INTERNATIONAL MARITIME ORGANIZATION

IMO

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SUB-COMMITTEE ON STANDARDS OF
TRAINING AND WATCHKEEPING
39th session
Agenda item 3

STW 39/3/1
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VALIDATION OF MODEL TRAINING COURSES

Model course – Familiarization training for liquefied natural gas (LNG) tanker operations

Note by the Secretariat

SUMMARY

Executive summary:	This document provides a draft model course on Familiarization training for liquefied natural gas (LNG) tanker operations
Action to be taken:	Paragraph 5
Related documents:	MSC 50/27, STW 17/11 and STW 37/18

1 The Maritime Safety Committee, at its fiftieth session (MSC 50/27, paragraph 12.10), had approved the procedures developed by the Sub-Committee, at its seventeenth session (STW 17/11, annex 5), for validation of model courses related to the implementation of the STCW Convention.

2 The Sub-Committee, at its thirty-seventh session (23 to 27 January 2006), had concurred with the proposal by India to develop a model course relating to familiarization training for Liquefied natural gas (LNG) tanker operations (STW 37/3/2) and to submit it to the Sub-Committee for validation in due course (STW 37/18, paragraphs 3.7 and 3.10).

3 The preliminary draft of this model course was forwarded to members of the validation panel for their comments. The comments received have been incorporated as appropriate.

4 The final draft model course is set out in annex.

Action requested of the Sub-Committee

5 The Sub-Committee is invited to consider the above information and decide as appropriate.

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ANNEX

MODEL COURSE X.XX

Draft

FAMILIARIZATION TRAINING FOR LIQUEFIED NATURAL GAS (LNG) TANKER OPERATIONS

International Maritime Organization

ACKNOWLEDGEMENTS

This course is based on the training guidelines as produced by SIGTTO and training material developed by the Directorate General of Shipping, Government of India.

It has been prepared by training institutions based in Mumbai.

IMO wishes to express its sincere appreciation to the Government of India for its provision of expert assistance, valuable co-operation, and generous funding 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.

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. As in all training endeavours, the knowledge, skills and dedication of the instructor 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 skill necessary to meet the technical intent of IMO conventions and related recommendations.

▪ Use of the model course

To use the model course the instructor should review the course outline and detailed syllabus, taking into account the information provided under the entry standards specified in the course frame-work. The actual level of knowledge and skills and prior technical education of the trainees should be kept in mind during this 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 designer should be identified. To compensate for such differences, the instructor is expected to delete from the course, or reduce the emphasis on, items dealing with knowledge or skills already attained by the trainees. He should also identify any academic knowledge, skills or technical training which they may not have acquired.

By analysing the detailed syllabus and the academic knowledge required to allow training in the technical area to proceed, the instructor can design an 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 technical course.

Adjustment of the course objectives, scope and content may also be necessary if in your maritime industry the trainees completing the course are to undertake duties which differ from the objectives specified.

Within the course outline, Part B, the course designers have indicated their assessment of the time which should be allotted to each subject area. However, it must be appreciated that these allocations, are arbitrary and assume that the trainees have fully met all the 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.

- **Lesson plans**

Having adjusted the course content to suit the trainee intake and any revision of the course objectives, the instructor should 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. An example of a lesson plan is included in the instructor manual in most model courses, but in this course, the exercise scenarios supplied as an appendix to the instructor manual serve this purpose. Where no adjustment has been, found necessary in the learning objectives 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 presentation of the material.

- **Presentation**

The presentation of concepts and methodologies must be repeated in various ways until the instructor is satisfied that the trainee has attained each specific learning objective. The syllabus is laid out in learning-objective format and each objective specifies what the trainee must be able to do as the learning outcome.

- **Evaluation or assessment of trainee progress**

The nature of this course involves all the trainees and the instructors in an ongoing process of individual and group evaluation.

- **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 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.

Part A: Course Framework

▪ Scope

This course provides training for Officers and ratings who have not previously served on board LNG tankers as part of the regular complement. It comprises of a familiarization training programme appropriate to their duties, including Liquefied natural gas tanker safety, fire safety measures and systems, pollution prevention, operational practice and obligations under applicable laws and regulations. The course takes full account of Section A-V/1 of the STCW Code adopted by the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended in 1995.

Any of this training may be given on board or ashore. It should be supplemented by practical instruction on board and, where appropriate, in a suitable shore-based installation.

▪ Objective

Those successfully completing the course should enable the candidate to serve on LNG tankers in a capacity other than master, chief engineer, chief officer or second engineer, and be able to operate or give support to those directly responsible for the Cargo equipment and for loading, discharging and care in transit for handling of cargo on liquefied natural gas tankers.

▪ Entry standards

This course is open to experienced seafarers not necessarily served on LNG TANKERS but who have completed a shore-based basic fire-fighting training course approved by the Administration, and an approved course on first aid. (See flow chart below).

▪ Course certificate

The liquefied natural gas tanker familiarization training programme must be approved by the Administration. Officers and ratings who are qualified in accordance with regulation V/1 paragraph 1 as appropriate, that is they have experience appropriate to their duties on LNG tankers, or complete this training programme, shall be issued with an appropriate certificate. An existing certificate may be suitably endorsed by the issuing Administration.

▪ Course intake limitations

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

▪ Staff requirements

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

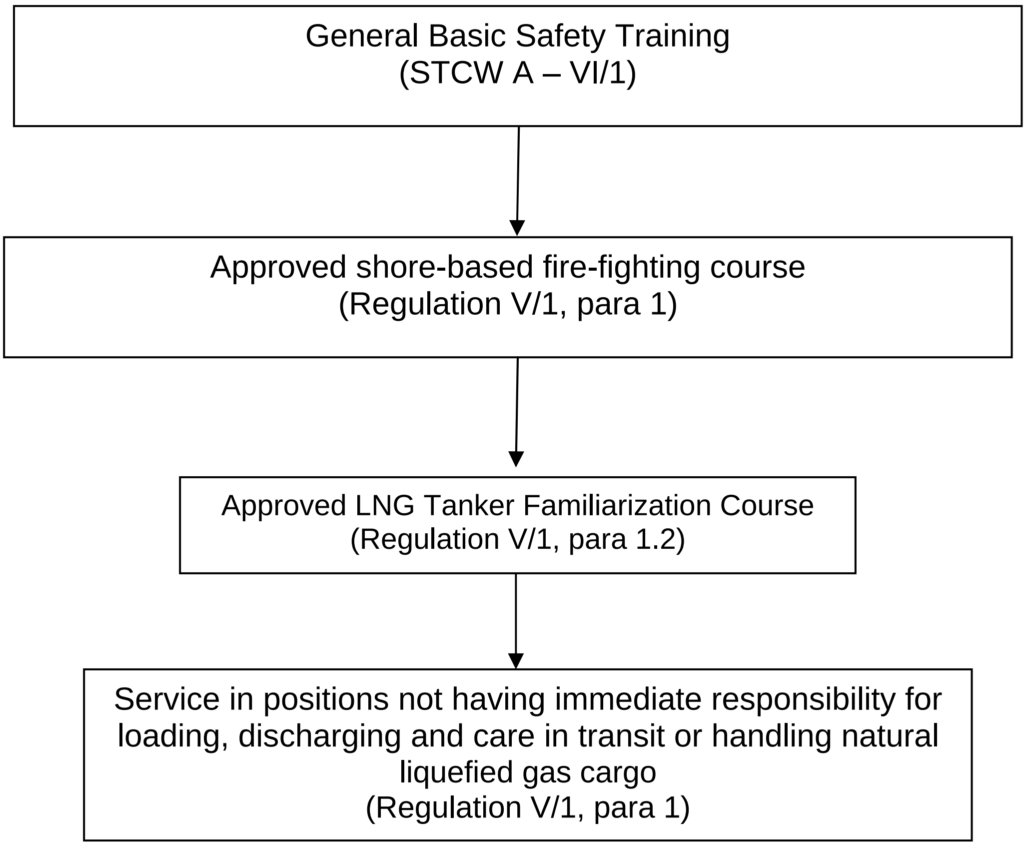
1. Oxygen Resuscitator
2. Breathing apparatus
3. Portable oxygen meter
4. Portable combustible-gas detector
5. Portable toxic-gas detector
6. Chemical absorption tubes for toxic-gas detector (for methane)
7. Tank evacuation equipment

▪ 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-l/12. Section B-1/12 provides guidance on the use of simulators in these activities. Simulator -based training and assessment is not a mandatory requirement for this liquefied natural gas tanker training program. However, it is widely recognized that well-designed lessons and exercises can improve the effectiveness of training and shorten training times compared to traditional methods.

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. Instructors should refer to STCW, Section A-I/12, and Part 2.

STCW 95 scheme for personnel joining a liquefied natural gas tanker in a capacity not having immediate responsibility for cargo operations



Note: Administrations may require additional training at sea or ashore to meet national regulations.

▪ Teaching Aids (A)

A 1 Instructor Manual (Part D of the course)

A2 Overhead projector and diagrams in Appendix 1 to Instructor Manual

A3 Videos

- An Introduction to Liquefied Gas Carriers (Catalogue Code No.103)
- Cargo Fire fighting on Liquefied Gas Carriers (Catalogue Code No.254)
- Permit to Work (Catalogue Code No. 621)
- Who Needs It? Personal Protective Equipment (Catalogue Code No.597)
- The Chemistry of Liquefied Gas (Catalogue Code No.641)
- The Physics of Liquefied Gas (Catalogue Code No.642)
- The International Safety Management Code (Catalogue Code No.524)
- Portable Gas Detectors -A Breath of Fresh Air (Catalogue Code No.650)

Available from: Videotel Marine International Ltd.
84 Newman Street
London W1P 3LD, UK
Tel: +44 171 299 1800 Fax: +44 171 299 1818
e-mail: mail@videotelmail.com
URL: www.videotel.co.uk

A4 CBT modules:

- Inert Gas Generator
- Low Temperature Insulation on Gas Carriers
- Gas Tanker Training System

Available from: Seagull A.S.
Gamleveien 36, PO Box 1062
N-3194 Horten, Norway
Tel: +4733047930 Fax: +47 33046279
e-mail: seagull@sgull.com
URL: www.sgull.com

▪ IMO references (R)

R1 International Convention for the Safety of Life at Sea, 1974 (SOLAS Consolidated Edition 2004 (IMO-110)

R2 International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978/1995 (IMO-938)

R3 Code for Existing Ships Carrying Liquefied Gases in Bulk, as amended (IMO-788) its Supplement 1980 (IMO-791)

R4 Code for the construction and Equipment of Ships Carrying Liquefied Gases in bulk as amended (IMO-782)

R5 International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), as amended (IMO-104)

R6 Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG) as amended (IMO-251)

R7 MARPOL 73/78 Consolidated Edition (IMO-520)

R8 IMO Model Course 1.01 (Tanker Familiarisation)

R9 International Safety Management Code (ISM Code) (IMO-117)

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

▪ Textbooks (T)

T1 Liquid SIGTTO, Liquefied Gas Handling Principles on Ships and in Terminals, Maguire and White, SIGTTO 2nd ed. (London, Witherby Marine Publishing, 1996) (ISBN 1 85609-0876)

T2 T.W.V. Woolcott, Liquefied Petroleum Gas Tanker Practice. 2nd ed. (Glasgow, Brown, Son & Ferguson Ltd., 1987) (ISBN 0-85174-510-5)

T3 International Chamber of Shipping, Tanker Safety Guide (Liquefied Gas). 2nd ed. (London, Witherby Marine Publishing, 1996) (ISBN 0-906270-03-0)

T4 Liquefied Gases Marine Transportation and Storage by Alain Vaudolon

T5 Safe Gas Tanker Operations, Capt. KSD Mistree and Mr. BK Sharma

▪ Bibliography (B)

B1 R. F Fooks, Gas Carriers. 1st ed. (London, Fairplay Publications Ltd., 1984) (ISBN 0-805045-52-1) [Out of Print 1999]

B2 R.G. Wooler, Marine Transportation of LNG and Related Products. (Cambridge, MD, Cornell Maritime Press Inc., 1975) (ISBN 0-87033-193-0)

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

B4 ICS/OCIMF SIGTTO, Ship to Ship Transfer Guide (Liquefied Gases). 2nd. ed. (London, Witherby & Co. Ltd., 1995) (ISBN 1-856090825)

B5 ICS, Guide to Helicopter/Ship Operations. 3rd ed. (London, Witherby & Co. Ltd., 1989) (ISBN 0-949691-44-1)

