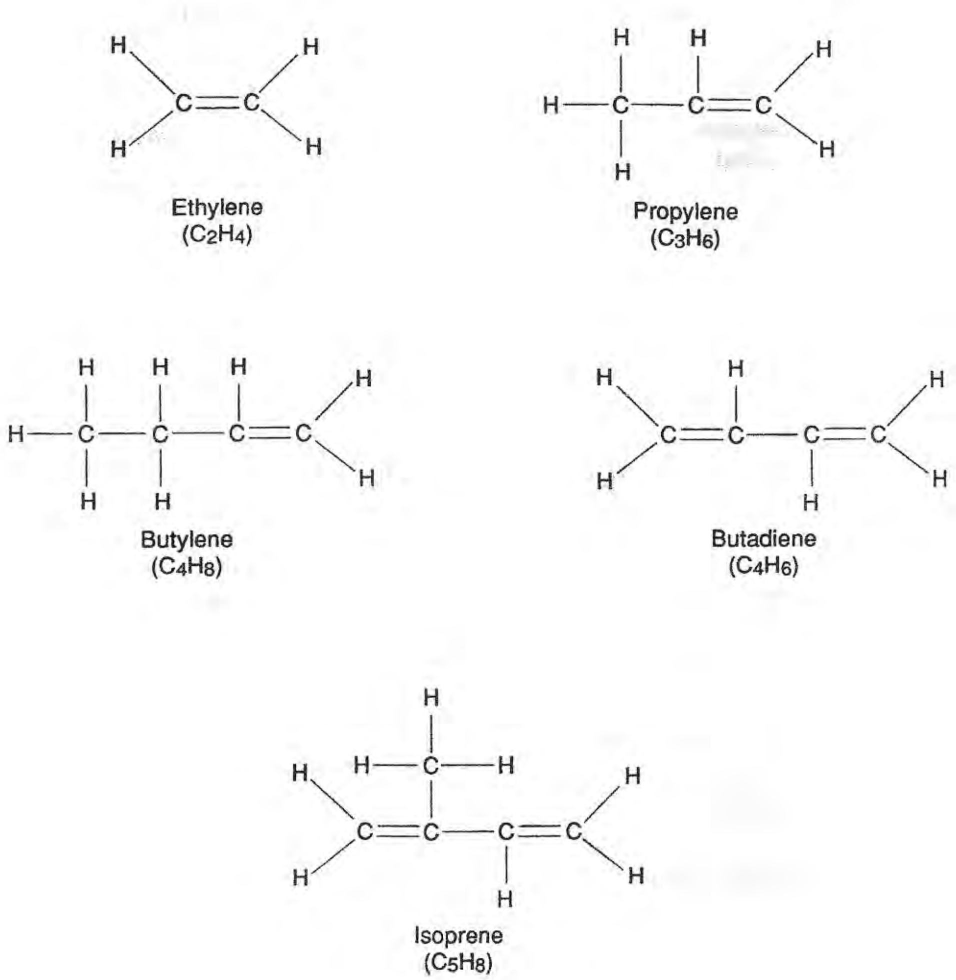


Figure 3.4(A) CHEMICAL SYMBOLS WITH MOLECULAR STRUCTURES

Reactive with \ Gas	Methane	Ethane	Propane	Butane	Ethylene	Propylene	Butylene	Butadiene /isoprene	Ammonia	VCM	Ethylene oxide	Propylene oxide	Chlorine (dry)
Magnesium								✓			✓	✓	
Mercury								✓	✓		✓	✓	✓
Zinc									✓				✓
Copper								✓	✓		✓	✓	
Aluminium								✓	✓	✓	✓	✓	✓
Mild steel	✓				✓								
Stainless steel											✓		
Iron											✓	✓	
PTFE									✓				
PVC									✓				
Polythene	✓	✓	✓	✓			✓						
Ethanol													✓
Methanol													✓

Note: Reference should be made to the data sheets in Appendix 1 to the ICS *Tanker Safety Guide (Liquefied Gas)* for details of chemical reactivity.

✓ = reactive

Figure 5.3 REACTIVITY DIAGRAM FOR SOME LIQUEFIED GASES

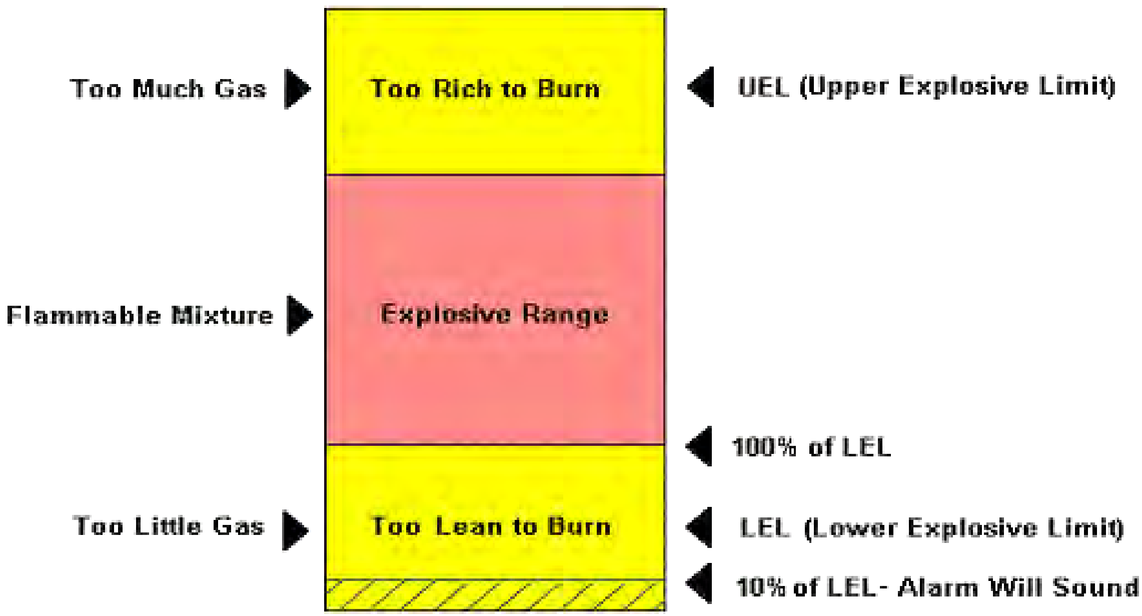


Figure 5.5 (A) FLAMMABLE GAS MIXTURE

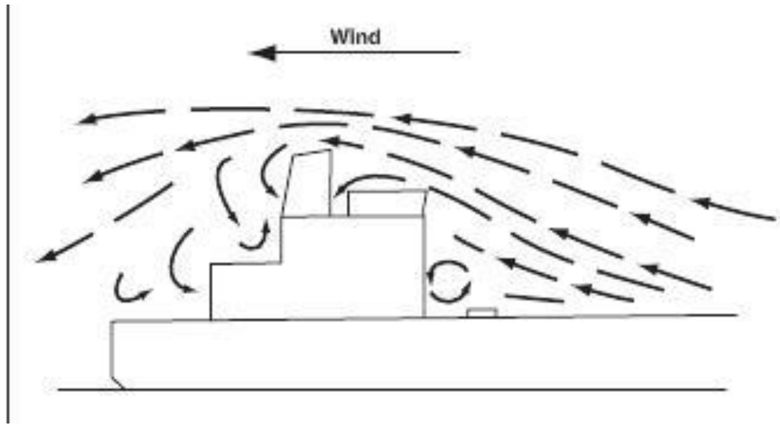


Figure 5.5 (B) FLOW OF EXPLOSIVE VAPOURS IN CASE OF VENTING / LEAKS

Liquefied gas	Flashpoint (°C)	Flammable range (% by volume in air)	Auto-ignition temperature (°C)
Methane	–175	5.3–14	595
Ethane	–125	3.1–12.5	510
Propane	–105	2.1–9.5	468
n-Butane	–60	1.8–8.5	365
i-Butane	–76	1.8–8.5	500
Ethylene	–150	3–32	453
Propylene	–180	2–11.1	458
α-Butylene (butene-1)	–80	1.6–9.3	440
β-Butylene (butene-2)	–72	1.8–8.8	465
Butadiene	–60	2–12.6	418
Isoprene	–50	1–9.7	220
VCM	–78	4–33	472
Ethylene oxide	–18	3–100	429
Propylene oxide	–37	2.8–37	465
Ammonia	–57	16–25	615
Chlorine	Non-flammable		

Figure 5.5 (C) FLAMMABILITY DATA FOR SOME LIQUEFIED GASES

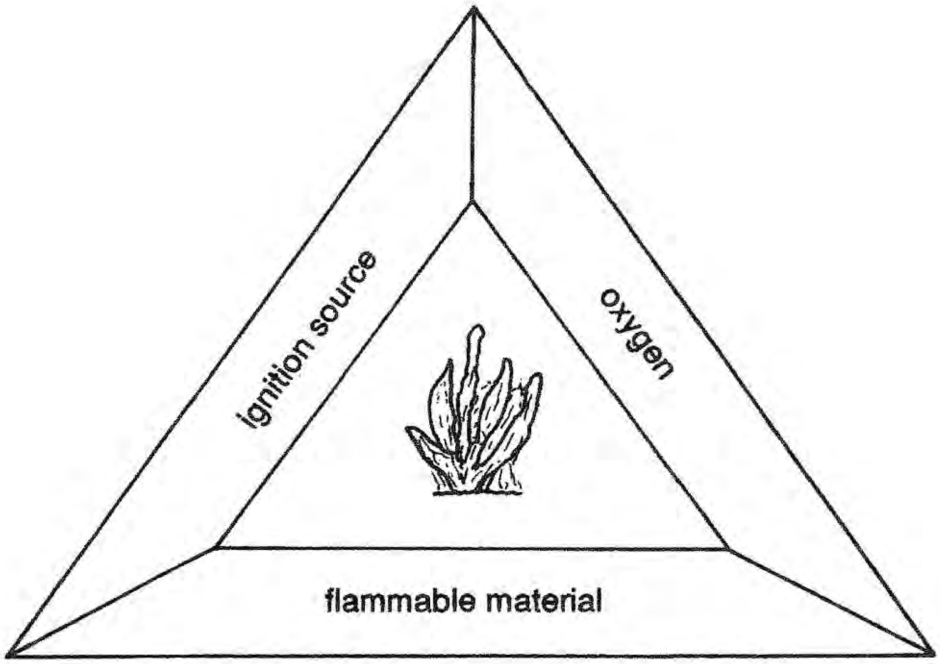


Figure 5.5.2 THE FIRE TRIANGLE

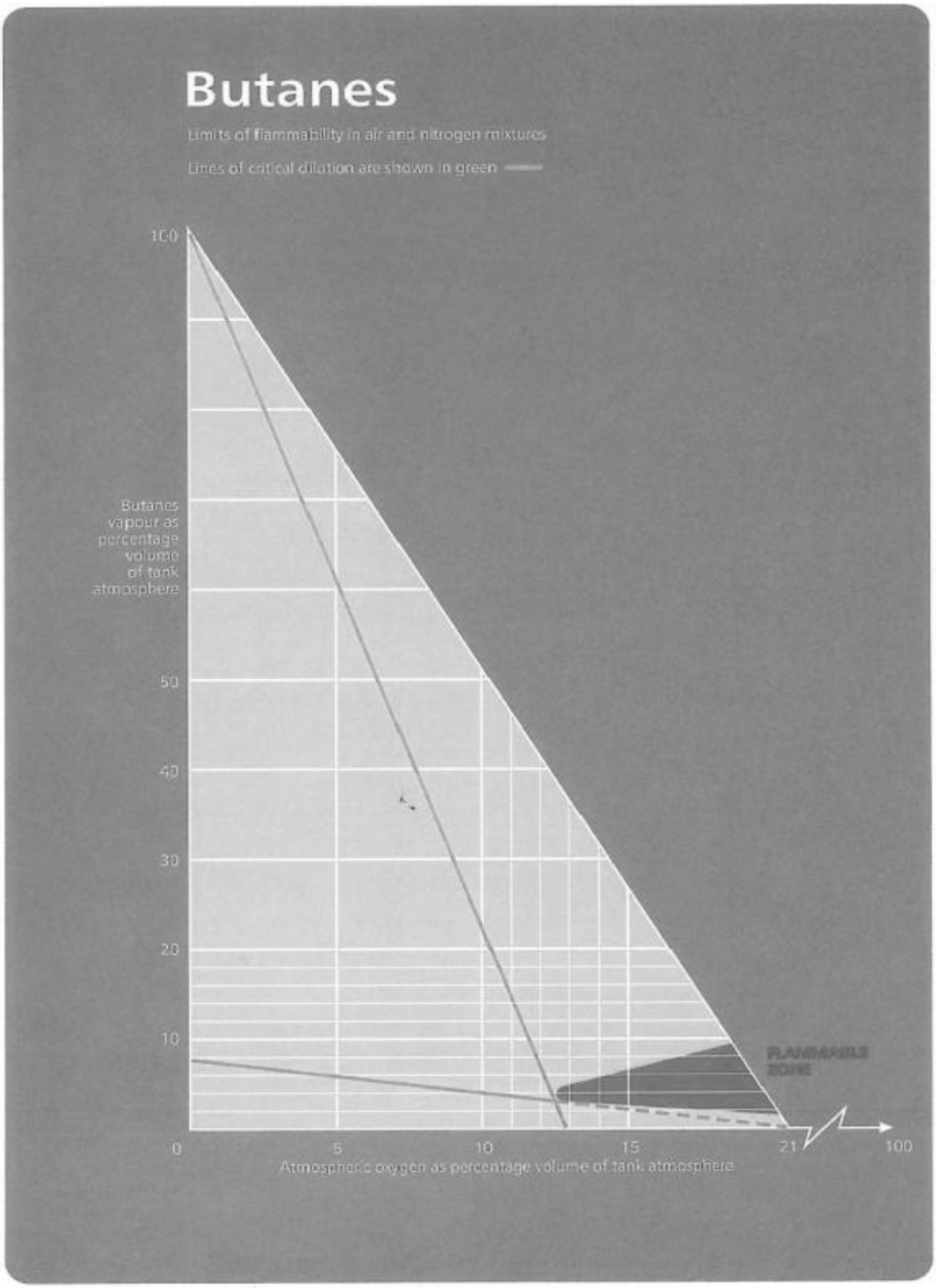


Figure 6.1.1 FLAMMABILITY DIAGRAM

LIQUEFIED GAS — INHIBITOR INFORMATION FORM

To be completed before loading an inhibited cargo

SHIP.. DATE..