B6 Safety in Liquefied Gas Tankers, 1980, ICS (Witherby Publication Code: 634)

B7 Bureau Veritas Gas Carrier Safety Handbook. (London, LLP Limited, 1997) (ISBN 1-85978-109-8)

B8 SIGTTO/IACS Applications of Amendments to Gas Carrier Codes Concerning Type “C” Cargo Tank Loading Limits. (London, Witherby & Co Ltd., 1997) (ISBN 1-85609-125-2)

B9 Recommendations and Guidelines for Linked Ship/Shore Emergency Shut-Down of Liquefied Gas Cargo Transfer, 1987, SIGTTO

B10 Code of Safe Working Practices for Merchant Seamen, 2004, MCA, UK

B11 Liquefied Gas Carriers: Your Personal Guide to Safety, 2002, SIGTTO, (Witherby Publication Code: 4582)

B12 Crew Safety Standards and Training for Large LNG Carriers, 2003, SIGTTO, (Witherby Publication Code: 5827)

B13 Ship Vetting and its Application to LNG, 2004, SIGTTO

B14 Guidelines for Automatic Cargo Tank Overfill Protection Aboard Gas Carriers, 1993, SIGTTO

B15 Recommendations for Manifolds for Refrigerated Natural Gas Carriers (LNG) (2nd Edition), 1994, SIGTTO & OCIMF

B16 LNG Terminal Information Web Portal SIGTTO/GIINGL (www.lngterminalinfo.org)

B17 Contingency Planning and Crew Response Guide for Gas Carrier Damage at Sea and in Port Approaches (1999), ICS & OCIMF (Witherby Publication Code: 3455)

Part B: Course Outline & Timetable

Subject Area		Approximate Time (Hours)	
		Lecture/ Discussion	Practical
1.	**Introduction & STCW 95 Requirements**	**2.5**	
1.1	Introduction – The Course	0.5	
1.2	Development of Bulk Liquefied Natural Gas Shipping and its Trade	1.0	
1.3	Terminology	0.5	
1.4	Rules and Regulations	0.5	
2.	**Properties and Hazards of Liquefied Natural Gas (LNG)**	**2.5**	
2.1	Types of liquefied gases	1.0	
2.2	LNG properties and properties of liquefied gases	0.5	
2.3	Hazards from LNG	1.0	
3.	**Ship Types and Arrangements**	**1.5**	
3.1	Independent tanks, Moss Rosenberg tanks	0.5	
3.2	Membrane tanks and Design principles	0.5	
3.3	Semi membrane tanks, Integral tanks, Internal insulation tanks	0.5	
4.	**The Liquefied Natural Gas (LNG) Tanker**	**1.5**	
4.1	LNG tanker types	0.5	
4.2	General layout of a LNG tanker	0.5	*
4.3	Survival capability and tank location	0.5	
5.	**Cargo Equipment and Instrumentation**	**6.5**	
5.1	Tank piping and Valves	0.5	*
5.2	Pressure relief and vacuum-protection system	0.5	
5.3	Pumps and unloading systems (Cargo pumps & Spray pumps)	0.5	
5.4	Control of boil off	0.5	
5.5	Cargo compressors and Heaters (Low duty (L/D)and High duty H/D)	1.0	
5.6	LNG Vaporisers and Forcing Vaporisers	0.5	
5.7	Inert gas Generator, Nitrogen Generator	1.0	
5.8	Instrumentation, Level gauging System,	1.0	
5.9	Integrated Automated System, Custody Transfer System (CTS), Dual fuel System, High Voltage System	1.0	

Subject Area		Approximate Time (Hours)	
		Lecture/ Discussion	**Practical**
6.	**Tank Environnent Control**	**5.5**	
6.1	Methods of control, Hold space and Cargo tank drying , Nitrogen purging	0.5	*
6.2	Warming up tanks		*
6.3	Inerting, Gas freeing/aerating	0.5	*
6.4	Purging Inert gas, Gassing up of Cargo System, Inerting of cargo System, Cooling down cargo System, Ship Shore Preparation and Manifold	0.5	*
6.5	Connection, Loading, Discharging, Emergency Discharging	2.0	
6.6	Loaded and Ballast passage	2.0	*
7.	**Safety Precautions and Measures**	**4.0**	
7.1	Tank atmosphere evaluation	-	1.0
7.2	Fire prevention and fire fighting	0.5	
7.3	Pollution prevention	0.5	
7.4	Protection and safety equipment/Demo	0.5	1.0
7.5	Accommodation	0.5	
8.	**Ship/Shore Interface**	**1.0**	
9.	**Emergency Operations**	**3.0**	
9.1	Organizational structure	0.5	
9.2	Alarms	0.5	
9.3	Emergency procedures (Leak from Cargo tank)	1.0	
9.4	First-aid treatment/Demo		0.5
9.5	Emergency Measures	0.5	
10.	**Assessment/Discussion/Case Studies/ Interchange of experiences and feedbacks**		**2.0**
	Sub Total	**25.5**	**4.5**
Total		**30.0**	

Note: It is suggested that an LNG – Liquid Cargo Handling Simulator can serve as an efficient teaching tool. Should such a system be available, then the class/lecture hours should be adapted to incorporate such without raising the overall duration of the course. Areas that may be suitable for such training are indicated with an asterisk (*).

Course Timetable

PERIOD / DAY	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
1ST Period (1.5 hours)	1. Introduction 1.1 The course 1.2 Development of liquefied gas shipping 1.3 Terminology	3. Cargo containment 3.1 Independent tanks 3.2 Membrane tanks 3.3 Integral tanks, internal insulation tanks	5.6 LNG Vaporizers 5.7 Inert gas Generator and Nitrogen Generator 5.8 Instrumentation	7.3 Pollution prevention 7.4 Protection and safety equipment	9.5 Emergency measures
B R E A K					
2nd Period (1.5 hours)	2. Properties and hazards of Liquefied Natural gas 2.1 Types of liquefied gases carried	4. The LNG tanker 4.1 General layout of a LNG tanker 4.2 Survival capability and tank location	5.9 Custody Transfer system (CTS) and Dual Fuel System 6. Tank environmental control	7.5 Accommodation	10. Exchange of information & experiences
L U N C H B R E A K					
3rd Period (1.5 hours)	2.2 LNG properties	5. Cargo equipment and instrumentation 5.1 Tanks, piping and valves 5.2 Pressure relief and vaccum-protection system 5.3 Pumps and unloading system	6.1 Methods of control, hold space and cargo tank drying 6.2 Warming up 6.3 Inerting, gas freeing, aerating 6.4 Purging, gassing up 6.5 Cooling down, loading, discharging 6.6 Loaded & ballast passage	8. Ship-shore interface 9. Emergency operations 9.1 Organizational structure	10.1 Discussion/ Case Studies
B R E A K					
4th Period (1.5 hours)	2.3 Hazards from LNG	5.4 Control of boil-off gas (BOG) 5.5 Low duty & High duty compressors and heaters	7. Safety precautions and measure 7.1 Tank atmosphere evaluation 7.2 Fire prevention and fire fighting	9.2 Alarms 9.3 Emergency procedures 9.4 First-Aid treatment	10.2 Assessment

Part C: Detailed Teaching Syllabus

The detailed teaching syllabus indicates the contents of the course and appropriate references and teaching aids.

- **Learning objectives**

The detailed teaching syllabus has been written in learning objective format in which the objective describes what the trainee must do to demonstrate that knowledge has been transferred. This format is an appropriate teaching and assessment tool to express:

- The depth of understanding of a subject and the degree of familiarization with a subject on the part of the trainee.

- What capabilities the trainee should really have and be able to demonstrate.

Every instructor is encouraged to teach learning in an 'objective-related' way instead 'material-related'. In this context, all objectives are understood to be prefixed by the words, 'The expected learning outcome is that the trainee is able to . . . '.

To indicate the degree of learning outcome of this course, the learning objectives for the Detailed Teaching Syllabus can be classified in three 'dimensions':

- C (cognitive)

- A (affective)

- P (psycho-motor)

Within a dimension, they are hierarchized by increasing complexity (C1 to C6, A1 to A5, and P1 to P5) where the complexity (depth, familiarization) is expressed (following B. Bloom and others) by a typical verb as follows:

Cognitive dimension of learning objectives:

C1	Knowledge	describe, outline
C2	Comprehension	explain
C3	Application	apply, perform, operate
C4	Analysis	analyse
C5	Synthesis	synthesize, construct, plan
C6	Evaluation	assess

Affective dimension of learning objectives:

A1	Reception; notice	recognize
A2	Response	respond
A3	Value	value
A4	Organization	organize
A5	Value characterization	accept, appreciate

Psycho-motor dimension of learning objectives:

P1	Imitation	imitate
P2	Manipulation	manipulate
P3	Precision	move, mark
P4	Co-ordination	co-ordinate (operations, menus)
P5	Naturalization	automate, internalize

- **References and teaching aids**

In order to assist the instructor, references are shown against the learning objective to indicate IMO references and publications, bibliographies, textbooks and other references, as well as additional teaching aids which the instructor may wish to use when preparing course material. The material is listed in the course framework. The following notations and abbreviations are used:

R	IMO reference
T	Textbook and other references
B	Bibliography
A	Teaching aid
Ap.	Appendix
An.	Annex
Ch.	Chapter
p.	Page
Para.	Paragraph
Sc.	Section

The following are examples of the use of references:

“R2” refers to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW Convention, 1978 (as amended 1995).

“A1”, refers to the instructor manual in Part D of this model course.

- **Instructor Manual**

The instructor Manual (Part D) is included to provide additional information to instructors. It is designed to help further in structuring and organizing a specific course.

The instructor is recommended to gain additional technical material from simulators suppliers and from LNG ship operators. Suppliers of simulators are also good sources of technical information.

The instructor should take pains to present the material within ‘a-use-at-sea’ context. It is not just a matter of imparting technical knowledge.

- **Note**

Throughout the course, safe working practices are to be clearly defined and emphasized with reference to current international requirements and regulations.

It is expected that the national institution implementing the course will insert references to national requirements and regulations as necessary.

- **Detailed Teaching Syllabus**

All objectives are understood to be prefixed by the words “The expected learning outcome is that the trainee is able to …………..”.

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
1	**Introduction**			
Required performance				
1.1	**The course**	R2		A1–para 1.1
1.1.1.	States the background for and the purpose of the course as:			
	• the 1995 STCW Convention calls for mandatory minimum requirements for training and qualification of masters, officers and ratings on LNG tankers			
	• the training is divided into two parts:			
	• **LEVEL 1 -** LNG Tanker familiarization course: a basic safety training course for officers and ratings ON BOARD			
	• LEVEL **2 -** A specialized liquefied natural gas tanker operations for masters, officers and others who are to have immediate responsibilities for cargo handling and cargo equipment			
	• this course covers the requirements for level 1 training required by Reg.V/3 Para.1 and specified in resolution 12 of STCW			
1.1.2.	States that personnel on LNG tankers should at least, have attended an approved basic fire-fighting course and an approved course on first aid before entering this training course			
Required performance				
1.2	**Development of liquefied gas shipping**	R2	T1, T2,T5	A1, A2, A3
1.2.1.	lists important stages in the transport of LNG by ships, such as:			
	• by 1963, LNG was in service carrying cargo at atmospheric pressure			
1.2.2.	States that the sea transport of LNG in bulk is internationally regulated –with regard to safety—through standards established by the International Maritime Organization			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
1.2.3.	States that these standards are set out in the IMO's Gas Carrier Codes which cover design, construction and other safety measures for ships carrying liquefied gases in bulk			
1.3	**Terminology**			
1.3.1.	Defines terminology and explains abbreviations commonly used aboard LNG tankers and on LNG terminals			
2	**Properties and Hazards of Liquefied Natural Gas**	R2	T1, T3, T5	A1
2.1	**Types of Liquefied gases carried**			
2.1.1	States that, generally speaking, a liquefied gas is the liquid form of the substance which at ambient temperature and atmospheric pressure would be a gas			
2.1.2	States that cargoes transported by gas tankers are listed in IMO's Gas Carrier Code, chapter XIX/19			
2.1.3	States that LNG is liquefied natural gas from which impurities are removed			
2.1.4	States that the principal constituent of LNG is methane			
2.2	**LNG properties**			
	• states of aggregation			
	• boiling point			
	• vapour pressure /temperature relationship			
	• liquid density			
	• vapour density			
	• vapour density			
	• flashpoint			
	• flammability			
	• flammable (explosive) range			
	• auto ignition temperature			
	• reactivity			
	• toxicity			
	• threshold limit value (TLV)			
	• control of boil off			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
2.3	**Hazards from LNG**			
2.3.1	States that LNG are transported at or close to their boiling point			
2.3.2	States that the boiling temperatures is -163 deg C for methane			
2.3.3	State that low temperatures can cause cold burns which may damage skin and tissue when in direct contact with cold liquid or vapour			
2.3.4	States that these low temperatures can cause brittle fracture if cold cargo comes in sudden contact with metals			
2.3.5	States that LNG cargoes gives off vapour readily because they are boiling			
2.3.6	States that cargo vapour can be flammable, toxic or both			
2.3.7	States that cargo vapour in sufficient concentration will exclude oxygen and may cause asphyxiation whether the vapour is toxic or not			
2.3.8	States that an explosive mixture may be produced when most cargo vapours are mixed with air			
2.3.9	States that the vapours from some LNG cargoes are toxic by inhalation			
2.3.10	States that some toxic gases are carried in gas tankers can be absorbed into the body through the skin			
2.3.11	States that some gases are caustic and can damage human tissue			
2.3.12	States that some cargoes in LNG tankers are reactive and may react in a number of ways			
2.3.13	States that necessary information for each cargo on board must be available on cargo data sheets			
2.3.14	States that all personnel on board should use the cargo data sheets to acquaint themselves with the characteristics of each cargo to be loaded			
3	**Cargo Containment Systems**	R2, R3, R4, R5, R8	T1,T5, B1, B2, B8, B13	A1, A2
3.1	**Independent tanks**			
3.1.1	States that independent tanks are completely self supporting and neither form part of the ship's hull not contribute to the hull strength			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
3.1.2	States that there are three different types of independent tanks for gas carriers: types A, B & C			
3.1.3	Describes generally a self supporting prismatic tank(type A)			
3.1.4	Describes generally a self supporting spherical tank(type B)			
3.1.5	Describes generally a self supporting cylindrical tank (type C)			
3.2	**Membrane Tanks, and its design principles**			
3.2.1	Describes generally a membrane tank and its design principles. Describes the tank support, cargo tank and cargo space protection devices			
3.2.2	**Semi Membrane tanks, Integral tanks & Internal Insulation tanks** Describes generally a semi membrane tank and its design principles			
3.3	**Describes generally Integral tanks & Internal Insulation tanks**			
4	**The Liquefied Natural Gas (LNG) tanker**	R1, R2, R3, R4,R5, R8	T1, T2, T3, T4, T5, B1, B2, B7, B8, B15	
4.1	**Layout of a LNG tanker**			
4.1.1	States that the cargo area is segregated from other parts of the ship			
4.1.2	States that cargo handling systems are completely separated from accommodation spaces, machinery spaces and other gas safe area			
4.1.3	States that gas dangerous spaces and zones are spaces and zones within the cargo area which are not equipped with approved arrangements to ensure that their atmosphere is maintained in a safe condition at all times and which are, therefore, likely to contain cargo vapours			
4.1.4	States that a gas safe space is a space other than a gas dangerous space			
4.1.5	States that air intakes for accommodation and engine room have to be at a minimum distance from ventilation outlets from gas dangerous spaces			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
4.1.6	States that access to accommodation or engine room has to be at a minimum distance from the forward division of the accommodation			
4.1.7	States that access from a gas dangerous zone on the open weather deck to a gas safe space is arranged through an airlock			
4.1.8	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			
4.1.9	States that an audible and visual alarm system gives a warning on both sides of the airlock when one door is moved from the closed position			
4.1.10	States that gas safe spaces within the cargo area have positive pressure ventilation			
4.1.11	States that when this over pressure is lost, all electrical equipment that is not of a certified safe type should be de energised			
4.1.12	States that use of segregation, separation and airlocks are fundamental to the safety of the LNG tanker			
4.2	**Survival capability and tank location**			
4.2.1	States that the IMO codes divide gas tankers into four categories, ship types 1G, 2G, 2PG, 3G, which reflect the hazard rating of the cargoes to be carried			
4.2.2	States that a type 1G ship is a gas tanker intended for the carriage of products considered to present the greatest overall hazards, and types 2G, 2PG and 3G are intended for products of progressively lesser hazards			
4.2.3	States that type 1G ships are required for highly hazardous cargoes such as chlorine			
4.2.4	States that the most common cargoes, such as LNG, must be carried in type 2G			
4.2.5	States that the background for IMO's grouping of ship types is the ship's capability to survive damage caused by collision or stranding and the capability of tanks to contain the cargo after sustaining such damage			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5	**Cargo Equipment and Instrumentation**	R2, R3, R4, R5, R8	T1, T2, T3, T4, T5, B3, B7, B11, B13, B14, B15	A1, A2
5.1	**Tanks, piping and valves**			
5.1.1	describes generally the cargo piping arrangement			
5.1.2	states that the construction materials in tanks, piping and equipment containing cargo liquid and vapour should be resistant to the cargo			
5.1.3	states that the resistance to the cargo is dictated by the minimum service temperature and the compatibility with the cargo carried			
5.1.4	states that all connections and personal access to a cargo tank have to be arranged through the cargo tank dome area			
5.1.5	lists commonly found fixed piping arrangements in a cargo tanks, such as:			
	• sample tubes			
	• vapour line			
	• condensate line			
	• stripping line/puddle heat line			
	• discharge line			
	• liquid line			
	• upper purge line/spray line			
	• ventilation line			
5.1.6	states that there are usually three sample tubes at different levels in the cargo tank			
5.1.7	states that the monitoring of tank atmosphere and cargo sampling can be done through the sample tubes			
5.1.8	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 cross-over			
5.1.9	states that the main purpose of the condensate line is to lead reliquefied gas from the reliquefaction plant to the cargo tank			
5.1.10	states that the stripping line is used for removal of remaining liquid cargo from the pump sump by means of pressure			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5.1.11	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 liquid cargo			
5.1.12	states that the main purpose of the discharge line is to lead the liquid cargo from the cargo tank to the crossover by means of the cargo pump			
5.1.13	states that the main purpose of the liquid line is to lead the liquid cargo from shore to the cargo tank via the crossover			
5.1.14	states that the purpose of the upper purge line is to lead different types of ventilation gases into or from the cargo tank			
5.1.15	states that the main purpose of the spray line is to spray liquid cargo into the tank during cool-down of the cargo tank			
5.1.16	states that the main purpose of the ventilation line is to lead vapour from the cargo tank safety relief valve to the vent outlet			
5.1.17	states that a cargo tank should have shutoff valves located as close to the tank as practicable for all liquid and vapour connections, with the exception of pressure-relief valves and liquid level gauging devices			
5.1.18	states that the IMO establishes rules for place, type and number of valves in a cargo piping system			
5.1.19	states that the IMO regulations require remotely operated emergency shutdown valves in the cargo piping system			
5.2	**Pressure-relief and vacuum-protection system**			
5.2.1	describes generally the pressure-relief piping system			
5.2.2	states that all cargo tanks should be provided with a pressure a relief system			
5.2.3	states that IMO has established rules for vacuum protection of cargo tanks			
5.2.4	states that all equipment and piping which may be isolated when full of liquid should be provided with a pressure-relief valve			
5.2.5	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			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5.3	**Pumps and unloading systems (Cargo pumps & Spray pumps)**			
5.3.1	describes generally the unloading system			
5.3.2	states that the main cargo pumps fitted aboard liquefied gas tankers are of the centrifugal type			
5.3.3	states that these cargo pumps are either submerged or deep well pumps			
5.3.4	states that on some LNG gas tankers the cargo pumps may be mounted on deck			
5.3.5	states that in addition to the main unloading pumps there are arrangements for alternative unloading			
5.3.6	states that alternative unloading can be done by means of vapour pressure, replaceable pump or eductor			
5.3.7	describes generally the operating principle of a centrifugal pump			
5.3.8	describes generally safe centrifugal pump handling			
5.3.9	explains the Operations of fully submerged pumps used on LNG Tankers			
5.4	**Control of boil-off gas (BOG)**			
5.4.1	states that heat is always transferred from a warmer area to a relatively cooler area			
5.4.2	states that the temperature of the cargo will increase as long as the cargo is relatively cooler than the environment			
5.4.3	states that when the temperature of the cargo increases, the pressure in the cargo tank increases			
5.4.4	states that because of the transmission of heat to the cargo means must be provided to control the vapour pressure in the cargo tanks			
5.4.5	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			
	• cooling the liquid cargo in a heat exchanger			