PORT & BERTH.. TIME ....

1. CORRECT TECHNICAL NAME OF CARGO..

2. CORRECT TECHNICAL NAME OF INHIBITOR ....

3. AMOUNT OF INHIBITOR ADDED..

4. DATE ADDED..

5. EXPECTED LIFETIME OF INHIBITOR...

6. ANY TEMPERATURE LIMITATIONS AFFECTING INHIBITOR...

7. ACTION TO BE TAKEN IF VOYAGE EXCEEDS EFFECTIVE LIFETIME OF INHIBITOR ....

IF ABOVE INFORMATION NOT SUPPLIED, CARGO SHOULD BE REFUSED (IMCO Codes 18.1.2)

FOR SHIP.. FOR SHORE..
(Signed) (Signed)

Figure 6.5 LIQUEFIED GAS – INHIBITOR INFORMATION FORM

EMERGENCY PROCEDURES

Fire	STOP GAS SUPPLY. Do not extinguish flame until gas or liquid supply has been shut off, to avoid possibility of explosive re-ignition. Extinguish with dry powder, halon or carbon dioxide. Cool tanks and surrounding areas with water spray.
Liquid in eye	DO NOT DELAY. Flood eye gently with clean fresh water. Force eye open if necessary. Continue washing for at least 15 minutes. Obtain medical advice or assistance as soon as possible.
Liquid on skin	DO NOT DELAY. Remove contaminated clothing. Handle patient gently. Do not rub affected area. Flood affected area with water. Continue washing for at least 15 minutes. Immerse frost-bitten area in warm water until thawed. Obtain medical advice or assistance as soon as possible.
Vapour inhaled	REMOVE VICTIM TO FRESH AIR. Remove contaminated clothing. If breathing has stopped or is weak or irregular, give mouth to mouth/nose resuscitation or oxygen, as necessary. Guard against self-injury if victim is confused or anaesthetised. Be alert to possibility of victim vomiting and then choking. Obtain medical advice or assistance as soon as possible.
Spillage	STOP THE FLOW. Avoid contact with liquid or vapour. Extinguish sources of ignition. Flood with large amounts of water to disperse the spill, and to prevent brittle fracture. Inform port authorities or coastguard of spill.

Health Data

TLV **600 ppm** Odour threshold **5000 ppm** but may be stenched for easier detection

Effect of liquid	**ON EYES** Tissue damage due to frost-bite.	
	ON SKIN Tissue damage due to frost-bite.	
	BY SKIN ABSORPTION Nothing known.	
	BY INGESTION Slight systemic effect.	
Effect of vapour	**ON EYES** Cold vapour could possibly cause frost-bite.	
	ON SKIN Cold vapour could possibly cause frost-bite.	
	WHEN INHALED *Acute effect* Asphyxiation at high concentrations; headaches, dizziness and drowsiness. *Chronic effect* May act as a narcotic.	

Personal protection

Splash-resistant suit, goggles or face shield, gloves and boots.

Figure 7.1 (A) MATERIAL SAFETY DATA SHEETS

Fire and Explosion Data

Flashpoint -60°C.

Auto-ignition Temperature
n-butane 365°C iso-butane 460°C.

Flammable Limits
1.5-9% by volume.

Explosion Hazards
Vapour can form a flammable mixture with air which, if ignited, may release explosive force causing structural damage.

Chemical Data

Formula C_4H_{10}
n-butane $CH_3CH_2CH_2CH_3$
iso-butane $CH_3CH(CH_3)CH_3$.

Chemical Family Hydrocarbon (saturated, aliphatic).

Reactivity Data

Water, fresh or salt Insoluble. No dangerous reaction. May form solid hydrates.

Air No reaction.

Other liquids or gases
Dangerous reaction possible with chlorine.

Physical Data

Boiling Point at Atmospheric Pressure
n-butane at -0.5°C
iso-butane at -12°C.

Vapour Pressure Bar (A)
1.04 at -4°C.

Specific Gravity 0.58 at 20°C.

Coefficient of Cubic Expansion
0.002 per °C at 15°C.

Freezing Point
n-butane at -138°C
iso-butane at -160°C.

Relative Vapour Density
2.0.

Molecular Weight 58.12Kg/Kmole.

Enthalpy (KJ/Kg) Not available.

Latent Heat of Vaporisation (KJ/Kg)
384.8 at -0.5°C 365.5 at 20°C.

Electrostatic Generation

Conditions of Carriage

Normal Carriage Condition
Pressurised. Fully refrigerated.

Ship Type 2G/2PG.

Independent Tank required No.

Control of Vapour within Cargo Tank
Oxygen content of tank to be maintained at not more than 2% by volume.

Vapour Detection
Flammable.

Gauging Closed, indirect or restricted.

Materials of Construction

Unsuitable Certain plastics.

Suitable Mild steel, stainless steel, most normal metals.

Figure 7.1 (B) MATERIAL SAFETY DATA SHEETS

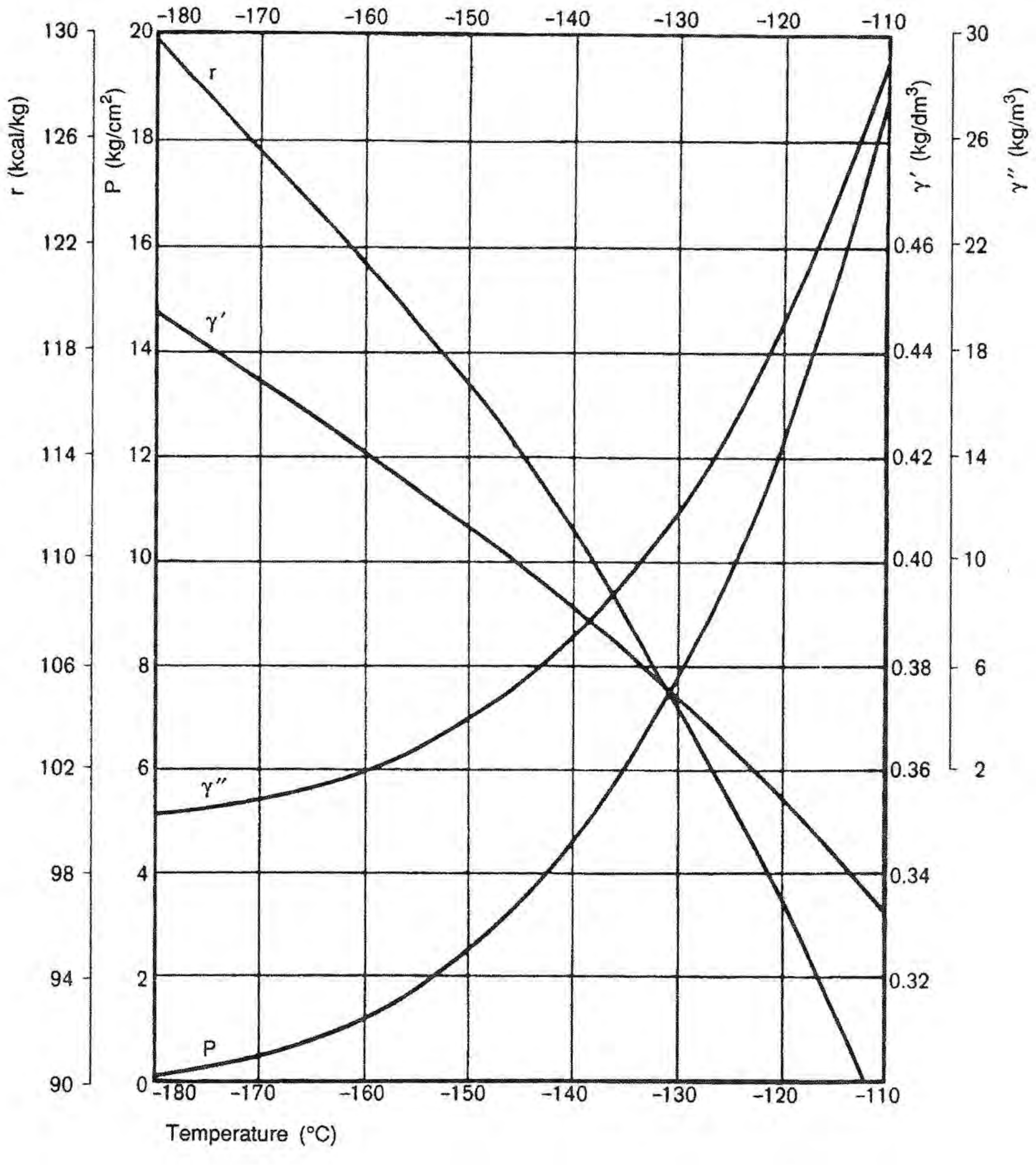
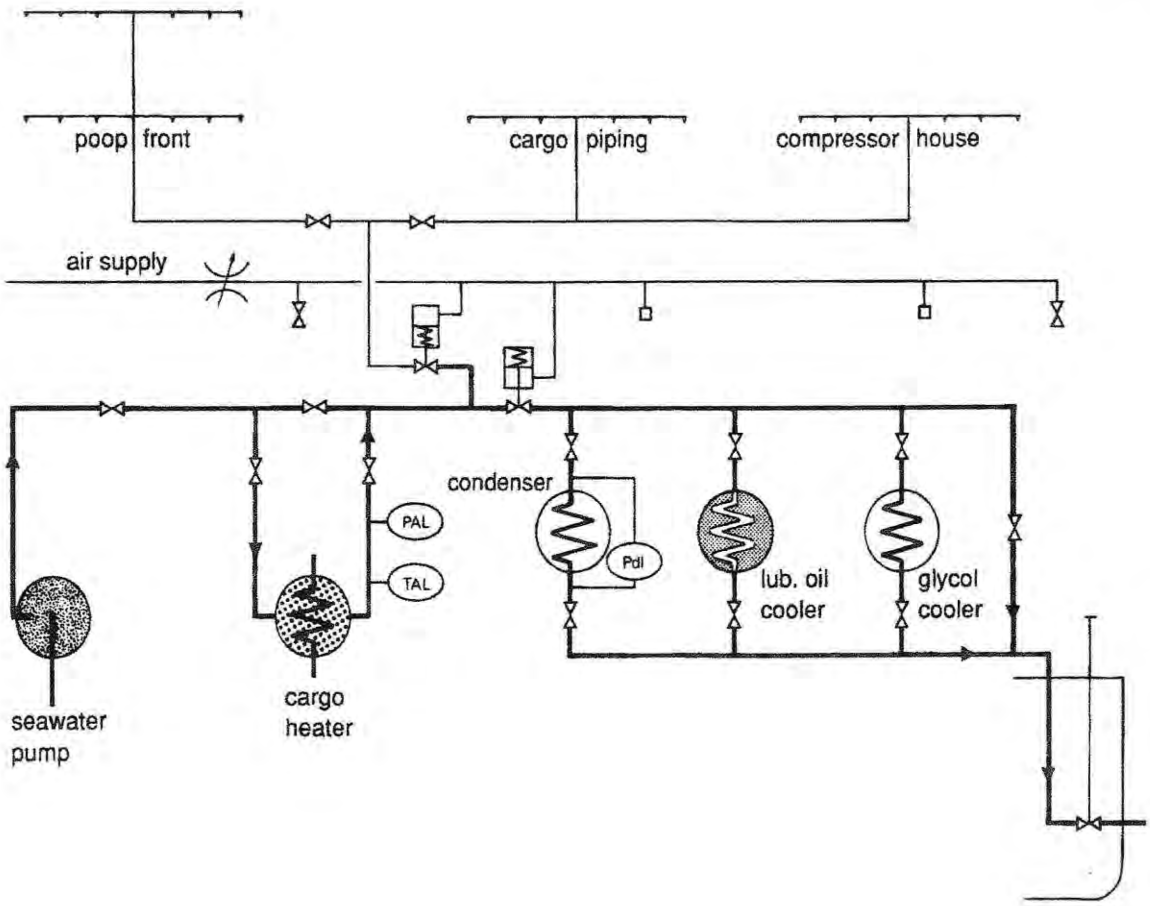


Figure 7.1.2 ICS CARGO DATA SHEET FOR METHANE



PAL = Pressure alarm (low)
TAL = Temperature alarm (low)
Pd I = Pressure differential indicator

Figure 12.2.2 A FIXED WATER – SPRAY SYSTEM

APPENDIX 2

INSTRUCTOR SIMULATOR GUIDANCE NOTES

INSTRUCTOR SIMULATOR GUIDANCE NOTES

General

This manual reflects the views of the course designer on methodology and organization and what is considered relevant and important in the light of his experience as an instructor. Although the guidance given should be of value initially, the course instructor should work out his own methods and ideas, refine and develop what is successful, and discard ideas and methods which are not effective.