Learning Objectives Knowledge, understanding and proficiency		IMO Reference	Textbooks, Bibliography	Teaching Aid
	• cooling the shell of the cargo tank and thereby the cargo			
5.4.6	describes generally a simplified vapour-handling system for LNG boil-off			
5.4.7	describes generally a simplified single-stage direct reliquefaction cycle			
5.4.8	describes generally a simplified cascade reliquefaction cycle			
5.4.9	describes generally a simplified indirect reliquefaction cycle			
5.4.10	states the differences between compressors used on LNG Tankers and those used on other Gas Carriers			
5.5	**Low Duty & High Duty Compressors, Low Duties & High Duties Heaters**			
5.5.1	describes generally the operating principle of a reciprocating compressor			
5.5.2	describes generally the operating principle of a screw compressor			
5.5.3	states that the reciprocating and screw compressors used on board gas carriers are commonly of the oil-free type			
5.5.4	describes generally the different type of cargo compressor and their operations on board LNG carriers when compared with other Gas carriers			
5.5.5	states that seawater is commonly used as a heating medium for the cargo heater			
5.5.6	states that it is necessary to run the booster pump when discharging to a pressurized shore tank			
5.5.7	states that a vaporizer is used to maintain the pressure in the cargo tank during discharging			
5.5.8	states that seawater and steam are each commonly used as the heating medium for vaporisers			
5.6	**LNG vapourizers & Forcing Vapourizers**			
5.6.1	LNG vaporiser is used for purging inert gas from the cargo tanks prior cooling down and Forcing vaporiser is used for producing LNG vapour to be sent to the main boiler as fuel gas			
5.6.2	The produced LNG vapour is added to natural boil-off gas in Forcing Vaporisers			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5.6.3	During cargo un-loading, if vapour return from the shore is not available to the cargo tanks, the LNG Vapourisers can be used to produce vapour by bleeding LNG from the main line and supplying it to the cargo tanks			
5.6.4	In the vent of both cargo pumps fail in a cargo tank, emergency discharge by pressurizing cargo tank using LNG vapouriser			
5.7	**Inert gas Generator and Nitrogen Generator, Nitrogen pressurization and purge**			
5.7.1	Defines 'inert gas' and lists generally the IMO requirements concerning inerting and the production of inert gas on board			
5.7.2	Describes different methods of producing inert gas			
5.7.3	States that the composition of inert gas produced by an inert gas generator is:			
	• approximately 84% nitrogen			
	• approximately 0.5% oxygen			
	• approximately 15% carbon dioxide			
	• approximately 0.5% carbon monoxide, oxides of nitrogen and sulphur dioxide			
5.7.4	Describes an inert gas generator system			
5.7.5	Describes the different factors which influence the content of soot in inert gas from an inert gas generator			
5.7.6	Describes the limitations of using inert gas produced by an inert gas generator			
5.7.7	Describes and explains different methods of drying inert gas			
5.8	**Instrumentation, Level Gauging System & Integrated Automated System (IAS)**			
5.8.1	states that all electrical equipments installed or used in gas-dangerous space or zones should be approved for operation in a flammable atmosphere			
5.8.2	states that each cargo tank is provided with means for indicating level, pressure and temperature of the cargo			
5.8.3	states that the liquid level in cargo tanks is commonly measured by means of float gauges			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5.8.4	describes generally a float gauge			
5.8.5	states that each cargo tank is fitted with high level alarms			
5.8.6	states that the purpose of high-level alarms is to prevent overflow of cargo tanks			
5.8.7	states that every gas tanker has a fixed gas-detection system			
5.8.8	states that the fixed gas-detection system's alarm is activate when the vapour concentration reaches 30% of the lower explosive limit (LEL)			
5.8.9	states that gas sampling and analysing from different parts of the ship is done continuously and sequentially			
5.8.10	describes a simplified fixed gas-detection system			
5.8.11	states that the fixed gas-detector gives an automatically controlled protection against concentrations of flammable gas that are too high, and that it is thereby fundamental to the safety of the liquefied Natural gas tanker			
5.8.12	Describes the principle of operation of IAS			
5.8.13	States the purpose and operation of IAS			
5.9	**Custody Transfer System (CTS), Dual fuel System & High Voltage System**			
5.9.1	Describes the principle of operation of CTS			
5.9.2	States the purpose and operation of CTS			
5.9.3	States the preloading and completion of loading procedures using CTS			
5.9.4	States that CTS is designed to provide continuous, maintenance free and reliable accuracy			
5.9.5	Describes the principle of operation of Dual fuel System			
5.9.6	States the purpose and operation of Dual fuel System			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
5.9.7	Describes the principle of operation of High Voltage System			
5.9.8	States the purpose and operation of High Voltage System			
6	**Tank Environmental Control**	R2, R7	T1, T5	A1, A2, A3
6.1	**Methods of control, Hold space and Cargo tank drying, Nitrogen purging**			
6.1.1	Explains that environmental control within cargo tanks and hold spaces is achieved by means of piping systems provided for this purpose			
6.1.2	explains that when a gas tanker is to change cargo, the following procedures for environmental control in cargo tanks are normally carried out:			
	• warming up			
	• inerting			
	• gas-freeing/aerating			
	• purging			
	• cooling down			
6.1.3	states that sampling tubes, pressure sensors and temperature sensors are provided in the tanks to ensure that procedures are correctly carried out			
6.2	**warming up**			
6.2.1	states that the warming up of cargo tanks is necessary for the following reasons:			
-	• vaporizing of liquid cargo residues in pumps sump after discharging/stripping			
-	• warming up of tank's shell prior to inerting and gas-freeing/aerating in order to avoid condensation and the formation of ice			
6.2.2	states that warming up is done by drawing cold vapour from the tip of cargo tanks to the heaters, where the vapour is heated and led back to the pump sump or to the bottom of the tanks			
6.2.3	states that during the warming up procedure the temperature and pressure readings must be kept under observation			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
6.3	**Inerting, Gas freeing/Aerating**			
6.3.1	states that the purpose of inerting is primarily to prevent flammable vapour/air mixtures in tanks and piping			
6.3.2	states that inerting is done by replacing cargo vapours with an inert gas until the percentage concentration of oxygen is lowered			
6.3.3	states that inert gas used on gas tankers is either nitrogen or inert gas produced in the ship's inert-gas plant			
6.3.4	state that the correct inerting procedure is ensured by regular checks of the tank atmosphere			
6.3.5	states that atmosphere checks are done by measuring the percentage of oxygen through the sampling tubes			
6.3.6	states that the atmosphere in a inerted tank or void space is safe with regard to fire hazard but dangerous with regard to health			
6.3.7	states that the purpose of gas-freeing or aerating is to replace residues of inert gas and cargo vapour with air			
6.3.8	states that gas-freeing is done by introducing air into the inerted tanks and piping			
6.3.9	states that correct gas-freeing operations are verified by regular checks of the tank atmosphere			
6.3.10	states that atmosphere checks are done by measuring the percentage of oxygen content and values of ppm of vapours from cargo or inert gas			
6.3.11	states that an atmosphere in tanks or void spaces is gas-free only when the oxygen content is 21% by volume and when no vapours from cargoes or inert gas can be measured in values above their TLV			
6.4	**Purging Inert Gas, Gassing up of Cargo System, Inerting of Cargo System**			
6.4.1	states that the purpose of purging is to prepare cargo tanks and piping to receive cargo			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
6.4.2	states that purging is done to reduce oxygen content and humidity in a tank by introducing nitrogen or inert gas from the ship's inert-gas plant			
6.4.3	states that in some cases purging with cargo vapours from the cargo to be loaded is also required after purging with inert gas or nitrogen			
6.4.4	states that regular checks of the tank atmosphere are carried out during the purging operation			
6.4.5	states that atmosphere checks are done by measuring percentage of oxygen and by reading the dew point temperature			
6.5	**Cooling down Cargo system, Ship shore Preparation & Manifold Connection, Loading, Discharging & Emergency Discharge**			
6.5.1	States that the reason for cooling down cargo tanks and piping prior to loading is to prevent undue thermal stresses			
6.5.2	states that cool-down is done by introducing cargo liquid slowly into the tank via the cooling-down line or the spray-line system			
6.5.3	states that the liquid cargo will tend to vaporize when introduced into a warmer tank, thus taking heat from the tank atmosphere and the tank shell			
6.5.4	states that the correct cool-down operation is verified by temperature readings which are made possible by temperature sensors installed in tank and/or the tank shell			
6.5.5	states that the cooling down in completed when the temperature of the tank atmosphere and shell is acceptably low in relation to the temperature of the cargo to be loaded			
6.5.6	states the procedure of loading, discharging and emergency discharge and precautions requires to be taken for manifold connection			
6.6	**Loaded and Ballast Passage**			
6.6.1	Lists the procedures during a loaded passage and during a ballast passage			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
7	**Safety Precautions and Measures**	R2, R8	T1, T3, T5, B6,B10,B15, B18,B21	A1, A2,A3
7.1	**Tank atmosphere evaluation**			
7.1.1	lists circumstances when the atmosphere in cargo tanks and enclosed spaces must be tested as:			
	prior to entry by personnel, with or without personal safety equipment			
	during inerting, gas-freeing and purging operations			
	to establish a gas-free condition prior to repair work, shipyard entry or dry-docking			
	for equality control before changing cargo			
7.1.2	states that gas measurements are the only way to get correct information about the composition of the atmosphere in a tank			
7.1.3	States that the essential information in evaluating the atmosphere in a tank includes:			
	• Constitute gases			
	• Flammability			
	• Toxicity/oxygen deficiency			
	• Reactivity			
7.1.4	states that any atmosphere in tanks or enclosed spaces is to be considered dangerous unless proper checks prove otherwise			
7.1.5	states that gas–measuring equipments of the evaluation of a tank atmosphere must be available on board			
7.1.6	States the importance of taking measurements of the atmospheres at several positions within a tank			
7.1.7	States that only a tank or space that has been declared gas–free can be entered by personnel without breathing apparatus and protective clothing			
7.1.8	states that a gas-free tank or space cannot be considered to remain gas-free unless regular measurement of the atmosphere prove that it is so			
7.1.9	lists the different types of gas measuring equipment common on board gas tankers			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
7.2	**Fire prevention**			
7.2.1	lists the three elements necessary to cause combustion or a fire:			
	• Flammable material			
	• Oxygen			
	• Source of ignition			
7.2.2	states that these three elements may be represented by the sides of a triangle			
7.2.3	states that the complete triangle represents a fir or explosion			
7.2.4	states that the way to prevent fire is to prevent the formation of such a triangle			
7.2.5	states that the removal of any one side of the triangle will extinguish the fire			
7.2.6	states that two sides of the triangle are normally removed on board gas tankers for safe operation in tanks and on decks			
7.2.7	states that oxygen and ignition sources must be eliminated in cargo tanks where flammable material is present in the form of cargo vapours			
7.2.8	states that cargo vapours and ignition sources must be eliminated on deck and in other gas-dangerous zones where oxygen is present			
7.2.9	lists precaution against fire as:			
	• Prohibiting smoking except in designated places			
	• Prohibiting any form of naked light			
	• Prohibiting matches and lighters outside accommodation			
	• Requiring only approved types of fixed electrical equipment			
	• Requiring only approved types of portable electrical equipment as hand lamps, radios, etc.			
	• Maintaining over pressure in gas-safe spaces inside cargo area			
	• Keeping accommodation doors, windows and portholes closed			
	• Stopping all cargo operations if an electrical storm is taking place			
	• Keeping close control over the condition and use of tools and equipment			
	• Keeping closed control and ensuring safe conditions if hot work, hammering, chipping or sandblastings is to be carried out			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
	• Keeping the bonding in hoses and line systems mechanically and electricity sound			
	• Avoiding spills of flammable liquid and releases of cargo vapour			
7.2.10	lists dangers from:			
	• Accumulation of oily rags, waste and other flammable materials			
	• Static electricity			
7.3	**Pollution Prevention**			
7.3.1	defines pollutions as inconvenience or damage, caused by human activities, to humans, animals, plants and to our environment as a whole, by introducing hydrocarbon compounds into the air, into the water or onto the land			
7.3.2	states that all operations on board involving cargo, ballast and bunkers should be done in accordance with the applicable pollution regulations			
7.3.3	States that during cargo-transfer operations care should be taken to avoid released of cargo liquid and/or vapours			
7.3.4	states that the preparation for cargo transfer includes procedures to be followed to prevent pollution of air and of water			
7.3.5	States that these procedure includes:			
	• 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			
7.3.6	states that personnel on watch should be present at all times during cargo transfer operations ,and should regularly carry out the inspection mentioned under 7.3.5			
7.4	**Protection and safety equipment**			
7.4.1	states that for purposes of emergency escape there must be respiratory and eye protection equipment for every person on board			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
7.4.2	states that for the protection of personnel engaged in loading and discharging operations ,there must be suitable protective clothing on board			
7.4.3	states that for entering gas – filled spaces there must be complete sets of safety equipment on board			
7.4.4	states that all equipment for personnel protection must be kept in clearly marked lockers			
7.4.5	states that decontamination showers and eyewash must be available in certain location on deck			
7.4.6	states that on all gas tankers a water spray system for cooling ,fire prevention and crew protection must be installed to cover certain deck areas, superstructure and accommodation			
7.4.7	states that protective clothing should be worn by all personnel when involved in cargo operations			
7.4.8	states that stretchers and medical first-aid equipment must be provided on board			
7.4.9	states that gas-measuring equipment for atmosphere evaluation must be provided on board			
7.4.10	demonstrates the use of:			
	• filter type respiratory protection for emergency escape			
	• self-contained breathing apparatus			
	• protective clothing			
	• a complete set of safety equipment			
	• oxygen resuscitator			
	• gas indicator tubes			
	• portable gas detector			
	• portable combustible –gas indicator			
	• portable oxygen meter			
7.5	**Accommodation**			
7.5.1	states that the accommodation is located outside the cargo area			
7.5.2	States that superstructure for accommodation are designed to minimize the possibility of entry of cargo vapour and that this design feature should not be impaired in any way			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
7.5.3	states that no entrances, air inlets or openings to the accommodation are facing the cargo area			
7.5.4	states that accommodation portholes and windows facing the cargo area and those within a certain distance from the cargo area, are of the non-opening type			
7.5.5	states that all doors, portholes or windows in accommodation should be kept closed during cargo operations			
7.5.6	states that mechanical ventilation and air conditioning units supply air to accommodation spaces			
7.5.7	states that all ventilation system should be stopped or operated on closed cycle if there is any possibility of cargo vapour being drawn into accommodation spaces			
8	**Ship/Shore Interface**	R2	T1,T3, T5, B9, B15	A1,A2
8.1.1	states that safe conditions alongside a terminal are enhanced by safety regulations, good communication and the best possible co-operation between ship and terminal			
8.1.2	lists safety precautions and procedures for personnel on watch prior to and during cargo transfer with regard to:			
	• Communication			
	• Cargo information			
	• Moorings			
	• Emergency towing–off wires			
	• Gangways or accommodation ladders			
	• Fire–fighting equipment			
	• Lighting			
	• Unauthorised persons			
	• Persons smoking, drunk or drugged			
	• Sign and notices			
	• Craft alongside			
	• Scuppers			
	• Weathers precautions			
	• Connection/disconnection of cargo hoses			
	• Safety equipment and protective clothing			
	• Doors and portholes			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
9	**Emergency Operations**	R2, R9	T1,T3,T5	A1,A2
9.1	**Organizational Structure**			
9.1.1	states that the planning for and the implementation of emergency procedures requires and emergency organization			
9.1.2	states that on most ships the basic structure of the emergency organization consists of four elements:			
	• emergency command centre			
	• emergency party			
	• back up emergency party			
	• engineers group or technical team			
9.1.3	states that general composition and the task of the emergency command centre			
9.1.4	states the general composition and the task of the emergency party			
9.1.5	states the general composition and task of the back up emergency party			
9.1.6	states the general composition and the task of the engineers group			
9.1.7	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			
9.2	**Alarms**			
9.2.1	states that fire alarms signals or general alarm signals are given in case of			
	• fire			
	• collision			
	• grounding			
	• man overboard			
	• hoses burst			
	• major spillage of cargo liquid or escape of vapour			
	• other emergency situation which call for emergency actions			
9.2.2	states that other alarm signals are given in case of:			
	• high concentration of toxic or flammable vapours			
	• Unacceptable conditions in cargo tanks or cargo systems			
	• Unacceptable conditions in auxiliary cargo system			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
	• system failures in engine – room or machinery spaces			
	• system failures in cargo plant and auxiliary system			
9.2.3	states that ship's muster list and emergency instructions specify details of the emergency alarm signals			
9.2.4	states that all personnel on board should be able to identify the different alarm signals			
9.2.5	states that all crew members should be familiar with the emergency plan and act according to the plan when the alarm is raised			
9.2.6	states that any person who discover an emergency should raise the alarm and pass on information as quickly as possible			
9.3	**Emergency procedures (Cargo tank leak) -**			
9.3.1	states that the ship's muster lists and emergency instruction specify action to be taken by all crew members and officers in case of an emergency			
9.3.2	state that all personnel should be familiar with the emergency instruction and act to the instruction when the alarm is raised			
9.3.3	states that the ship's safety plan and fire control plan specify details and location of all equipment for emergency use			
9.3.4	states that all personnel should know the location of emergency equipment and be familiar with its use			
9.3.5	states that it is essential that personnel are properly trained for emergency operations			
9.3.6	state that all equipment which may be used in an emergency must be maintained in good order and be ready for use at all times			
9.3.7	list basic emergency action to be taken in case of:			
	• fire			
	• collision			
	• grounding			
	• bursting of a cargo hose, cargo tank leak			
	• accident involving personnel			

Learning Objectives Knowledge, understanding and proficiency		**IMO Reference**	**Textbooks, Bibliography**	**Teaching Aid**
9.3.8	lists fire-extinguisher media and explain their use			
9.3.9	states the emergency procedure for fighting a liquefied Natural gas fire			
9.3.10	State that emergency procedures for accidents involving cargo on board are given in the ICS cargo data sheets			
9.4	**First-Aid treatment**	R6	T1	A1,A2
9.4.1	states that first-aid procedure for accidents involving cargo are given in the ICS cargo data sheets			
9.4.2	states that all personnel should be familiar with the first aid procedure set out in the data sheet for the cargo carried			
9.4.3	states that the emergency showers should be used in the event of spillage of cargo liquid in eyes or on skin			
9.4.4	states that correct treatment for most cargoes in washing within water at least 15 minutes and removing affected clothing			
9.4.5	States that if frostbites has occurred this should be treated by immersion in lukewarm water			
9.4.6	states that for symptoms of vapours exposure the treatment for most cargoes is to:			
	• remove victim to fresh air			
	• give artificial resuscitation if breathing has stopped or is weak/irregular			
9.4.7	states that all personnel should be instructed and trained in the technique of mouth-to mouth resuscitation and basic first-aid treatment			
10	**Assessment/Discussion**	STCW Code Reg. V/1		A3
10.1	To be arranged by course instructor			

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 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.

Preparation and planning constitute a major contribution to effective presentation of the course.

The instructor 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 liquefied natural gas tankers as specified in paragraph 1.2 of regulation V/1 of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1995.

The material covers the following topics:

1 Introduction

2 Properties and Hazards of LNG

3 Cargo Containment System

4 The LNG Tanker

5 Cargo Equipments and Instrumentation

6 Tank Environment Control

7 Safety Precautions and Measures

8 Ship/Shore Interface

9 Emergency Operations

10 Assessment/Discussion

The texts used as references throughout the course are given in Part A: Course framework.

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.

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

Topics marked with an asterisk (*) could be better taught using a simulator. IMO Model Course "Liquid Cargo Handling Simulator – LNG" provides detailed training programme for LNG Tanker operations using specially created cargo handling exercises on a simulator.

Guidance Notes

1. Introduction (2.5 hrs)

This section covers an introduction to the course, explains the sources and production of liquefied natural gas. The development of natural gas transport by sea, the type of cargo and the conditions of carriage. It also describes the different types of ships used for transporting liquefied natural gas.

1.1 The Course (0.5 hrs)

This is a brief explanation of the course, its background and its purpose. It should include a presentation of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended in 1995 (the 1995 STCW Convention), and the mandatory minimum requirements for training set out in the Convention should be explained and discussed.

Regulation V/1 of the STCW Convention as amended in 1995 (R2) provides the necessary text on which to base the lesson. The block diagram on page 6 of this course may be used to give the trainees a general view of the requirements for training and qualifications of personnel on liquefied natural gas tankers.

At the end of this lesson, a lesson plan with a list of topics should be presented. This will give the trainees a view of the course content and the course objectives.

During the course, liquefied gas tanker terminology should be used and, when necessary, explained. The trainees should also be issued with a "dictionary of terms" for their own reference. The list of trade terms given in textbook T1 can be used for this purpose. Commonly used abbreviation in the LNG Trade are given on section 10.

1.2 Rules and Regulations (0.5 hrs)

This section introduces trainees to the international and national rules and regulations affecting shipping of gas. Institutions implementing this course should introduce their national requirements and regulations as necessary.

1.3 International and national codes and regulations

This section should include a presentation of international requirements and regulations and related national rules. The syllabus is self-explanatory with regard to international regulations, but the trainees must also acquire the necessary knowledge of national rules and regulations.

References R1, R2, R7 and R8 should be made available to the trainees for this lecture.

1.4 Gas Carrier Codes

The Gas Carrier Codes comprise:

- ❑ International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (Ref. R5)
- ❑ Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (Ref. R4)
- ❑ Code for Existing Ships carrying Liquefied Gases in Bulk (Ref. R3)

The purpose of this lesson is to familiarize trainees with all aspects of the Codes, including their purpose, philosophy, layout and application. Related national codes and regulations should also be presented.

The syllabus provides the information on which to base the lecture. References R3, R4 and R5 should be made available to the trainees for this lecture. Figure 7 may be used for introducing chapter 19 of the Codes.

Instructors should note amendments to the IGC Code adopted by MSC Resolutions MSC.32(63) and MSC.59(67) which entered in to force on 1 July 1998. These amendments include increased loading limits for type C tanks without the additional pressure relieving system if the cargo vent system is shown to be adequate using the guidelines developed by the IMO. Chapter 15, Filling limits for cargo tanks, has been revised with related amendment to Chapter 8, Cargo tank vent systems. Amendments in MSC.59(67) mainly replace expressions such as “satisfactory to the Administration” by requiring compliance with recognized standards’, which are defined.

Reference B8 describes how ship owners and ship masters can apply the new rules in practice.

1.5 Certification and surveys

This lecture should give the trainees a general view of surveys and certification of liquefied gas tankers. The lecture should cover both international and national certification.

Textbook T1, paragraph 3.7 provides text additional to that in the syllabus. Reference R1 provides regulations covering surveys and certification of ships in general, and reference R5 gives the surveys and certification regulations for liquefied gas tankers.

Forms of certificates for liquefied gas tanker should be presented to the trainees during this lecture.

2. Properties and Hazards of liquefied natural gases and their vapours (2.5 hours)

2.1 Types of Liquefied Gases

The purpose of this lecture is to familiarize the trainees with the basic chemical composition and properties of LNG. The instructor should start by describing the most common hydrocarbon molecules and pointing out the difference between the molecules of saturated hydrocarbons, of unsaturated hydrocarbons and of LNG. Chemical reactions and ways of preventing them should be explained in relation to the different molecular structures, and reference should be made to ICS Cargo Data Sheets for common cargoes.

2.2 Properties of single liquids

The purpose here is to explain physical properties of cargo liquids and their vapours so that the trainees can read and understand physical data given in the ICS Cargo Data Sheets and make use of diagrams for pressure, temperature and density of LNG cargo.

2.3 Hazards

This section of the course deals with the hazards of liquefied natural gas in relation to health, reactivity and flammability.

2.4 Health hazards

During this lecture the trainees should be introduced to the health hazards of liquefied natural gas cargoes. After the lesson, trainees should be able to understand the health data given in the Cargo Data Sheets for methane cargo carried on LNG tankers, and should be familiar with the medical terms used.

The ways in which liquefied natural gases and their vapours may be toxic, and the acute and chronic effects following exposure to toxic cargoes, should be made clear. Inert gas, which is commonly used on gas tankers, also have toxic properties and should be discussed in this connection. The fact that combustion or fire may produce toxic gases, and that poisonous fumes may be emitted from burning cargoes or materials, should be explained. This section should also cover the hazards of oxygen deficiency caused by the presence of gas in closed spaces.

2.5 Reactivity

This lecture deals with the reactivity of liquefied gas cargoes. The trainees should be made familiar with the ways of cargo reactions and how reactions are avoided. The lecture concerning reactivity should cover an explanation of the process and the terms polymerization, hydrate formation and peroxide formation.

The “reactivity data” column of the Cargo Data Sheets in appendix 1 of textbook T3 should be referred to during this lecture in order to relate the aspects of reactivity to methane cargoes transported on LNG tankers.

2.6 Flammability and explosion hazards

All liquefied gas cargoes, with the exception of chlorine, are flammable, and their vapours may form flammable mixtures. This fact should be the basis of this lecture, and the trainees should be given a thorough explanation of the aspects of flammability and explosion. The main object of this lesson is that the trainees should be able to fully understand the fire and explosion data given for LNG and be able to use these data for the safe handling of LNG and its vapours.

3. Ship Types and Arrangements (1.5 hrs)

The essential message in this lecture is that the use of segregation, separation and airlocks is fundamental to the safety of gas tankers. The instructor should begin by explaining that the cargo area has to be segregated from other parts of the ship and that it is divided into defined gas-dangerous and gas-safe spaces and zones. This division makes it easier to establish rules for construction and equipment requirements within the different parts of a gas tanker and, thereby, increase the safety. The next step is to illustrate these terms with a sketch of a gas tanker (Figure 28) on which gas-dangerous spaces and zones are marked out.

Cargo containment

3.1 Independent Tanks, Moss Rosenberg Tanks

3.2 Membrane Tanks

3.3 Semi membrane, Integral & Internal Insulation tanks

The purpose of this lecture is to describe the different cargo-containment systems on liquefied natural gas tankers and to explain factors that have to be taken into consideration when designing these systems. It should also include a short briefing on the IMO requirements concerning secondary barriers.

4. Ship types and survival capability (1.5 hrs)

4.1 LNG Ship types

4.2 General Layout of LNG tankers

4.3 Survival capabilities and tank locations

The instructor should start by explaining the reasons for IMO's grouping of natural gas tankers and the factors resulting in this grouping.

5. Cargo Equipment and Instrumentation (6.5 hrs)

5.1 LNG vaporisers and Forcing vaporisers LNG vaporisers and Forcing vaporisers (0.5 hrs)

LNG vaporiser is used for purging inert gas from the cargo tanks prior cooling down and Forcing vaporiser is used for producing LNG vapour to be sent to the main boiler as fuel gas.

The produced LNG vapour is added to natural boil-off gas in Forcing Vaporisers.

During cargo un-loading, if vapour return from the shore is not available to the cargo tanks, the LNG Vaporisers can be used to produce vapour by bleeding LNG from the main line and supplying it to the cargo tanks.

In the event of both cargo pumps failing in a cargo tank, emergency discharge is possible by pressurising cargo tank using LNG vaporiser.

5.2 Inert gas Generator and Nitrogen Generator, Nitrogen pressurization and purge (1.0 hour)

The purpose of this lecture is to explain 'inert gas' and lists generally the IMO requirements concerning inerting and the production of inert gas on board, giving different methods of producing inert gas.

The composition of inert gas produced by an inert gas generator is:

- approximately 84% nitrogen
- approximately 0.5% oxygen
- approximately 15% carbon dioxide
- approximately 0.5% carbon monoxide, oxides of nitrogen and sulphur dioxide.

With the help of Diagrams listed in part D of this model course describe an inert gas generator system and give the different factors which influence the contents in inert gas from an inert gas generator and describe the limitations of using inert gas produced by an inert gas generator.

It is important to also explain the different methods of drying inert gas.

LNG vaporiser is used for purging inert gas from the cargo tanks prior cooling down and Forcing vaporiser is used for producing LNG vapour to be sent to the main boiler as fuel gas.

The produced LNG vapour is added to natural boil-off gas in Forcing Vaporisers.

During cargo un-loading, if vapour return from the shore is not available to the cargo tanks, the LNG Vapourisers can be used to produce vapour by bleeding LNG from the main line and supplying it to the cargo tanks.

In the event of both cargo pumps failing in a cargo tank, emergency discharge is possible only on those ships which have an adjustable MARVS by pressurising cargo tank with utmost care controlling the pressures using LNG vapouriser. On the membrane tanks the emergency unloading may be possible by having separate emergency pumps and arrangements for emergency discharge by connecting these pumps into separate fittings on deck having Nitrogen barrier punch arrangements.