The simulator is not essential in the conduct of this course. However, where a simulator is available it would help in better understanding of the cargo operations and the setting of pipelines and valves. Where simulator is not available, table top exercises using the hard copies of relevant cargo plans and loading manuals may be used.

Preparation and planning constitute a major contribution to effective presentation of the course. The Operational requirements of the course are recommended with the use of Simulators.

Simulator exercises

The cargo-handling plant and systems used aboard merchant ships which transport liquefied gases in bulk listed in chapter 19 of IGC code can differ in their layout and in the types of machinery units and associated systems, so that the trainees will have varied knowledge and experience of such plant.

It is important, therefore, to use the briefing period to explain precisely which machinery units and systems are being simulated in the exercise as well as their function, how they are inter-linked with each other and the role of the trainees during the exercise.

The trainees should be encouraged to co-operate with each other, working together as a team during the exercise and to demonstrate initiative and enthusiasm which will bring the exercise to a successful conclusion.

An important aspect of cargo and ballast handling is safety and it is vital to ensure that safe practices are followed throughout the exercise. Safety should be stressed during the briefing. One major contribution to safety is the use of checklists which should be prepared before-hand, possibly as part of the briefing procedure.

During an exercise it is useful if one trainee assumes the role of officer-in-charge, with the responsibility of ensuring that the requirements and activities of the exercise are properly carried out. Role playing is an important element in the learning process and with a number of trainees taking part in the exercises on the simulator, this aspect could provide a stimulus in the process of gaining knowledge and understanding.

Preparing and conducting exercises

If further exercises are to be developed or the ones supplied in the course modified, it is important that they should not be too complex otherwise the trainees might have difficulties in carrying out their tasks and duties within the allotted time.

An exercise should start with simple activities, making use of uncomplicated components such as valves, pumps, fluid systems, tanks etc. and slowly move step by step into more complex activities.
The aim of the training programme is to use a step-by-step process to introduce the trainees to the range of activities associated with the operations of loading and unloading a liquefied gas cargo.

However, initially it is beneficial to study such operations in isolation so that what is taking place can be observed and studied without reference to some other activity.

The simulator is designed to provide training for normal operational procedures and for the input of abnormal or malfunction conditions. It is important that the trainees achieve a satisfactory level of competence under normal conditions before proceeding to abnormal operations due to the introduction of faults.

The exercises should provide the trainees with the most realistic impression of actually being in a cargo control centre aboard ship. Realism is important for this type of learning process. For this reason, if the simulator has an associated sound system, it should be used.

Exercise scenarios

The content of a scenario is governed to a large extent by the units and systems that are being simulated.

The syllabus used for the basic gas tanker course has been structured to provide some flexibility in this respect, and the scenarios can be prepared using those syllabus elements which match a specific simulator design.

For this course, scenarios should be designed to cover the operational areas contained in the syllabus; for example:

- ❑ Familiarization with Equipment and Instrumentation.
- ❑ Loading
- ❑ Unloading
- ❑ Operational Problems.

The familiarization scenarios should aim at making the trainees not only feel "at home" with the units and systems being simulated, but should also provide some "hands-on" experience with the controls and some of the more basic equipment and operations, such as valves, pumps, pipe systems, instrumentation, filling and emptying tanks etc.

The operational scenarios should aim at providing experience in preparing and carrying out the various tasks and procedures that are involved with the safe transportation of liquefied gases in bulk. If the institution does not have Simulators then the simulator photographs appended in Appendix 1, part D can be used to project and let the trainees trace out and execute the operations.

The trouble-shooting scenarios should be designed to provide experience in identifying malfunctions and faults, and applying remedial procedures. It should be noted that most simulator designs can introduce a large number of malfunctions and faults. In this course, the scenarios can only deal with a few faults because of time constraints. The course implementer is free to introduce additional faults if time allows or to change the faults to comply with a particular simulator design.

For further guidance on simulator exercises, reference may be made to IMO Model course 1.35 Liquefied Petroleum Gas (LPG) tanker cargo and ballast handling simulator and IMO Model Course 1.36 Liquefied Natural Gas (LNG) Tanker Cargo and Ballast Handling Simulator.

Monitoring the exercises

During the exercises the instructor should monitor the trainees' progress and record particular events which relate to safety or correct procedure in the exercise, making a summary for use during debriefing. However, even an experienced instructor may occasionally find things going wrong when trainees are trying to control all the parameters and actions involved in an exercise and any resulting incidents should be noted and discussed during debriefing.

If a second instructor is available, he should assist in monitoring the trainees in their work. His task will vary according to the trainees' abilities and competence. He will be involved not only in the briefing and debriefing activities but also when the trainees become more experienced, assisting and guiding them in the use of the equipment. He should follow their work closely but should avoid interrupting them and save important observations for debriefing.

Debriefing

The time spent on debriefing should generally occupy between 10 and 15 per cent of the total time used for simulator exercises. Various facilities may be used in debriefing, such as playback (in which the whole exercise is recorded and any sequence is available for discussion), multi-channel recorder or data-logging equipment or snap shots.

The instructor should refer to the summary made during the exercise, raise important points and direct the discussion among the trainees. He should encourage them to examine critically the actions taken during the exercises. He should try to avoid imposing his own views, but should ensure that the trainees have used safe and correct procedures at all times.

Guidance on specific subject areas

The guidance notes which follow contain advice on the treatment of the subject areas listed in the course outline. The instructor should develop a methodology based on his own experience, together with the advice and guidance provided with the simulator being used in the course.

Each simulator will have its own layout and entails a different format to be prepared by the instructor.

The exercises below are to be carried out on a simulator or table top. For tabletop exercises the candidates should be provided with PC loaded with a liquefied gas tanker's loadicator software and hard copies of same ship's capacity, cargo pipeline layout, pumping, ballasting, ventilation, reliquefaction plans and calibration tables of ballast and cargo tanks.

EXERCISE NO. 1: CARGO HANDLING SIMULATOR LAYOUT

Objectives:

Understanding of the sub-systems and their overall interactivity in the cargo handling simulator and the operations involved. Becoming familiar with terminology used in liquefied gas cargo transport and operations.

Briefing:

Explanation of the ship type modeled. Explanation of the various sub-systems and how they connect in real life.

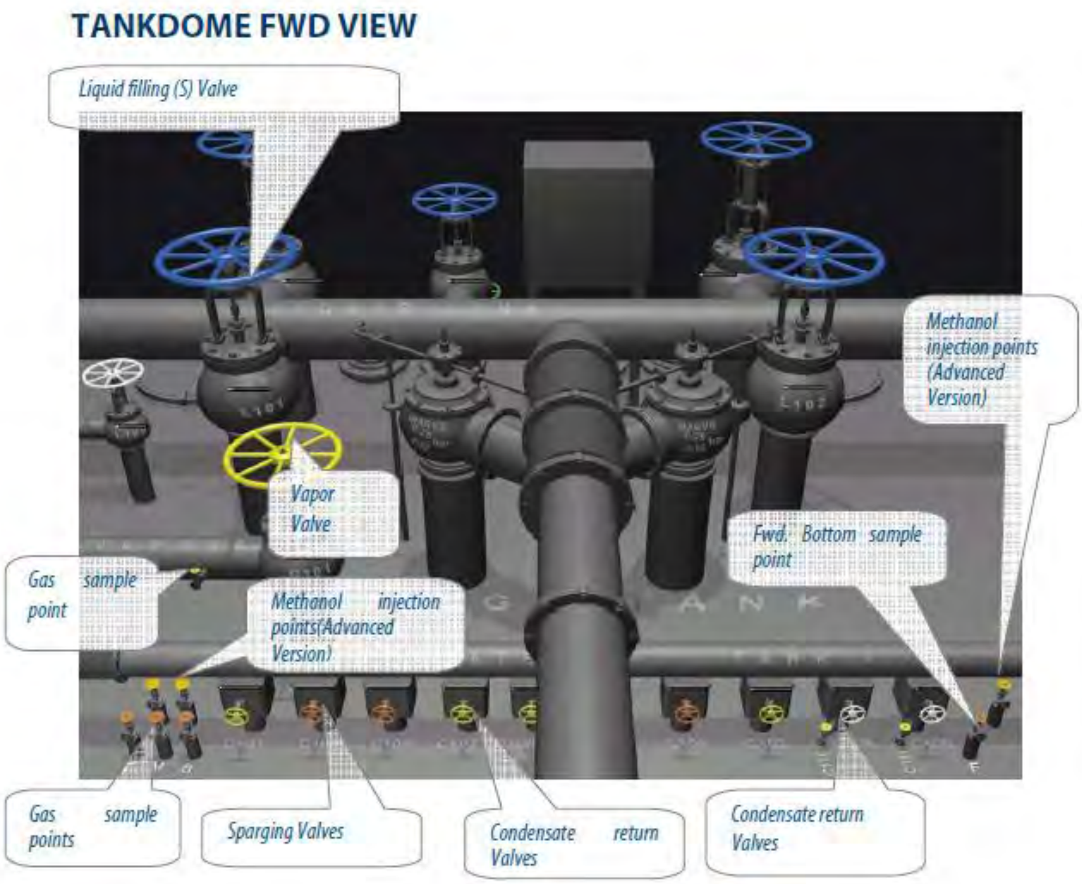
Student action:

- The cargo handling plant, its systems and equipment in general arrangement (cargo liquid, vapour, condensate and Inert gas and Ballast pipelines line)
- CCR panels and Monitor panel, the instrumentation being used and what parameters are indicated and recorded
- The CCR control panels, identification of valves
- The alarms and trips that are fitted and what they protect, location of ESD
- Opening and closing valves
- Starting and stopping pumps/compressors
- Using a checklist to prepare the simulator for handling ballast and transferring ballast from one tank to another tank
- Using a checklist to prepare the simulator for loading cargo and filling a cargo tank.
- Cargo compressor line up (including cooling water system) and starting procedure.
- Explanation of the Loadicator functions, trim, draft, heel
- Line up for unloading of cargo from tanks
- Use of Fixed gas detector
- Use of portable gas detector and identification of sample points

Debriefing:

Check if all systems understood and interconnection of systems in simulator. Discuss if relationships with previous theory are properly understood.

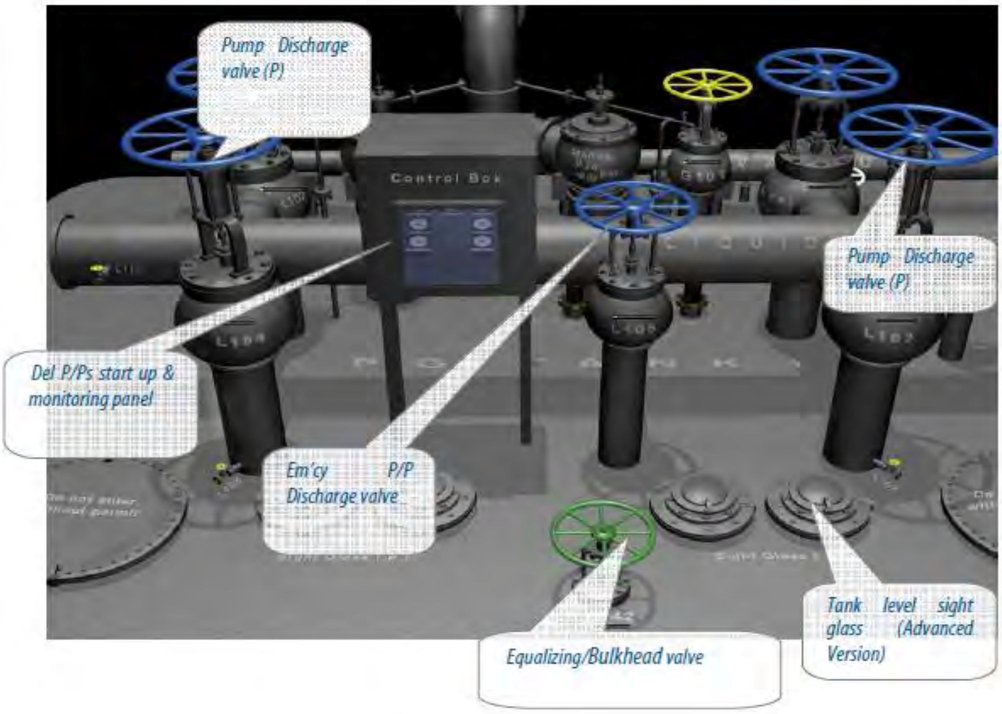
Students to familiarize with the students station based on the following guidelines.



Forward View

1. Loading and discharging valves of the tank. Operate and notice the indicator bar.
2. Gas valves i.e. vapour line valve. Check the operating method.
3. Condensate lines valves for spraying reliquefaction line return.
4. Gas Sample detection (T,M,B) and forward and aft.
5. Methanol injection lines valve can be seen and operated.
6. Hold eductor valve is also present, but not connected to any system.
7. On the vapour manifold check for vapour concentration.