5.3 Instrumentation (1.0 hours)

5.4 Level Gauging System (0.5 hour)

The gauging system could be of:

Float type
Capacitances type
Radar type
Sighting board type

Describe each type give the principle and method of operations, likely problems and their maintenance procedures.

5.5 Integrated Automation System (IAS) (0.5 hour)

The purpose of this lecture is to explain the Design Operator interphase, It is important at this point to tell the students about the Local Operations where a number of Input/Output interphase can affect the operations of the entire ship. Backup system is available to make the system fail safe and that there is a requirement for maintenance and testing.

5.6 Custody Transfer, Dual Fuel systems, High voltage (1 hour)

Custody transfer system (CTS)

The purpose of this lecture is to explain the purpose and principle of operation of CTS, preloading procedures and completion of loading.

High Voltage System

The purpose of this lecture is to explain that High Voltage Systems have specific control procedures. Explain Switchgear Transformer Operations, and specify the requirements of isolation dead giving details of earthing procedures and its importance. Also explain Generator and Motor maintenance and testing procedures.

Dual Fuel Systems

The purpose of this lecture is to introduce the principle of the new propulsion dual fuel systems, it is important to state that as the prices of LNG are increasing it is more economical for the shipper to reliquify the LNG Vapour rather than consume it as fuel but as an additional means of the intensified cooling requirements of LNG, it would be best to have a dual-fuel system.

6. Tank Environmental Control (5.5 hours)

This section deals with the operational safety aspects of a liquefied natural gas tanker. The topics dealt with are evaluation of tank atmosphere.

6.1 Hold Space and Cargo Tank Drying, Nitrogen Purging

Air ingress into the cargo tanks during routine inspections/dry-docking. Ice formation, corrosion effects due to the pressure of humid air in the cargo tank. Dew point of dry air produced in IGG - Introduction to the cargo tanks for purging operations.

Purging and inerting of cargo tanks/hold space to prevent possibility of flammable air/LNG mixture safe procedure for inerting.

6.2 Warming up tanks

Warming up of tanks with the help of HD compressor, cargo heater upto +50^{0}C. Inerting the tanks, reduction of HC below 1.5%. Inerting from bottom line filling. Aeration and getting oxygen content more than 20% before dry docking.

6.3 Inerting, Gas freeing, Aerating

Requirement of emptying the cargo residues from the cargo tanks during the last discharge operation. Stripping line draining, adjustment of list/trim to effect maximum cargo discharge.

6.4 Purging IG, Gassing up, Inerting, cooling down of cargo systems, Ship shore Manifold connection

Here, the trainees should be instructed in how to carry out the different procedures prior to loading. While the detailed learning objectives indicate what the trainees must do, the instructor's experience in this field is essential for teaching this subject.

6.5 Loading and Discharging (2 hrs)

As with procedures for loading preparation and loading, procedures prior to unloading should be explained in detail to the trainees. Unloading can be done in different ways, the ship type, cargoes and terminal conditions being decisive in choosing which method is used. The learning objectives indicate the level of knowledge required.

Before starting, the pumps must be moved manually to ascertain that they are not frozen. Pumps have to be started with the valve on the pressure side almost closed, to prevent overload and pressure surge and to minimize accidents in the event of faulty lining up. When the pump is running normally, the pressure valve is opened and finally the discharge valve at the manifold is opened. This has to be done with care and caution.

In some ships, when starting to discharge, the piping is arranged for recirculating, i.e. pumping back to the ship's tank, before opening up the shore connection. This might prevent major pockets of vapour being forced through piping to shore tanks. It is advisable at first only to start one pump and to let it run smoothly before starting other pumps that will discharge to the same shore line.

When everything is functioning normally, the ampere reading is noted and the switch ammeter is set for 80% of the ampere reading, thus securing the correct function of the automatic stop when the pump is empty or is cavitating.

When the tank is empty the pump will stop and the valves are closed. If a remainder is left in the pump-well, the pump can be forced to run for about 10 seconds by pressing the starter; this may be done several times at short intervals. The discharge valve has to be closed immediately afterwards, to prevent liquid running back to the tank and forcing the pump to run backwards and cause damage to the motor.

Remember that the bearings in the discharge pipe in the tank are lubricated by the product. Bearings therefore must never get dry when the pump is running.

6.6 Loaded and Ballast Passage (2 hour)

The purpose of this lecture is to describe cargo condition maintenance on passage and in port. The trainees should be familiarized with the use of Figures 13 to determine cooling efficiency and cool-down time.

Some of the topics in this section may have been addressed by instructors and covered here in the context of cargo handling operations with the use of simulators.

7. Safety Precautions and Measures

7.1 Tank atmosphere evaluation

The essential message here is that tank atmosphere evaluation is fundamental to safe working conditions in any cargo tank or enclosed space. The lecture should be regarded as a theoretical session, followed by practical training, an exercise with gas-measuring equipment.

7.2 Fire prevention and Fire fighting

Although the trainees should have attended approved shore-based training in practice all fire fighting applicable to gas tankers, it is also useful to cover the topic theoretically at this stage of the course. Such lessons must be regarded as a supplement to the fire-fighting course, not as a substitute for it.

7.3 Pollution

Pollution from cargoes on liquefied natural gas tankers cannot be regarded as posing a major problem because of the nature of the cargoes. Stringent rules with regard to cargo containment, cargo vent systems, overflow control, etc., also minimize the risk of pollution during normal operations.

However, pollution should be defined and discussed. The ways in which cargo liquid or vapours can pollute should be stressed, as should the pollution hazard posed by the release of refrigerant gases from components of the cargo plant on board. As a rule, no cargo liquid or vapour should be released to the environment, and the applicable pollution regulations should be strictly followed.

The syllabus for this topic is self-explanatory, and provides sufficient background material for the lecture.

7.4 Protective and safety equipment (2.0 hrs)

The lecture should emphasize the hazards encountered on board and the equipment, procedures and constructional features that exist to control those hazards. This section should cover mainly the practical use of those types of protective and safety equipment which are common on gas tankers. The learning objective here is that the trainees should be able to use the actual equipment which is required by international and national regulations to be available on board.

The equipment listed in Part A of this course should be available for the trainees, and exercises should be carried out individually or in groups.

7.5 Accommodation (0.5 hrs)

The Lecture gives the student an understanding of safe and hazardous zones. It is essential for the trainees to understand the importance of a closed cycle ventilation system and the need for stopping ventilation if there is any possibility of vapours being drawn into the accommodation.

8. Ship/Shore Interface (1 hour)

Operating separately, a ship and the terminal cannot function safely or efficiently in port. It should be stressed that close co-operation between a ship and the terminal is essential for safe operation; the working procedures to ensure such co-operation should be explained and discussed.

9. Emergency Operations (3 hrs)

This section deals with procedures which are adopted to protect life and property in the event of accidents. It is important that after a briefing the ships safety management system and standard emergency procedures from ship manuals are discussed. State that there may be emergency operation which may not be stated in the manuals and short term strategy will need to be developed for these situations.

9.1 Organizational structure

The lecture gives the organizational structure of an emergency organization on board which requires all individual to play an active role in this planning exercise. Briefly describe various parties formed and then responsibilities.

9.2 Alarms

9.3 Emergency procedures (Leak from Cargo tank)

Various Standard emergencies are discussed, an exercise can be carried out that using standard emergency procedures. The standard emergency may be discussed are:

1. Grounding
2. Fire in engine room/deck/accommodation
3. Cargo tank leak
4. Deck spill
5. Collision
6. Explosion

9.4 First-aid treatment/Demo

IMO Model Course 1.14 covers medical first-aid training as required by Section A-VI/4-1 of the STCW Code. This session is revision with the focus on response to cargo related accidents on liquefied natural gas tankers. The subsection on first-aid treatment is not intended to cover first-aid in general; first-aid procedures related to accidents involving cargoes transported in gas tankers should, however, be covered.

10. Glossary of LNG-Related Terms & Definitions

Absolute Pressure: Gauge pressure plus barometric or atmospheric pressure. Absolute pressure can be zero only in a perfect vacuum. See PSIA - Pressure, Absolute.

Atmospheric Pressure: The pressure due to the weight of the atmosphere (air and water vapor) on the earth’s surface. The average atmospheric pressure at sea level has been defined as 14.696 pounds per square inch absolute Ð see PSIA.

Auto-refrigeration: The process in which LNG is kept at its boiling point, so that any added heat is countered by energy lost from boil off.

Bcf - Billion Cubic Feet: A unit of gas measurement approximately equal to one trillion (1,000,000,000,000) Btu's.

Boil off: A small amount of LNG evaporates from the tank during storage, cooling the tank and keeping the pressure inside the tank constant and the LNG at it's boiling point. Rise in temperature is countered by LNG being vented from the storage tank.

Btu - British thermal unit: The Btu is the standard unit of measurement for heat. A Btu is defined as the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit from 58.5 to 59.5 degrees under standard pressure of 30 inches of mercury.

California Environmental Quality Act (CEQA): A California law which sets forth a process for public agencies to make informed decisions on discretionary project approvals. The process aids decision makers to determine whether any environmental impacts are associated with a proposed project. It requires environmental impacts associated with a proposed project to be eliminated or reduced, and that air quality mitigation measures have been implemented.

Compression: Natural gas is compressed during transportation and storage. The standard pressure that gas volumes are measured at is 14.7 Pounds per Square inch (psi). When being transported through pipelines, and when being stored, gas is compressed to save space.

CNG - Compressed Natural Gas: Natural gas in its gaseous state that has been compressed.

Cryogenic Liquid or Cryogens: Cryogenic liquids are liquefied gases that are kept in their liquid state at very low temperatures and have a normal boiling point below -238 degrees Fahrenheit (-150 degrees Celsius). All cryogenic liquids are gases at normal temperatures and pressures. These liquids include methane, oxygen, nitrogen, helium and hydrogen. Cryogens normally are stored at low pressures.

Cf - Cubic Foot: A unit of measurement for volume. It represents an area one foot long, by one foot wide, by one foot deep. Natural gas is measured in cubic feet, but the measurements are usually expressed in terms of Mcf, Bcf, Tcf, or Quads.

Deliverability Rate: A measure of the amount of gas that can be delivered (withdrawn) from a storage facility on a daily basis, typically expressed in terms of millions of cubic feet per day (MMcf/day).

FERC - Federal Energy Regulatory Commission: The federal agency that regulates interstate gas pipelines and interstate gas sales under the Natural Gas Act. The FERC is considered an independent regulatory agency responsible primarily to Congress, but it is housed in the Department of Energy.

Gauge Pressure: The pressure generally shown by measuring devices. This is the pressure in excess of that exerted by the atmosphere. See Absolute Pressure.

Hydrocarbon: An organic compound containing only carbon and hydrogen. Hydrocarbons often occur in petroleum products, natural gas, and coals.

Liquefaction: The process by which natural gas is converted into liquid natural gas.

Liquefied Natural Gas (LNG): Natural gas that has been cooled to -259 degrees Fahrenheit (-161 degrees Celsius) and at which point it is condensed into a liquid which is colorless, odorless, non-corrosive and non-toxic. Characterized as a cryogenic liquid.

Liquefied Petroleum Gas (LPG): Gas consisting primarily of propane, propylene, butane, and butylene in various mixtures. Stored as a liquid by increasing pressure.

Mcf - Thousand Cubic Feet: One thousand cubic feet. One mcf equals the heating value of 1,000,000 Btu (mmbtu).

Methane: Methane (CH_4) is commonly known as natural gas. It is colorless and burns efficiently without many byproducts. Natural gas has odor added as a safety measure since it is naturally odorless.

MMBtu: One Million Btu.

MMcf: A volume measurement of natural gas; one million cubic feet.

MMtpa: Million tonnes per annum - one tonne (or metric ton) is approximately 2.47 cubic meter of LNG.

National Environmental Policy Act (NEPA): The environmental law that establishes federal energy policy, sets goals, and provides means for carrying out the policy. A national policy for the purpose of encouraging productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

Natural Gas: A hydrocarbon gas that is usually obtained from underground sources, often in association with petroleum and coal deposits. Natural gas generally contains a high percentage of methane and inert gases. See Methane.

Nitrogen Rejection Unit (NRU): At NRU facilities, the entire gas stream is liquefied to remove impurities then regasified and sent on as pipeline-quality gas.

Peak-Shaving: Using sources of energy, such as natural gas from storage, to supplement the normal amounts delivered to customers during peak-use periods. Using these supplemental sources prevents pipelines from having to expand their delivery facilities just to accommodate short periods of extremely high demand.

Peak-Shaving Facility: A facility which stores natural gas to be used to supplement the normal amount of gas delivered to customers during peak-use periods.

Peak Use Period: The period of time when gas use on a particular system is at its maximum. This is the period when gas supply is most likely to be suspended for interruptible service customers. Distributors also employ techniques such as peak shaving to soften the impacts of high demand on the pipelines.

Pounds per Square Inch (psi): Pressure measured with respect atmosphere pressure. This is a pressure gauge reading in which the gauge is adjusted to read zero at the surrounding atmospheric pressure.

PSIA - Pressure, Absolute: Gauge pressure plus barometric or atmospheric pressure. Absolute pressure can be zero only in a perfect vacuum. See Absolute Pressure.

Quad: An abbreviation for a quadrillion (1,000,000,000,000,000) Btu. For natural gas, roughly equivalent to one trillion (1,000,000,000,000) cubic feet, or 1 Tcf.

Rapid Phase Transitions: LNG undergoes a rapid transition to vapor especially when spilled on water. The volume of the LNG instantly expands 600 times resulting in a Rapid Phase Transition (RPT) or physical explosion which poses a hazard for structures and people close to the site of the incident. This explosion does not involve combustion. When LNG is spilled on water, heat is transferred from the water to the LNG. This results in a rapid transformation of liquid to gas releasing a large amount of energy.

Regasification: The process by which LNG is heated, converting it into its gaseous state.

Reserves: Volumes of hydrocarbons (measured in Bcf, Tcf or billion of barrels) that are considered to be economically recoverable using current technology.

Reservoir: The portion of a resource, such as natural gas, that has been discovered and that is technically and economically extractable.

Storage Facilities: Facilities used for storing natural gas. These facilities are generally found as gaseous storage facilities and liquified natural gas (LNG) storage facilities.

Stranded Utility: A stranded local utility system is typically very small and too far from the pipeline grid to be economically connected.

Tcf - Trillion Cubic Feet: A volume measurement of natural gas; approximately equivalent to one Quad.

Therm: 100,000 British thermal units (Btu). A common measure of gas sold to residential customers.

Appendix 1

Figures for use by the presenter
Use on OHP (transparencies)/LCD Projectors
Or
Print off as hand-outs

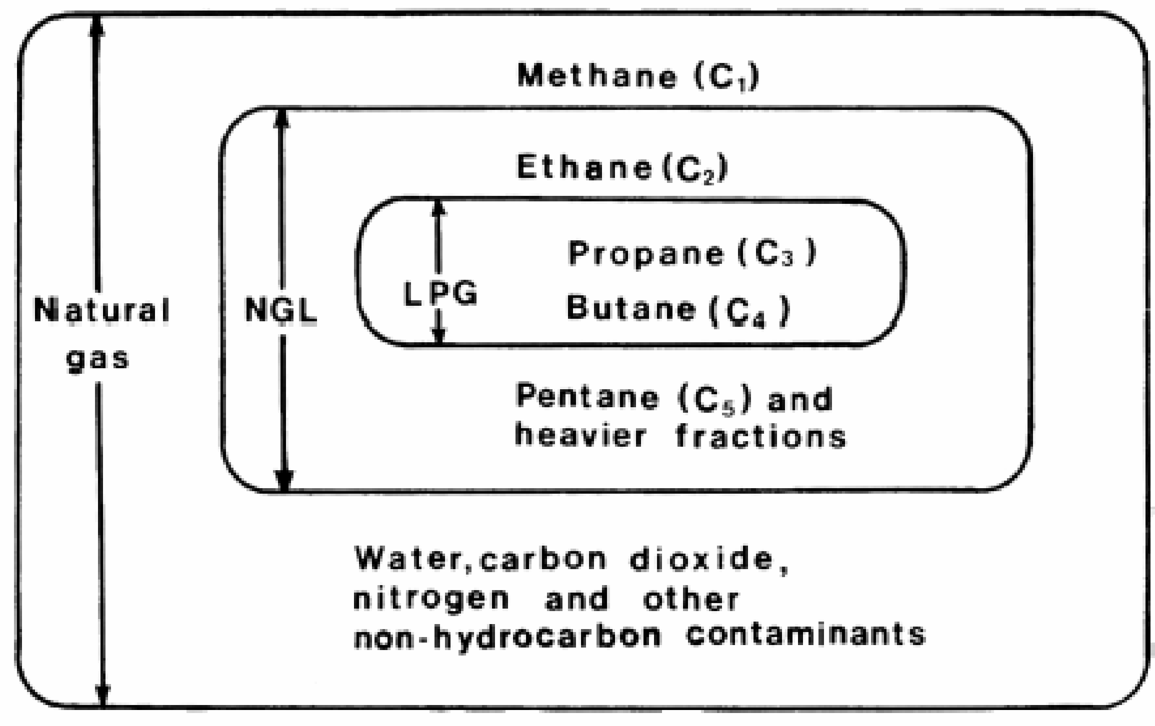


Figure 1: The constituents of natural gas from a well

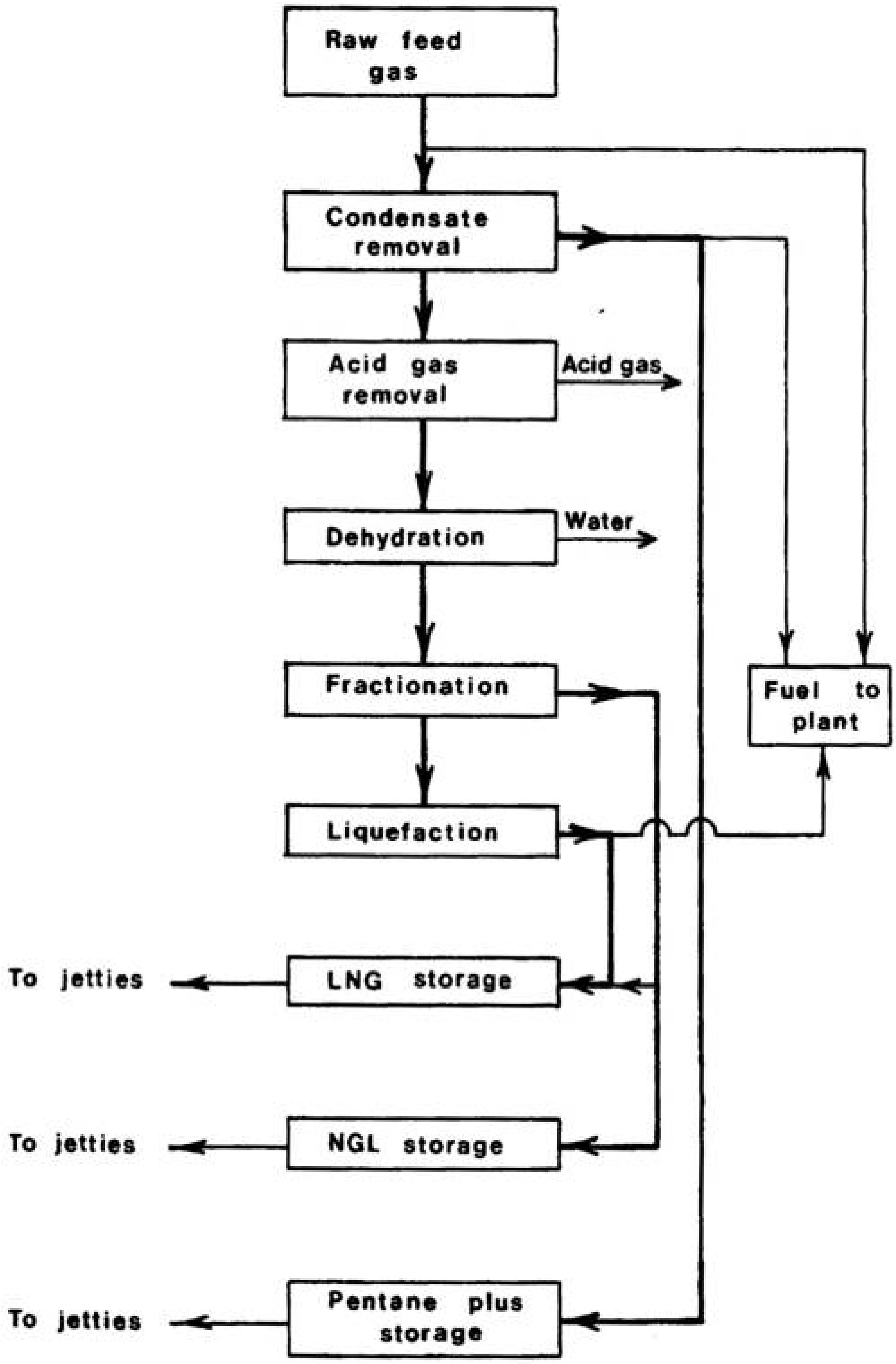
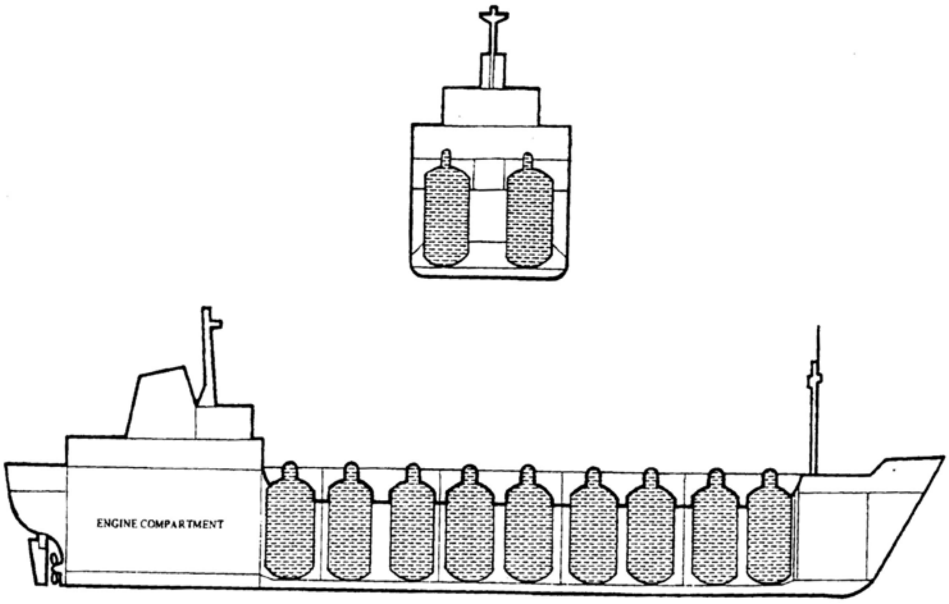
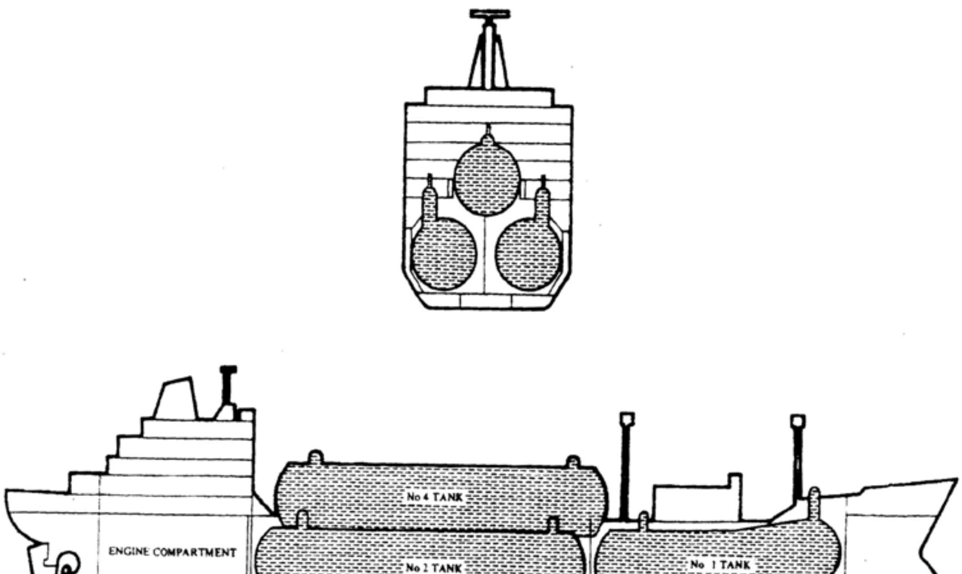