TANK DOME AFT



AFT View
1. Loading / discharging / gas valves can be operated.
2. Sight glass for local reading during top off.
3. Sample checking on liquid line.
4. Discharge pumps pressure _ visible.
5. Pump local start and stop.
6. Ullages of tanks
7. Pressure inside the tank
8. Condensate line pressure and temperature
9. Hold pressure
10. Tank Intermediate bulk head valve.

Control box with 2 – Normal and Emergency cargo pumps

Theses valves can be operated from deck console and PC's

Loading and discharging valves can also be operated only from CCR.

RELIQUEFACTION SYSTEM – COMPRESSOR ROOM

This view is in the compressor room.

1. Below the low pressure chamber (Gas inlet section from tank). We have the – compressor cooling water system. Observe the valves operating the system where the cooling water is directed, right thru the LP and HP chamber's and re circulated.
2. Note the thermometer temp's on the system to ensure cooling water never freezes.
3. Notice the hand turning requirements for the compressor shaft, which is required to be carried out just before, starting the comp.
4. Lube oil cooling water system has to be operated prior to starting the compressor.
5. Temps of the Lube oil cooler inlet and outlet are required to be monitored.
6. Just before starting the compressor on zero load, start the lube oil pump and switch off after starting the compressor.
7. Condensate line valves to be opened as required follow the flow of gases coming out from HP compressor.
8. The discharge HP compressor can be feed to the condenser or the Hot- gas line, for pushing line cargo or into the tank sump to flush off ROB cargo.
9. The condenser has got salt water in and out line with a thermometer indicating the temp.
10. An ethane vent line is provided to vent out the lighter ethane faction from the accumulator.

FRESH WATER COOLING SYSTEM FOR RELIQ COMPRESSORS

Cooling system

FW system of the compressor and L.O. cooler is present and is always on. Notice the temperature inlet and outlet of cooler can be monitored in the CCR also.

CCR have got tank and hold pressure gauges. Cargo Main and emergency pump amp-reading pump discharge pressure, level gauges etc.
Inert gas Pressure,Temp, dew point and $O_2$are displayed.
Additionally tank 3 and 4 CCR monitor will be displayed in lieu of I G information.

Starting and stopping of hydraulic valves.

Control air pressure of fire / bilge / general service pump along with suction and discharge pressure.

Top gauges are manifold liquid and Vapour line, Pressure for forward and aft lines.

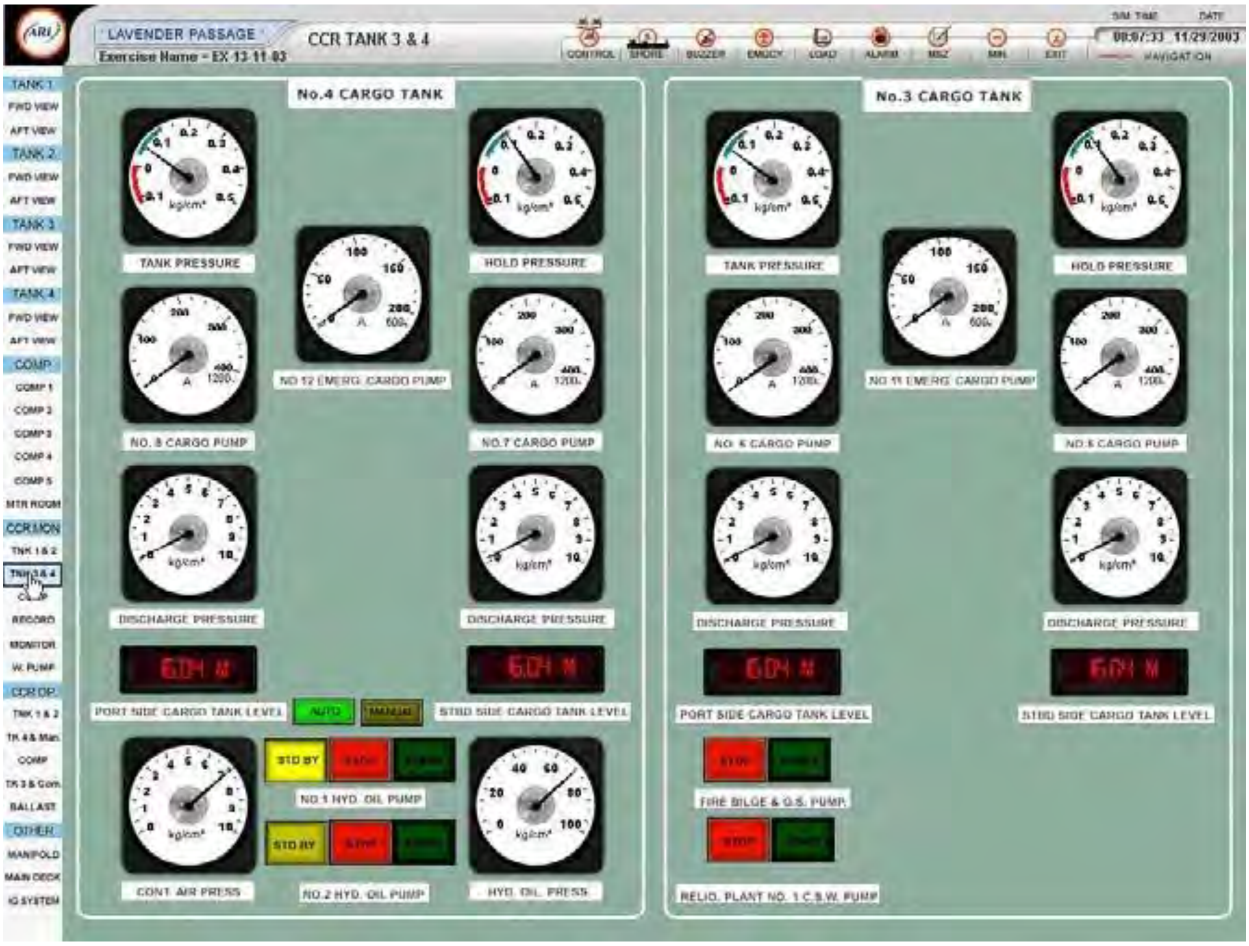
2nd set of gauges represent all 5 compressor discharge pressures.

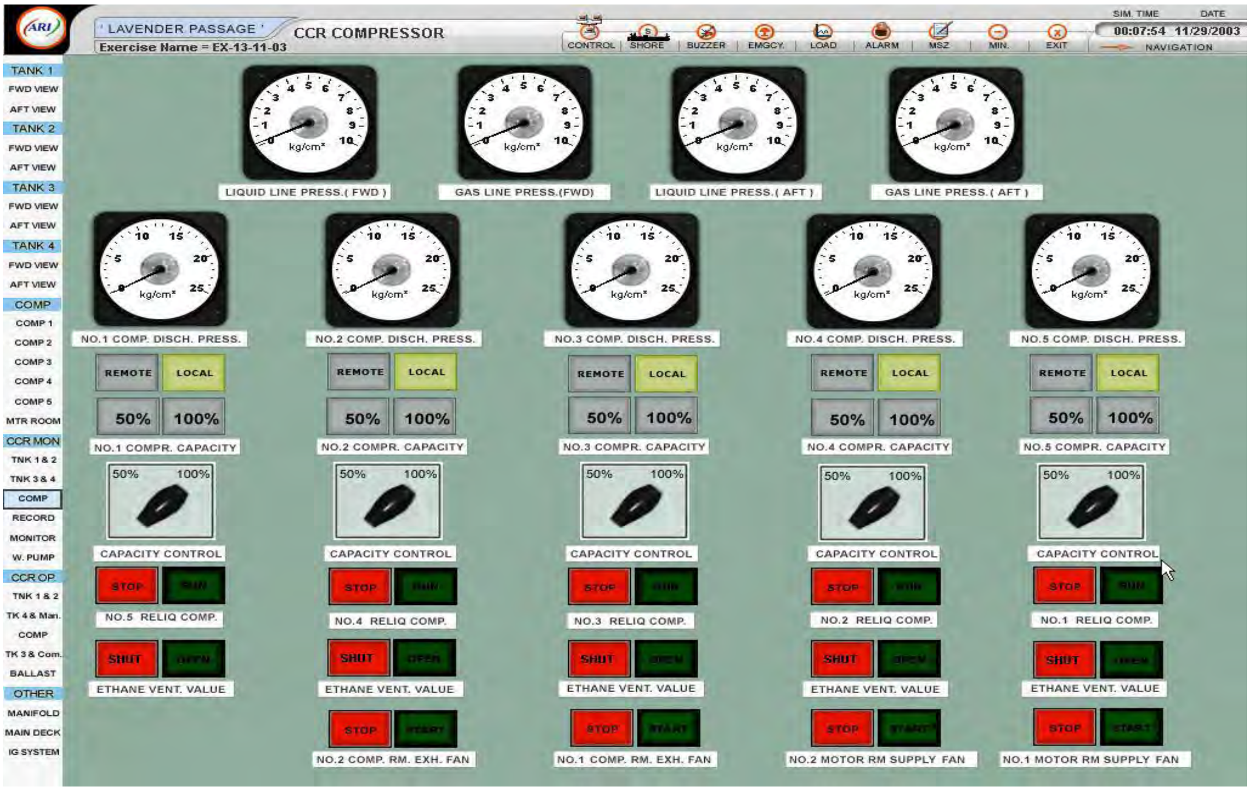
- Capacity controls for remote and local operations have to be set from deck console.
- Compressor room and motor exhaust fans can be stated and stopped.
- Ethane vent valves can be operated from here.
- record of all tank inside, outside – can be seen on graphics
- Verification of temp. at individual locations can be checked by using the up and down points.

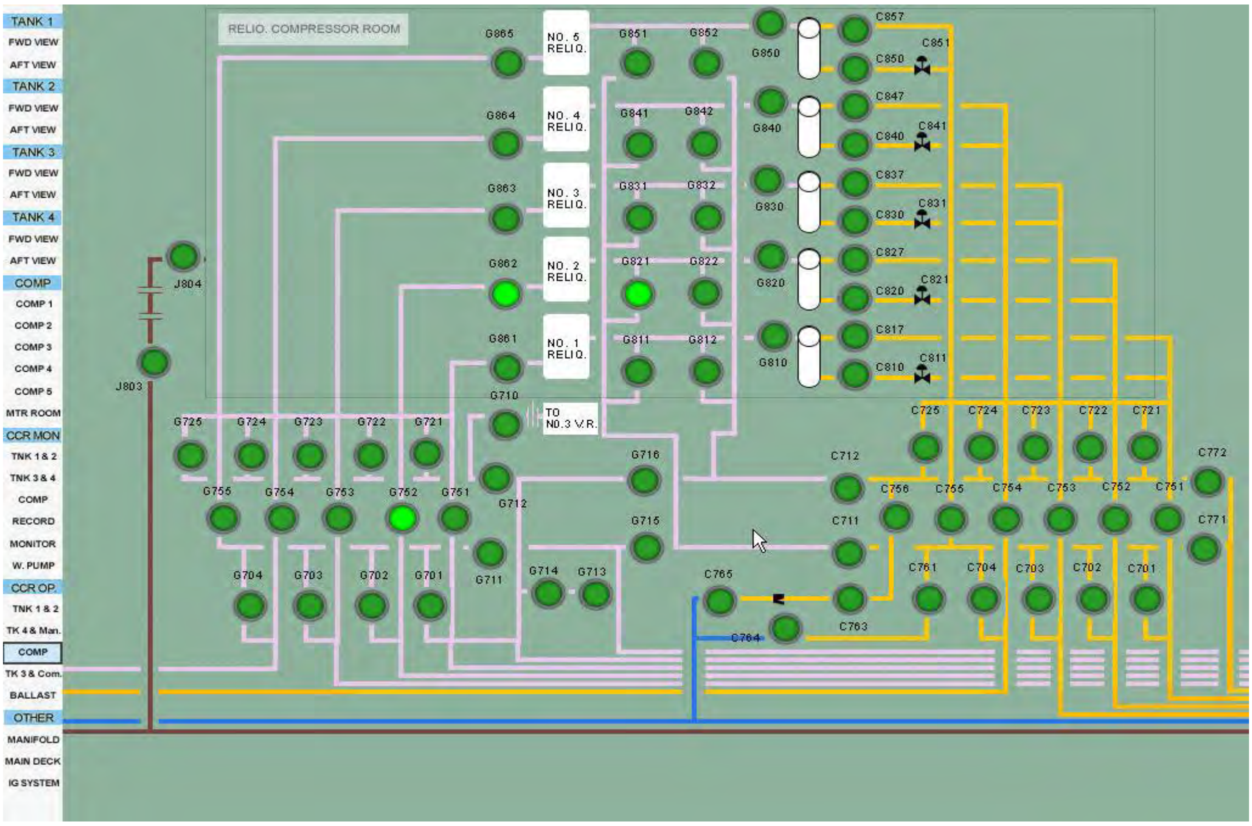
Monitoring of alarms / tank data / comp. data / tank pressure and temp trends and comp. pressure and temp trends can be monitored.

Under Misc. screen, liquid / gas line hydraulic oil and control air pressure can be monitored.

- Wind direction and speed can be seen
- Water spray, fire and bilge pump, gas pump and water ballast pump amp. Gauges.
- Third set of gauges are discharge pressure for the above pumps.
- The bottom gauges show water ballast stripping educator suction pressure.
- No. 1 to 4 tank cargo pressure records
- List / trim / draft / SF / BM can be read from this page




' LAVENDER PASSAGE '
Exercise Name = EX-13-11-03
CCR COMPRESSOR
CONTROL
SHORE
BUZZER
EMGCY.
LOAD
ALARM
MSG
MIN.
EXIT
SIM. TIME
DATE
00:07:54
11/29/2003
NAVIGATION
TANK 1
FWD VIEW
AFT VIEW
TANK 2
TANK 3
TANK 4
COMP
COMP 1
COMP 2
COMP 3
COMP 4
COMP 5
MTR ROOM
CCR MON
TNK 1 & 2
TNK 3 & 4
RECORD
MONITOR
W. PUMP
CCR OP.
TK 4 & Man.
TK 3 & Com.
BALLAST
OTHER
MANIFOLD
MAIN DECK
IG SYSTEM
LIQUID LINE PRESS.(FWD)
GAS LINE PRESS.(FWD)
LIQUID LINE PRESS.(AFT)
GAS LINE PRESS.(AFT)
kg/cm²
NO.1 COMP. DISCH. PRESS.
NO.2 COMP. DISCH. PRESS.
NO.3 COMP. DISCH. PRESS.
NO.4 COMP. DISCH. PRESS.
NO.5 COMP. DISCH. PRESS.
REMOTE
LOCAL
50%
100%
NO.1 COMPR. CAPACITY
NO.2 COMPR. CAPACITY
NO.3 COMPR. CAPACITY
NO.4 COMPR. CAPACITY
NO.5 COMPR. CAPACITY
CAPACITY CONTROL
STOP
RUN
NO.5 RELIQ COMP.
NO.4 RELIQ COMP.
NO.3 RELIQ COMP.
NO.2 RELIQ COMP.
NO.1 RELIQ COMP.
SHUT
OPEN
ETHANE VENT. VALUE
START
NO.2 COMP. RM. EXH. FAN
NO.1 COMP. RM. EXH. FAN
NO.2 MOTOR RM SUPPLY FAN
NO.1 MOTOR RM SUPPLY FAN


RELIQ. COMPRESSOR ROOM
NO. 5 RELIQ.
NO. 4 RELIQ.
NO. 3 RELIQ.
NO. 2 RELIQ.
NO. 1 RELIQ.
TO NO.3 V.R.
J804
J803
G865
G864
G863
G862
G861
G851
G852
G841
G842
G831
G832
G821
G822
G811
G812
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C857
C851
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C847
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G725
G724
G723
G722
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G755
G754
G753
G752
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G704
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G713
C725
C724
C723
C722
C721
C712
C756
C755
C754
C753
C752
C751
C772
C771
C711
C761
C704
C703
C702
C701
C765
C764
C763

CCR Operations

Starting and stopping of cargo pump can be done from CCR as well as deck console.
Discharge and comment for all 3 pumps can be monitored from the pop up screen. Inert gas valves to hold top and bottom can be indicated in CCR.
Covers the Manifold area valve and Tank No. 3 cargo pump discharge / condensate / gas valves.
Cover indicating valves for the compressor room / manifolds of vapour line coming from tank and condensate line manifold going to tanks and liquid line.
Inert gas units indicates going into holds and cargo tanks
- Trace – ballast lines from the tanks for ballasting and deballasting.
- Eductor line to be traced.
- There is a No.2. SW relic plant with ballast system.

Manifold areas valves can be operated, liquid and vapour line.
Inert gas line can be connected to vapour line
Gauges for Manifold vapour and liquid line, pressure and temperature.

Drain valve connection from Nitrogen and condensate line

Sampling of gas at manifold.
Vapour Manifold from tank and condensate area valves have to be operated.
This display we can connect IG / Air to the vapour manifold also inert gas for hold's spaces for ventilation in case of an emergency.
Hydraulic system tank can be seen.
Fixed gas detection screen is visible with continuous monitoring in Auto modes and manual.

TABLE TOP Exercise: If a simulator is not available the appended Simulator screen shots may be used by the instructor enable the students to achieve the same learning objectives as a Table top simulation. C**andidates should also be familiarized with a ship's loadicator software and same ship's hard copies of capacity, cargo pipeline layout, pumping, ballasting, ventilation, reliquefaction plans and calibration tables of ballast and cargo tanks.**

EXERCISE NO. 2: LOADING FULL CARGO

Objectives:

To load full cargo into the vessel, appreciating efficient cargo planning, stability, stress criteria and maximum allowable draft and trim. Dangers accompanied with gas leak/lifting of cargo tank relief valve.

Prerequisites:

The trainees will have performed familiarization exercises on the simulator and they will have knowledge of loading zones, stability, shear forces, bending moments and thermodynamic properties of gasses and pressure-temperature relationships.

Training Materials:

- Diagram of the vessel cargo system, Loadicator and Loading zone chart.
- Mollier diagram/thermodynamic properties of cargo being loaded.

Simulator Condition:

- Cargo tanks empty, tanks gassed up.
- Normal ballast condition.
- Shore connection for 1 grade and 1 temperature of cargo in all tanks.

Briefing:

- Trainees should be told that all tanks are empty and segregated ballast tanks full for normal ballast condition.
- Tanks have to be filled to 98%
- Shear forces and bending moments to be kept within limits; preliminary check can be done by off-line Loadicator.

Student action:

- Prepare cargo plan, Perform preliminary stress check with the Loadicator.
- Tank filling to commence simultaneously or in order according to stress limitations.
- Lining up and starting cooling plants on full load.
- Checking parameters of cooling plant and determining whether the system is running efficiently.
- When loading tanks, levels to be monitored as well as tank atmosphere and shear forces and bending moments.
- Ballast to be pumped out in accordance with the loading sequence.

Debriefing:

- Trainees should understand possibilities and limitations of a full cargo being loaded.
- Stability and stresses to be monitored and final draft, heel, tank ullages and temperature / pressures to be checked.

Evaluation:

By means of observation of final condition assessing, that all values of levels, volumes, trim and list, shear forces and bending moments are within the determined limits.

Table Top Exercise:
For table top exercise candidates to make a loading plan showing different stages of loading/deballasting using bar charts.

Candidates to use the loadicator software and same ship's hard copies of capacity, cargo pipeline layout, pumping, ballasting, ventilation, reliquefaction plans and calibration tables of ballast and cargo tanks

EXERCISE NO. 3: UNLOADING AND BALLASTING

Objectives:

By means of this exercise the relationship between the various sub-systems is supposed to be demonstrated. The overall understanding of simultaneously discharging and ballasting to be demonstrated and realized.

Prerequisites:

Theoretical knowledge of shear force, stress, trim, heel is required.

Simulator Condition:

- Cargo tanks loaded with LPG.
- No ballast

Briefing:

- The trainees should be convinced of the complexity of the exercise, which should be built up step by step.
- Discharging to be started first.
- Stress, trim and heel to be monitored.
- Discharging and ballasting as per pre-prepared plan.

Student action:

- Preparing a discharging plan, which will keep stress, trim and heel within the acceptable limits.
- Discharging, ballasting and stripping will take place simultaneously.
- In this order operations will continue until all cargo tanks are empty, and vessel ballasted according to IMO requirements.

Debriefing:

By means of discussion bring up problems in operations and problems due to complexity. Check which order tanks have been handled and in which order ballast has been loaded.

Evaluation:

- By means of question and answer determine understanding of operations.
- Time needed to complete operations will be a measure of efficient conduct of operations.
- All cargo should be unloaded.
- Pump performance during discharging and tank residue is an indicator of correct use of pump operating procedures.
- After completion of discharging operations, vessel should be in correct trim, heel and within acceptable limits of stresses and stability.

Table Top Exercise:

For table top exercise candidates to make a unloading plan showing different stages of unloading/ballasting using bar charts.

Candidates to use the loadicator software and same ship's hard copies of capacity, cargo pipeline layout, pumping, ballasting, ventilation plans and calibration tables of ballast and cargo tanks.

APPENDIX 3 CASE STUDIES

Introduction

In this appendix, a few case studies on gas tanker accidents have been presented. The objective is to sensitize the students regarding the huge fallout of accidents on board a tanker, in terms of loss of life, property and coastal amenities, and subsequent expenditure of valuable resources in terms of economic cost of a cleanup.

Working on board a gas tanker is very serious business that requires a high degree of professionalism. Majority of incidents that take place on tankers, can be avoided by following the basic rules of safety and ensuring that corners are not cut. It does not pay to behave rashly. The point of continuous training is to make the student aware of the meaning of responsibility. When the essence of being responsible for one's actions comes from within, rather than being forced upon, it is the first sign of a good safety culture developing on board.

Each case history is organized as follows:

- A brief incident summary including weather conditions and events leading up to the spill
- A description of the behavior of the gas including movement, evaporation and dispersion / fire
- A description of other special interest issues such as communication problems, unusual hazards encountered.
- Points for discussion have been enumerated
- The students should work individually to answer these question and then engage into a discussion within a smaller group.

The group may give a presentation on the aftermath of the discussion.

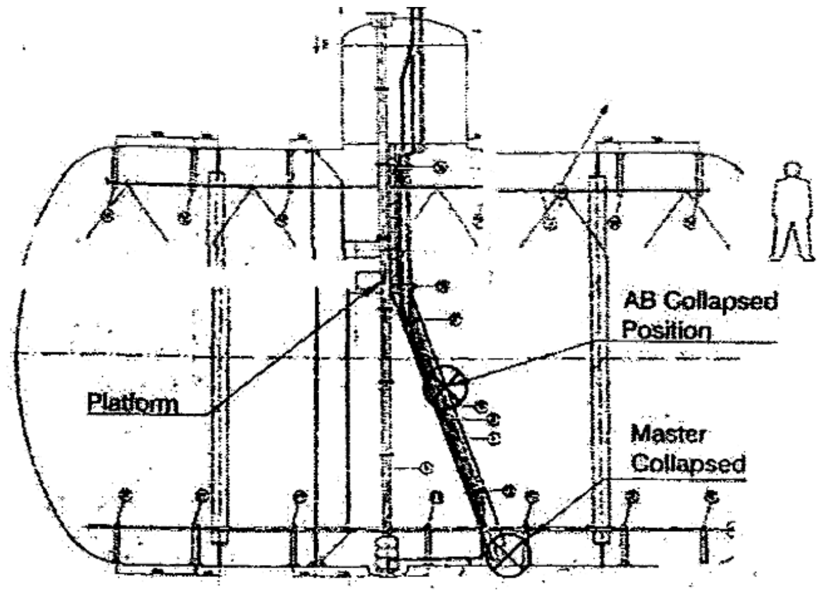
CASE STUDY - 1

Fatal accident on board an ethylene carrier

An LPG/ ethylene tanker was being prepared for dry- docking following a discharge of ethylene. In order to arrive at the yard with breathable air in the cargo tanks, purging and gas-freeing operations were carried out. Due to technical problems there were several stops of the vessel's oil-fired inert gas generator, and the final inerting was done by wet inert gas, bypassing the dryer and the compressor. The inert gas was partly of poor quality and observed at times to be quite blackish. Once the inerting process was completed, ventilation of all tanks was started.

When the oxygen content of cargo tank no.3 was measured to 21 percent, the master and chief officer entered the tank for a five-minute inspection, wearing ELSA sets for safety. Around the sump of the pump suction some water from the wet inert gas was found, and to remove this, three crew members with a portable pump entered the tank. Once the pump was rigged, one AB remained in the tank to monitor the pumping. After about 20 minutes, he began to feel dizzy and started to climb the ladder when he passed out. The last thing he remembered was hooking his foot behind a ladder step to avoid falling down.

The other two crew members notified Master of the accident. The Master immediately entered the tank without donning a breathing apparatus. Struggling to rescue the AB, the master managed to put a rope around him before getting into trouble himself and falling to the bottom of the tank, unconscious.



After twenty minutes, the crew members were able to rescue the AB, who regained consciousness once brought to open air on deck. A chain block had to be rigged on deck to hoist the master and it took forty minutes to get him out. It also took considerable time to get him ashore by a launch, while supporting him on the vessel's portable oxygen supply, until it eventually ran out. The master was pronounced dead upon arrival ashore.

Points for Discussion

a) What would be your action in the event of you having noticed the AB unconscious in the cargo tank?

b) Do you think that the Master's action to rescue the AB was correct? If not, describe the correct action in your own words.

c) What all checks especially with regards to the measurement of gases need to be made prior entering an enclosed space?

d) Do you need a tank entry permit prior entering an enclosed space? If yes, who issues such a permit?

e) Make general comments on the safety issues directly contributing to the accident.

f) What gas freeing procedures should have been carried out for making the tank ready for man entry?

CASE STUDY- 2

Major LPG leak from a liquefied gas tanker

A liquefied gas tanker experienced a major leak of liquefied propane, while cargo sampling operations were taking place alongside a marine terminal. The leak was sealed 29 hours later, after an estimated 66 tonnes of propane had been lost to atmosphere.

The fully pressurized liquefied gas tanker had arrived at the berth to load liquefied propane. Preloading checks were conducted and loading commenced shortly after. Approximately 2 hours before the loading was due to be completed, the cargo operations were halted to allow a 'freeze' test to be conducted. A cargo surveyor came aboard and attached his cargo sampling equipment to the sampling point of tank No. 1. The cargo was then circulated for 2-3 minutes. The process was repeated for tank No. 2. With the test results satisfactory, cargo loading was continued and completed.

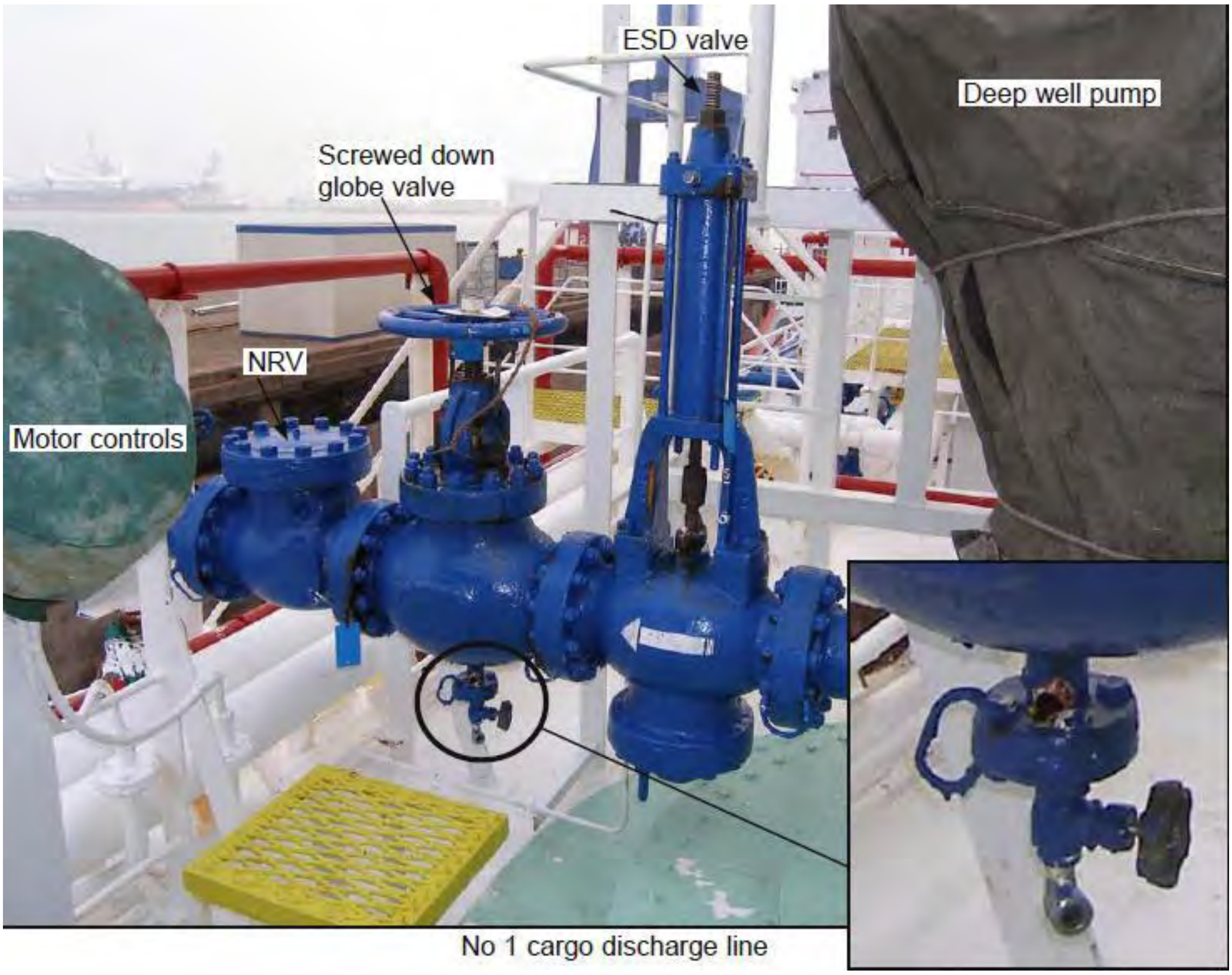
The cargo surveyor returned to the ship and went straight to the sampling point of tank No.1, where the chief officer was already preparing for the sampling. The cargo surveyor used a thread adapter to connect the sampling device to the ship's sampling connection. The chief officer then circulated the cargo, using the deep well pump, to ensure a good representative sample was obtained. The cargo surveyor flushed the sampling device through three times before filling it. He repeated the process, taking four samples in total, before moving aft to the sampling point of tank No. 2. While the chief officer secured tank No. 1, the cargo surveyor prepared to fit his equipment to the sampling point of tank No. 2. As he turned the sampling connection towards himself, the sampling valve assembly came off in his hand. The chief officer saw and heard a leak and activated the emergency shutdown (ESD) valves.

Attempts were made to refit the sampling valve but the 11 bar pressure of the cargo, and the formation of ice on the connection, made it impossible. It soon became apparent that the ESD valve adjacent to the tank on the same line as the sampling connection was not completely shut. The emergency services were alerted soon after the accident and the ship was doused in water sprays to disperse the gas cloud.

Thereafter the port was closed to all traffic and all ships were evacuated from the terminal. After few hours, with the situation stabilised, traffic restrictions were reduced to a 400 m exclusion zone around the gas tanker, which allowed the port to reopen to traffic.

After several options to stop the leak had been considered, it was decided to hot tap the cargo pipework and inject a sealing compound to stop the leak of gas. A local company successfully drilled into the pipework and the sealing compound was then slowly injected into the pipework, enabling the leak to be sealed and capped.

The gas tanker then sailed and anchored awaiting clearance to sail which was contingent upon class approval of the repair and the discharge port agreeing to accept the vessel. This completed, she sailed the same day.



Points for Discussion

a) What would be your action in the event of you experiencing a leak from the sampling point ?

b) Explain the function of emergency shutdown (ESD) valve.

c) Do you think that the cargo surveyors need to be closely supervised by a member of ship's crew while taking cargo samples ?

d) Make general comments on the safety issues directly contributing to the accident.

e) List the precautions to be taken prior taking cargo samples.

Part E: Evaluation

The effectiveness of any evaluation depends to a great extent on the precision of the description of what is to be evaluated. The detailed teaching syllabus is thus designed, to assist the Instructors, with descriptive verbs, mostly taken from the widely used Bloom's taxonomy.

Evaluation/Assessment is a way of finding out if learning has taken place. It enables the assessor (Instructor), to ascertain if the learner has gained the required skills and knowledge needed at a given point towards a course or qualification.

The purpose of evaluation/assessment is to:

- To assist student learning.
- To identify students' strengths and weaknesses.
- To assess the effectiveness of a particular instructional strategy.
- To assess and improve the effectiveness of curriculum programs.
- To assess and improve teaching effectiveness.

The different types of evaluation/assessment can be classified as:

Initial/Diagnostic assessment

This should take place before the trainee commences a course/qualification to ensure they are on the right path. Diagnostic assessment is an evaluation of a trainee's skills, knowledge, strength and areas for development. This can be carried out during an individual or group setting by the use of relevant tests.

Formative assessment

Is an integral part of the teaching/learning process and is hence is a "Continuous" assessment. It provides information on trainee's progress and may also be used to encourage and motivate them.

Purpose of formative assessment

- To provide feedback to students.
- To motivate students.
- To diagnose students' strengths and weaknesses.
- To help students to develop self-awareness.

Summative assessment

It is designed to measure trainee's achievement against defined objectives and targets. It may take the form of an exam or an assignment and takes place at the end of a course.

Purpose of summative assessment

- To pass or fail a trainee
- To grade a trainee

Evaluation for Quality assurance

Evaluation can also be required for quality assurance purposes.

Purpose of assessment with respect to quality assurance

- To provide feedback to Instructors on trainee's learning.
- To evaluate a module's strengths and weaknesses.

To improve teaching.

Assessment Planning

Assessment planning should be specific, measurable, achievable, realistic and time-bound (SMART).

Some methods of assessment that could be used depending upon the course/qualification are as follows and should all be adapted to suit individual needs.

- Observation (In Oral examination, Simulation exercises, Practical demonstration);
- Questions (written or oral);
- Tests;
- Assignments, activities, projects, tasks and/or case studies
- Simulations(also refer to section A-I/12 of the STCW code 2010);
- CBT;

Validity

The evaluation methods must be based on clearly defined objectives, and it must truly represent what is meant to be assessed, for example only the relevant criteria and the syllabus or course guide. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' KNOWLEDGE, UNDERSTANDING AND PROFICIENCY of the concepts.

Reliability

Assessment should also be reliable (if the assessment was done again with a similar group/learner, would you receive similar results). We may have to deliver the same subject to different group of learners at different times. If other assessors are also assessing the same course/qualification as us, we need to ensure we are all making the same decisions.

To be reliable an evaluation procedure should produce reasonably consistent results no matter which set of papers or version of the test is used.
If the Instructors are going to assess their own trainees, they need to know what they are to assess and then decide how to do this. The *what* will come from the standards/learning outcomes of the course/qualification they are delivering. The *how* may already be decided for them if it is an assignments, tests or examinations.

The instructors need to consider the best way to assess the skills, knowledge and attitudes of our learners, whether this will be formative and/or summative and how the assessment will be valid and reliable.

All work assessed should be valid, authentic, current, sufficient and reliable; this is often known as VACSR – "valid assessments create standard results".

- Valid – the work is relevant to the standards/criteria being assessed:
- Authentic – the work has been produced solely by the learner;
- Current – the work is still relevant at the time of assessment;
- Sufficient – the work covers all the standards/criteria:
- Reliable – the work is consistent across all learners, over time and at the required level.

It is important to note that no single methods can satisfactorily measure knowledge and skill over the entire spectrum of matters to be tested for the assessment of competence.

Care should therefore be taken to select the method most appropriate to the particular aspect of competence to be tested, bearing in mind the need to frame questions which relate as realistically as possible to the requirements of the officer's job at sea.

STCW Code 2010

The training and assessment of seafarers, as required under the Convention, are administered, supervised and monitored in accordance with the provisions of section A-I/6 of the STCW Code.

Column 3 - Methods for demonstrating competence and Column 4 - Criteria for evaluating competence in Table A-V/1-2-1 (Specification of minimum standard of competence in basic training for liquefied gas tanker cargo operations) of STCW Code 2010, sets out the methods and criteria for evaluation.

Instructors should refer to this table when designing the assessment.

Instructors should also refer to the guidance as given in section B-V/1-2 STCW code

Evaluation of competence

17. The arrangements for evaluating competence should be designed to take account of different methods of assessment which can provide different types of evidence about candidates' competence, e.g.:

1. *direct observation of work activities (including seagoing service);*
2. *skills/proficiency/competency tests;*
3. *projects and assignments;*
4. *evidence from previous experience; and*
5. *written, oral and computer-based questioning techniques.*

18. One or more of the first four methods listed should almost invariably be used to provide evidence of ability, in addition to appropriate questioning techniques to provide evidence of supporting knowledge and understanding.

Assessment is also covered in detail in another IMO Model Course, however to assist and aid the Instructors, some extracts from the Model course is used to explain in depth.

Multiple choice questions

Marking or scoring is easier if multiple-choice test items are used but in some cases difficulties may arise in creating plausible distracters.

Detailed sampling allows immediate identification of errors of principle and those of a clerical nature. It must be emphasized that this holds true, in general, only if the test item is based on a single step in the overall calculation. Multiple-choice items involving more than one step may, in some cases, have to be resorted to in order to allow the creation of a sufficient number of plausible distracters, but care must be exercised to ensure that distracters are not plausible for more than one reason if the nature of the error made (and hence the distracter chosen) is to affect the scoring of the test item.

Compiling tests

Whilst each examining authority establishes its own rules, the length of time which can be devoted to assessing the competence of candidates for certificates of competency is limited by practical, economic and sociological restraints. Therefore a prime objective of those responsible for the organization and administration of the examination system is to find the most efficient, effective and economical method of assessing the competency of candidates. An examination system should effectively test the breadth of a candidate's knowledge of the subject areas pertinent to the tasks he is expected to undertake. It is not possible to examine candidates fully in all areas, so in effect the examination samples a candidate's knowledge by covering as wide a scope as is possible within the time constraints and testing his depth of knowledge in selected areas.

The examination as a whole should assess each candidate's comprehension of principles, concepts and methodology; his ability to apply principles, concepts and methodology; his ability to organize facts, ideas and arguments and his abilities and skills in carrying out those tasks he will be called upon to perform in the duties he is to be certificated to undertake.

All evaluation and testing techniques have their advantages and disadvantages. An examining authority should carefully analyse precisely what it should be testing and can test. A careful selection of test and evaluation methods should then be made to ensure that the best of the variety of techniques available today is used. Each test shall be that best suited to the learning outcome or ability to be tested.

Quality of test items

No matter which type of test is used, it is essential that all questions or test items used should be as brief as possible, since the time taken to read the questions themselves lengthens the examination. Questions must also be clear and complete. To ensure this, it is necessary that they be reviewed by a person other than the originator. No extraneous information should be incorporated into questions; such inclusions can waste the time of the knowledgeable candidates and tend to be regarded as 'trick questions'. In all cases, the questions should be checked to ensure that they measure an objective which is essential to the job concerned.

Advantages and disadvantages of oral and practical tests

It is generally considered advisable that candidates for certificates of competency should be examined orally. Some aspects of competency can only be properly judged by having the candidate demonstrate his ability to perform specific tasks in a safe and efficient manner. The safety of .the ship and the protection of the marine environment are heavily dependent on the human element. The ability of candidates to react in an organized, systematic and prudent way can be more easily and reliably judged through an oral/practical test incorporating the use of models or simulators than by any other form of test.

One disadvantage of oral/practical tests is that they can be time-consuming. Each test may take up about 1 to 2 hours if it is to comprehensively cover the topics concerned.

Equipment must also be available in accordance with the abilities that are to be tested. Some items of equipment can economically be dedicated solely for use in examinations.

A sample format of both multiple choice question and assessing candidates in simulator exercises are provided below for guidance sake only.

1. What is the boiling temperature of Propane at atmospheric pressure ?
   a) $-0.5^{O}C$
   b) $-42^{O}C$
   c) $-48\ ^{O}C$
   d) $-34\ ^{O}C$

2. What is the main content of LNG ?
   a) Propane
   b) Butane
   c) Methane
   d) Ethane

3. Which of these is a chemical symbol?
   a) N_2
   b) C/H
   c) IBC
   d) NLS

4. What is the purpose of running cargo pumps in parallel ?
   a) To increase pressure
   b) To increase flow
   c) To increase NPSH
   d) To decrease NPSH

5. Why is it necessary to cool down cargo tanks during bulk loading ?
   a) To avoid over flow
   b) To avoid vapour emission
   c) To avoid vacuum in tank
   d) To avoid excessive tank pressure

6. What is the minimum allowed oxygen content prior making an entry in enclosed space?
   a) 7 % by volume
   b) 10 %
   c) 21 %
   d) No requirements

7. What is the minimum oxygen content in tank for checking vapour with Combustible gas indicator ?
   a) 5 – 7 %
   b) 8 – 10 %
   c) 12 - 14 %
   d) 14 – 16 %

8. What type of valves are mostly utilized on cargo lines on liquefied gas tankers ?
   a) All types
   b) Ball valves
   c) Seat and Needle valves
   d) Globe and butterfly

9. Materials used for thermal insulation should be tested for the following properties as applicable, to ensure that they are adequate for the intended service:
   a) Compatibility with the cargo, Solubility in the cargo and abrasion
   b) Absorption of the cargo, shrinkage and cohesion
   c) Ageing, density, mechanical properties and thermal expansion
   d) All of the above

10. Cargoes transported ________ -50^0C are cooled down by a cascade system where the cargo condenser is cooled by a liquid refrigerant gas such as R22.
    a) Below
    b) Above
    c) Equal to
    d) None

ANNEX 1

SAMPLE PARTICIPANTS HANDOUT

1.1 Types of Liquefied Gas Tankers

Liquefied gas tankers range in capacity from the small pressurized tankers of between 500 and 6,000 m3 for shipment of propane, butane and the chemical gases at ambient temperature up to the fully insulated or refrigerated seagoing tankers of over 100,000 m3 capacity for the transport of LNG and LPG. Between those two distinct types is a third tanker type – semi pressurized liquefied gas tanker. These very flexible tankers are able to carry many cargoes in a fully refrigerated condition at atmospheric pressure or at temperatures corresponding to carriage pressure of between five and nine bar.

A feature almost unique to the liquefied gas tanker is that the cargo is kept under positive pressure to prevent air entering the cargo system. This means that only cargo liquid and cargo vapour are present in the cargo tank and flammable atmospheres cannot develop.

Furthermore all liquefied gas tankers utilise closed cargo systems when loading or discharging, with no venting of vapour being allowed to the atmosphere. In the LNG trade, provision is always made for the use of a vapour return line between tanker and shore to pass vapour displaced by the cargo transfer. In the LPG trade this is not always the case as, under normal circumstances during loading, reliquefaction is used to retain vapour on board. By these means cargo release to the atmosphere is virtually eliminated and the risk of vapour ignition is minimised.

LPG ships

Fully refrigerated LPG Ships

These ships are designed to carry fully refrigerated cargoes at near atmospheric pressure at temperatures down to -50^{o} C. The cargoes include LPG, ammonia and, in most cases, some of the chemical gases, butadiene, propylene and VCM. Ships of the fully refrigerated type generally have capacities above 15,000m^3, up to about 85-100,000m^3. These ships are normally equipped with between three and six cargo tanks, extending almost the full beam of the ship. Double bottom tanks are fitted, together with topside or complete side ballast tanks. Prismatic free-standing tanks (Type A) are the most common, being supported on wooden chocks and keyed to the hull to permit expansion and contraction. This type of tank usually has an internal centreline bulkhead to improve stability and reduce sloshing. The secondary barrier is normally provided by the use of special steels for all hull structure which may be exposed to the cargo if a rupture of the primary barrier occurs. The hold is inerted when flammable cargoes are carried or filled with dry air for non-flammable cargoes.

LEG ships

Ethylene Carriers
In appearance this type of ship is very similar to the semi-pressurised ship, and competes for the same cargoes when the ethylene market is less profitable. The main difference is the design temperature of -104°C for the cargo containment system.

The sizes are typically between 2000m^3-12,000m^3, and the cargo tanks are independent pressure vessel Type C tanks made from nickel-steel or stainless steel. For the Type C tanks, no secondary barrier is required. The ships are normally fitted with a double bottom. A cascade type refrigeration plant is fitted, of sufficient capacity for reliquefaction of ethylene carried fully refrigerated at -104°C, and the cargo tanks normally have a thicker insulation than on fully refrigerated LPG ships. A few ethylene carriers of small size have been built with semi-membrane tanks and secondary barrier.

LNG Ships

Methane / LNG Carriers

Methane/LNG is carried at atmospheric pressure at -163°C in cargo tanks made from aluminium, nickel-steel or stainless (austenitic) steel. Insulation is fitted and most LNG ships are more correctly described as fully insulated since they usually have no reliquefaction plant; boil-off gas is normally burnt in the main propulsion machinery. The ships are large, mainly from 40,000 to 135,000m^3, with four to six cargo tanks of Type A, B or membrane. The space between the primary and secondary barriers is inerted. However, for Type B systems with only a partial secondary barrier, the hold space is usually filled with dry air. A full double bottom and side ballast tanks are fitted. The arrangement of primary and secondary barriers varies widely from system to system.

Chlorine Ships

Chlorine is a very toxic gas that can be produced by the dissolution of sodium chloride in electrolysis. Because of the toxicity of Chlorine it is therefore transported in small quantities, and must not be transported in a larger quantity than 1200m^3. The liquefied gas tanker carrying chlorine must be type 1G with independent type C tanks. That means the cargo tank must, at the least, lie B/5 "Breadth/5" up to 11.5 meter from the ships side. To transport Chlorine, the requirements of IMO IGC code, chapters 14, 17 and 19 must be fulfilled. Cooling of Chlorine requires indirect cargo cooling plants. The difference of Chlorine and other gases transported is that Chlorine is not flammable. Chlorine is utilised in producing chemicals and as bleaching agent in the cellulose industry

LPG/Chemical ships

Liquefied gas tankers that are allowed to transport ethylene oxide or propylene oxide must be specially certified for this. Ethylene oxide and propylene oxide have a boiling point at atmospheric pressure of respectively 11°C and 34°C and are therefore difficult to transport on tankers without indirect cargo cooling plants. Ethylene oxide and propylene oxide cannot be exposed to high temperature and can therefore not be compressed in a direct cargo cooling plant. Ethylene oxide must be transported on gas tanker type 1G. Chemical gases like propylene, butadiene and VCM are transported with medium-sized atmospheric pressure tankers from 12000 m^3 to 56000 m^3. Semi-pressurised liquefied gas tankers are also used in chemical gas trade and then in smaller quantity as from 2500 m^3 to 15000 m^3. Chemical gases are transported all over the world, and especially to the Far East where there is a large growth in the petro-chemical industry.

ANNEX 2

TYPICAL FIXED DRY CHEMICAL POWDER FIREFIGHTING INSTALLATION

The items marked with double hash (##) in the time table and course outline could be be part of a specific firefighing module or other appropriate practical firefighting training as determined by the administration.

The practical exercise (3 hours) corresponding to this competence may not be carried out if the candidates have already undertaken an approved Fire prevention and Firefighting course with Gas firefighting training.

SCOPE

Fire Prevention and Firefighting training as required under STCW A-VI/1-2 is covered by IMO Model course 1.20. STCW code A-V/1-2-1 requires trainees to demonstrate competence in extinguishing a gas fire with the use of dry chemical powder from a fixed DCP installation under truly realistic training conditions (e.g. simulated shipboard conditions) and whenever possible and practicable in darkness also.

This requires that the trainee should hold a charged hose, approach a live LPG fire and release the DCP and direct the firefighting medium to the fire in such a manner so that the correct technique for extinguishing the fire may be effectively demonstrated. Since the course addresses the basic level, the focus of the firefighting should be the fighting and extinguishing of the fire at the sharp end and not so much on the knowledge and understanding the specifications of the fixed DCP installation.

OBJECTIVES

On successful completion of the training the candidates shall be able to:

1. Describe the nature of an LPG/LNG fire and enumerate the precautions when approaching the fire as well as list and implement the immediate measures or precautions when dealing with gas fires.
2. Approach the LPG/LNG fire with firefighting protection equipment (fire suit and PPE) in a manner prescribed in the firefighting theory sessions and demonstrate the proper technique.
3. Deploy the firefighting medium (Dry chemical powder) from the installation by correctly operating the release mechanism and engaging the equipment, demonstrating a clear understanding of sequence and procedure.
4. Extinguish the LPG/LNG fire by applying the firefighting technique with regard to the correct position, posture, application method and monitor the quelled flame until the fire is completely extinguished.

TEACHING FACILITES AND EQUIPMENT

IMO Model course 1.20 on Fire Prevention and Firefighting provides a model layout of the firefighting mock up and installation for the basic firefighting training. This annexure describes the additional installation to the existing firefighting mock up, to enable demonstration of fixed DCP extinguishing system.

The typical installation suggested below takes into account that this installation will be activated and used on a daily basis for demonstration of firefighting to the trainees, hence unlike a shipboard installation which will be very rarely operated and only in an emergency, the installation fitted in the training establishment must be smaller, easily operable, have good demonstrability, and with smaller quantities of dry chemical powder deployed to make the system environmentally sound and waste by-product more manageable.

The system mentioned in this annexure is a scaled down version of a shipboard installation and incorporates all the elements of the installation in a manner that permits the frequent use of the system on a daily basis. The variation in the types of installation found on board ships, in terms of complexity may be adequately addressed during classroom interaction and video instruction.

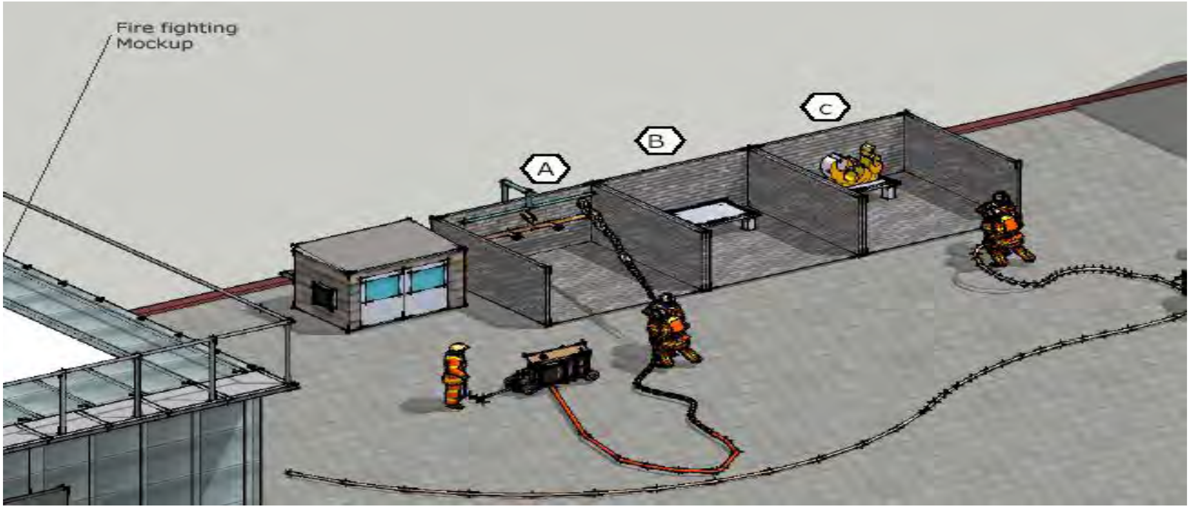
The typical installation consists of:

- Fire pit incorporating a fire tray for gas fire
- DCP firefighting installation (mounted on a skid, which can be wheeled to the central demonstration area)
- Piping system

Fire pit (DCP)

The fire pit consists of a concrete / brick and mortar tray with dimensions of 2 x 2 x 2 (L x B x D). The tray is to be equipped with a means to demonstrate with repeatability an LPG/LNG fire. Other fire pits may be placed adjacent to the gas fire pit but not in a manner that affects the primary function and use of the fire pit as a demonstration area. For this purpose it is recommended to have a U bend pipeline with a flange to flange joint in the centre. The eccentricity of the flange mating surfaces has to be developed to allow for the leakage of LPG in the pipeline in a controlled manner. The U bend pipeline is equipped with one inlet valve from where it receives the LPG gas charge. Another outlet valve safely drains the gas charge in case it is desired to quell the flame instantly controlling any risk of a blaze. The fire pit is also fitted with sufficient drainage facility to collect the volume of spent DCP collected in the drain pit.

The fire pits may be arranged next to the firefighting mock-up recommended in IMO model course 1.20, bearing in mind safe radial distance from adjacent buildings or services. (Fig. 1 and 2)



Section A, B and C for Gas, Wood and Oil fire demonstration

A, the gas fire installation is fitted with a manifold to feed secure arrangement of LPG through a mock arrangement

B, represents wood or general fire

C, Oil fire tray with floating diesel and water arrangement.

Note: All these niche's have drain arrangement for water run-off

Figure 1: General Layout of the Fire pits approached and demonstration of extinguishing of fire by means of firefighting application techniques

Figure 2: LPG / LNG fire pit view and demonstration of extinguishing of fire by using fixed DCP system

DCP firefighting skid

Keeping in mind the repeated deployment of the system and better demonstrability to the trainees the fixed DCP installation is mounted on a skid with wheels so that it can be rolled out to the centre of the open ground ready for activation. The unit is serviceable by the personnel who handle the plant. It miniaturizes a typical shipboard installation and emulates in terms of function and operation all the features provided onboard ships fitted with such fire-extinguishing system.

The skid arrangement that has been recommended has the following advantages.

1. Small system that can be moved easily as the entire skid is on wheel arrangement thus providing better demonstrability.

2. The skid can be brought to the centre of the firefighting field. The front panel of the skid holds the hose cabinet, release levers, pilot bottles and pressure gauges. The rear portion of the skid is open permitting easier and better inspection by candidates so that the various components and parts of the system can be clearly studied and comprehended in terms of function as well as position in the system integration.

3. The quantity of DCP discharged is small thereby reducing the environmental impact of frequent releases and also keeping the DCP suspension levels down to minimum, posing lesser challenges for disposal of chemical waste.

4. Operational cost is controlled, considering the volume of DCP discharged.

5. The discharge pressures are controlled thereby enhancing the safety of the installation

6. Multiple candidates get an opportunity to handle the charged DCP hose and approach the gas fire to practice the correct application technique.

The system allows for multiple discharges during the same course as readying and refilling the system will be quick and efficient requiring no special techniques

Description of the skid (Fixed DCP installation)

The sketch of the skid is given in fig 3 and 4. The unit is mounted on a solid steel base and houses the following components.

- Main DCP container or cylinder
- Propellant bottle (Nitrogen)
- Automatic remote actuation valve
- Pressure relief system
- Flexible hose with stop cock lever arrangement (auto shut-off)
- Hose cabinet and control levers

The front portion of the skid is fitted with the hose cabinet and houses the fire hose connected to the outlet of the DCP cylinder. The remote actuation valve is fitted on this line. The pilot bottle is released from the main cabinet. This is the 'pilot release station'. The pilot bottle operates a valve, whereby the propellant (nitrogen) is charged into the DCP cylinder. The pilot bottle also activates the zone remote actuation valve thereby enabling the DCP now under pressure to travel to the flexible hose. The flexible hose is capable of holding back the pressure in the system and permitting the DCP charge to be directed to the fire as required. A pressure gauge on the front portion of the skid monitors the pressure in the line.

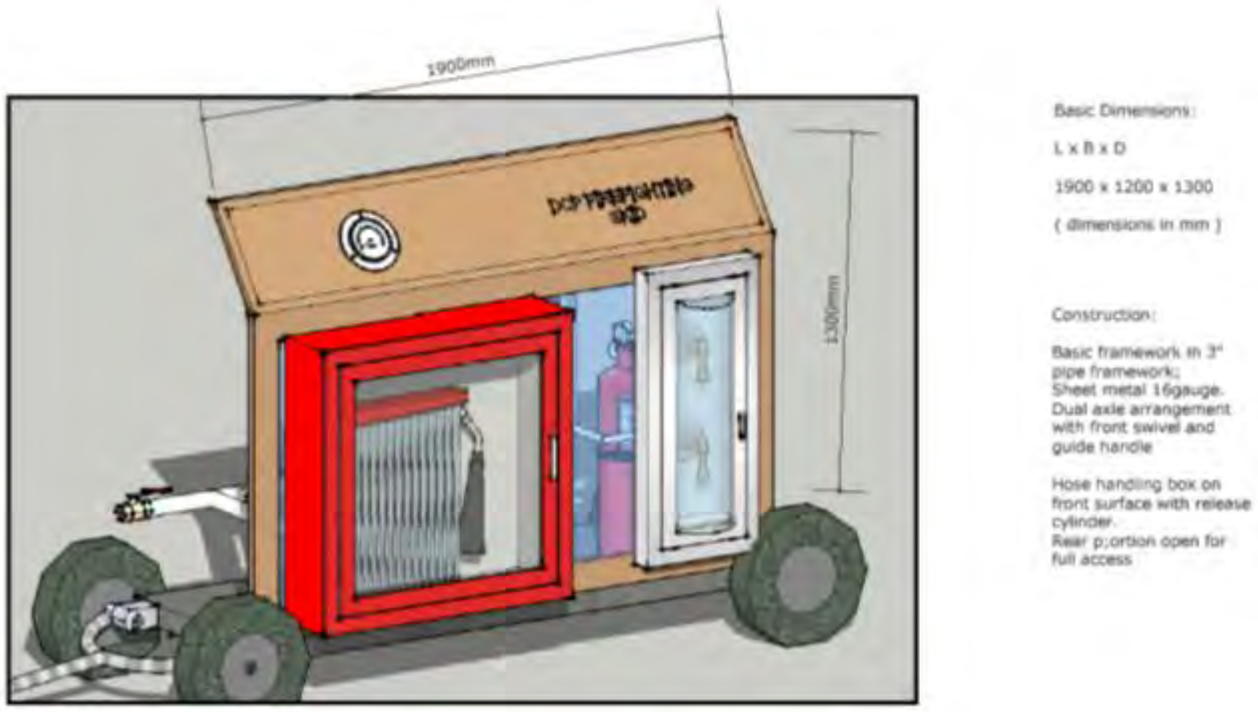


Figure3: DCP skid front view

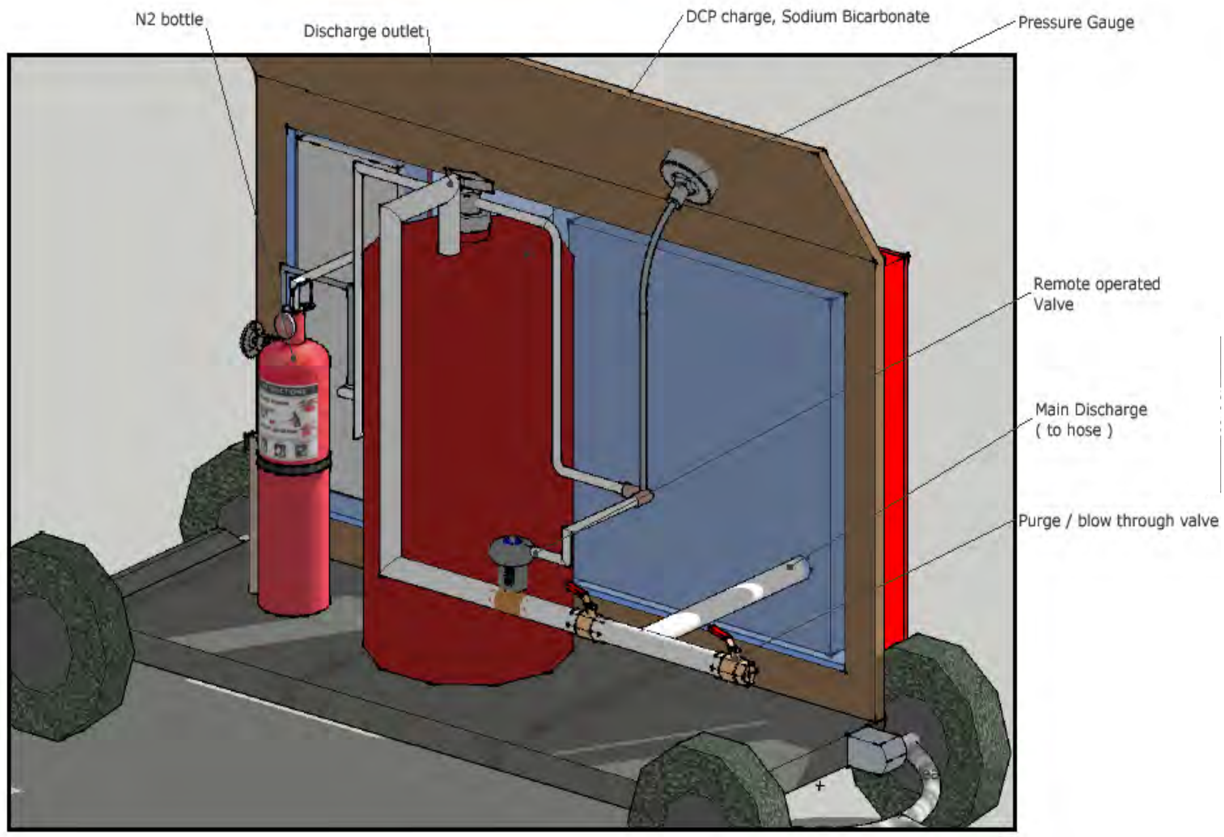
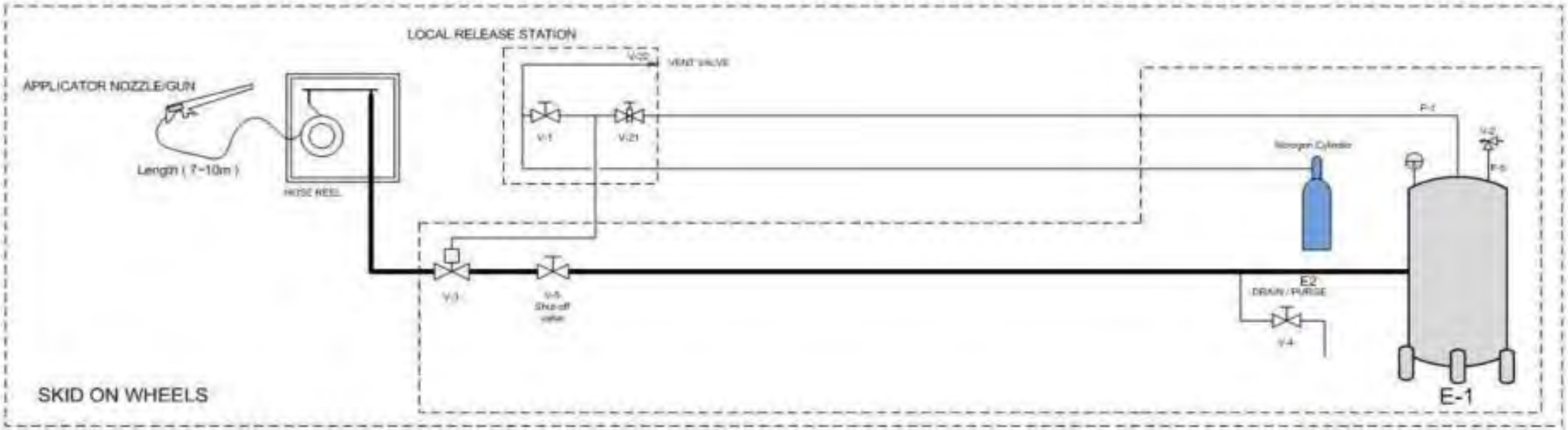


Figure 4: DCP skid (rear view)

The schematic of the system is shown in Figure 5 along with the table of specifications of the components.



Equipment List					
Displayed Text	**Description**	**Material**	**Detail**	**Design Pressure**	**Model**
E-1	Pressure Vessel DCP	Mild Steel	50 Kgs, Expulsion time 45 sec, Sodium Bicarbonate charge	30bar, (IS 1079)	PN16 (Pressure Class), IS 10658
E-2	Nitrogen Cylinder	Mild Steel	Volume 3~5 ltrs, working pressure 140 bar , IS 7285	250 bar	Hand valve / external trigger release
F1	Portable DCP Turret	Casting AL Alloy	Throw distance 10m (Range 8~10m)		Hand release type (quick latch type)
V1	Line valve	Casting AL Alloy			Manual relase
V2	Safety Vavle	Casting, Alloy			
V3	Release Valve	Casting, Alloy			Remote operated, Quick opening latch on type
V4	Purge / drain valve	Casting, Alloy	Purge valve to blow through the DCP line		
P	Pressure Gauge	Composite		0~220 bar	
V5	shut off valve	Casting, Alloy	Isolation valve		
V21	shut off valve	Casting, Alloy	Isolation / Release valvein FRP cabinet		
V22	shut off valve	Casting, Alloy	Vent valve to depressurize line		
Skid		Mild Steel	Dimensions : L X B X H = 1900 x 1200 x 1300		

Figure 5: The schematic of the Fixed DCP Firefighting Installation along with the table of specifications of the components

Jet Fires

Small leaks from pump glands, pipe flanges or from vent risers will initially produce vapour.

This vapour will not ignite spontaneously but, if the escape is large, there may be a risk of the vapour cloud spreading to a source of ignition. Should a gas cloud occur, ignition should be prevented by closing all openings to hazardous areas. Furthermore, the vapour cloud should be directed or dispersed away from ignition sources by means of fixed or mobile water sprays.

If ignition does occur, it will almost certainly flash back to the leak. Leaks from pipelines are likely to be under pressure and, if ignited, will give rise to a jet flame. Emergency shut-down of pumping systems and closure of ESD valves should have already occurred but, even so, pressure may persist in a closed pipeline until the liquid trapped within has been expelled through the leak. In such a case, the best course of action is often to allow the fire to burn out. The alternative of extinguishing the fire has a high risk of further vapour cloud production and flash-back causing re-ignition. While the fire is being allowed to burn itself out, the surroundings should be protected with cooling water.

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