Figure 2: Production of LNG from natural gas reservoirs



A fully pressurized LPG carrier



A semi-pressurized/fully refrigerated LPG/NH_3 carrier

Figure 3: Gas carriers (1)

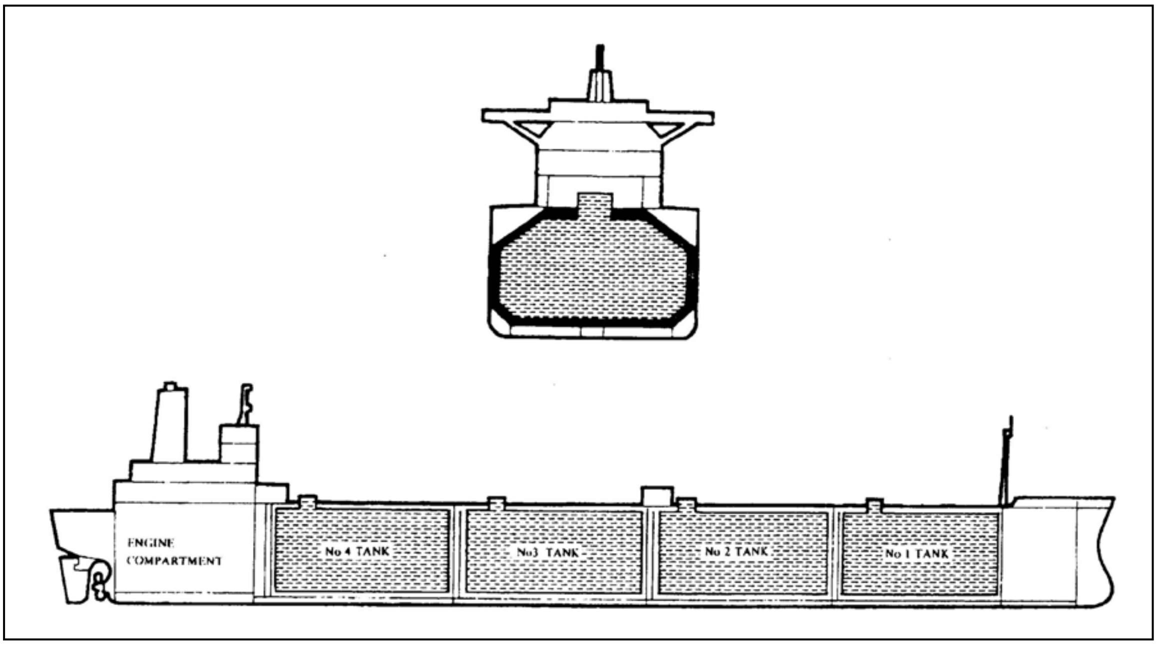
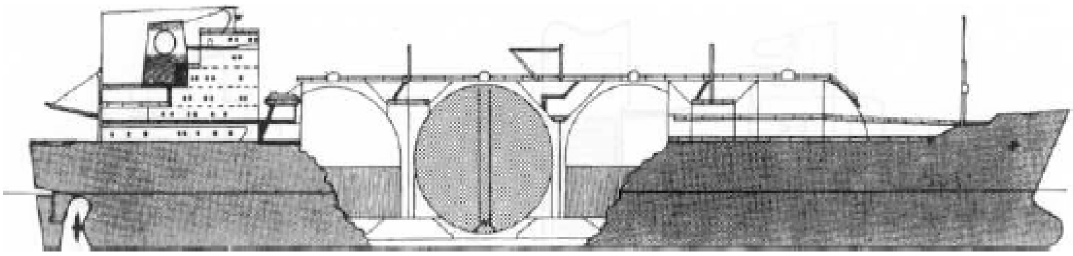
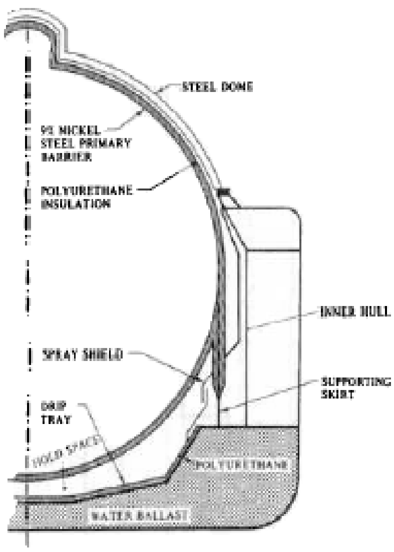


Figure 4: A fully refrigerated LPG carrier



LNG/ethylene/LPG tanker



Independent self-supporting spherical tank (type B)

Figure 5: LNG carrier

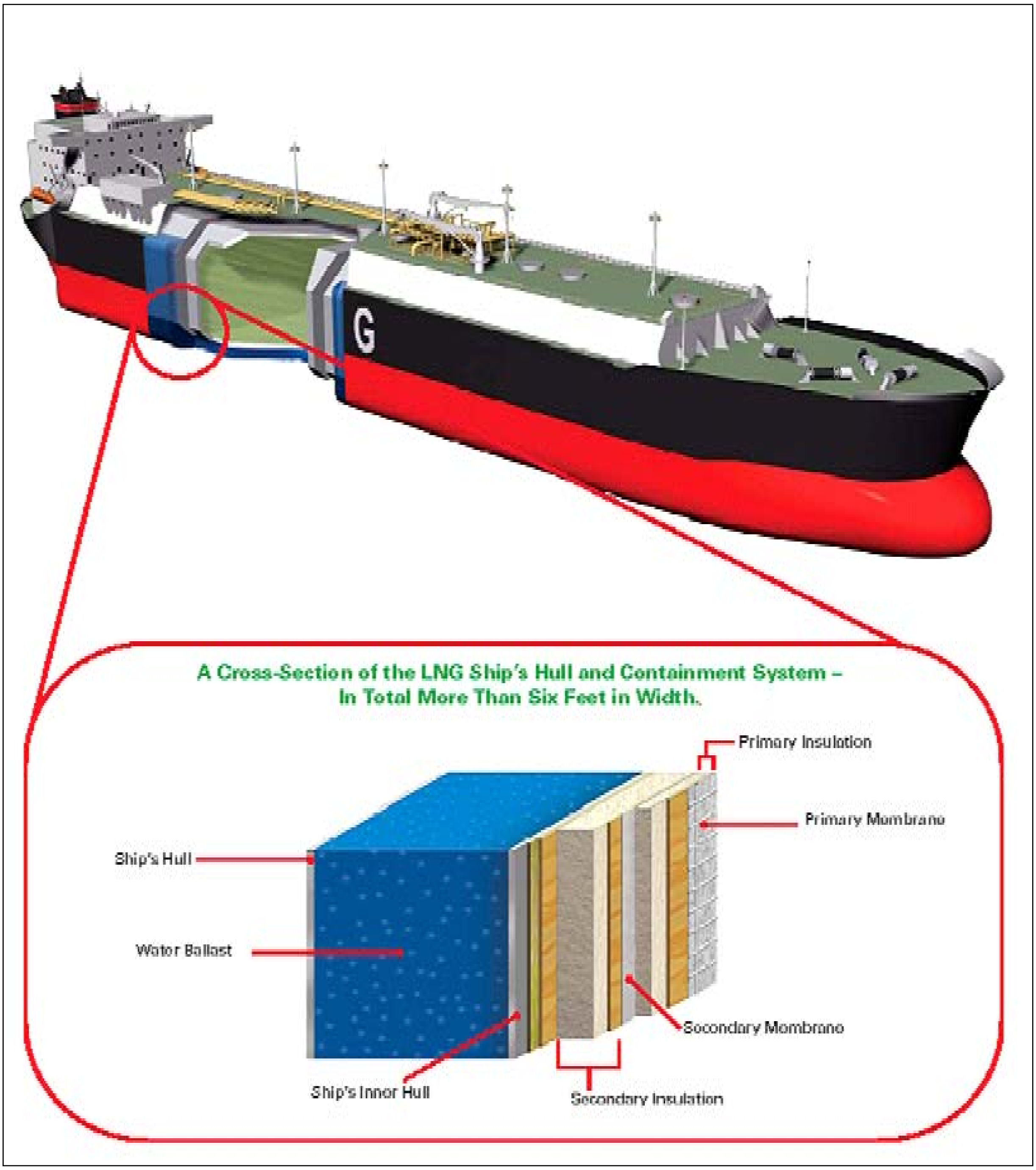


Figure 6: LNG Tanker GTT Cross section

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	2G/2PG
less than 30% by weight	2G/2PG
Isoprene	2G/2PG
Isopropylamine	2G
Methane	2G/2PG
Methylacetylene/propadiene mixture	1G
Methyl bromide	2G/2PG
Methyl chloride	2G/2PG
Monoethylamine	3G
Nitrogen	2G/2PG
Propane	2G/2PG
Propylene	2G/2PG
Propylene oxide	3G
Refrigerant gases	1G
Sulphur dioxide	2G/2PG
Vinyl chloride	2G/2PG
Vinyl ethyl ether	2G/2PG

Figure 7: List of cargoes suitable for transport in liquefied gas tankers
(as listed in IMO Gas Carrier Codes)

Methane	CH_4	GASES
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	
Pentane	C_5H_{12}	LIQUIDS
Hexane	C_6H_{14}	
Heptane	C_7H_{16}	
Octane	C_8H_{18}	
Nonane	C_9H_{20}	
Decane	$C_{10}H_{22}$	
⋮	⋮	
Nonadecane	$C_{19}H_{40}$	SOLIDS

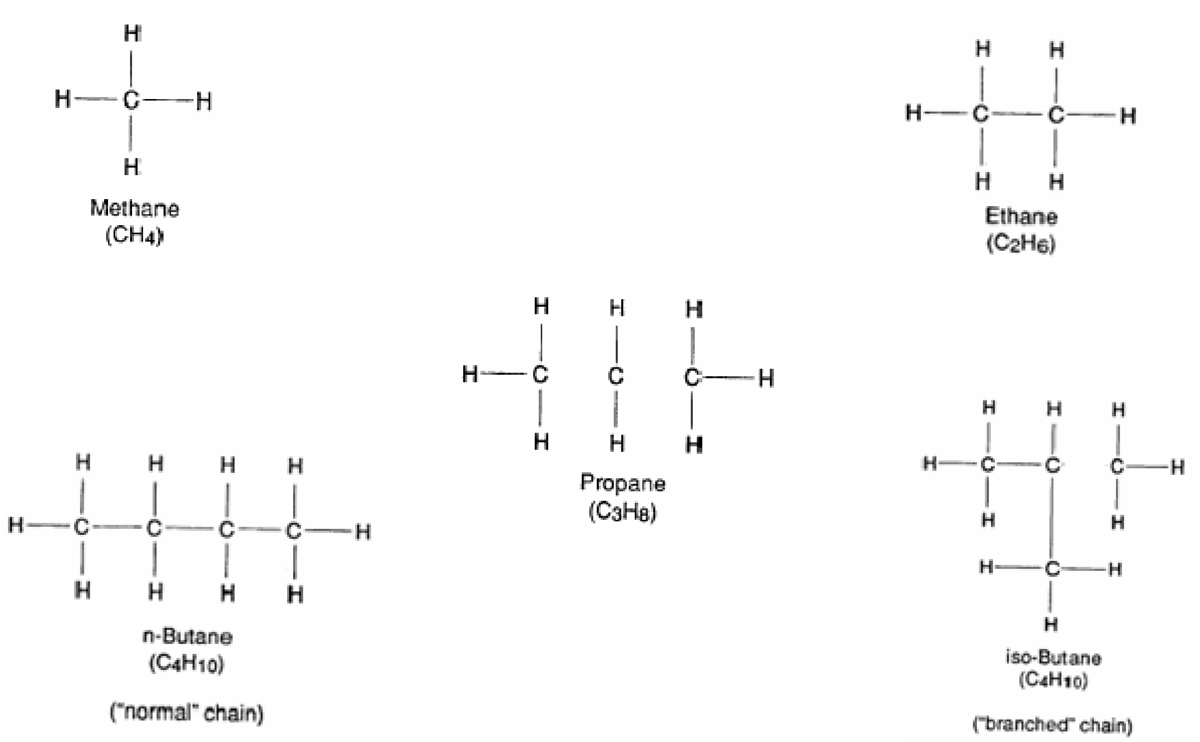


Figure 8: Molecular structures of some saturated hydrocarbons

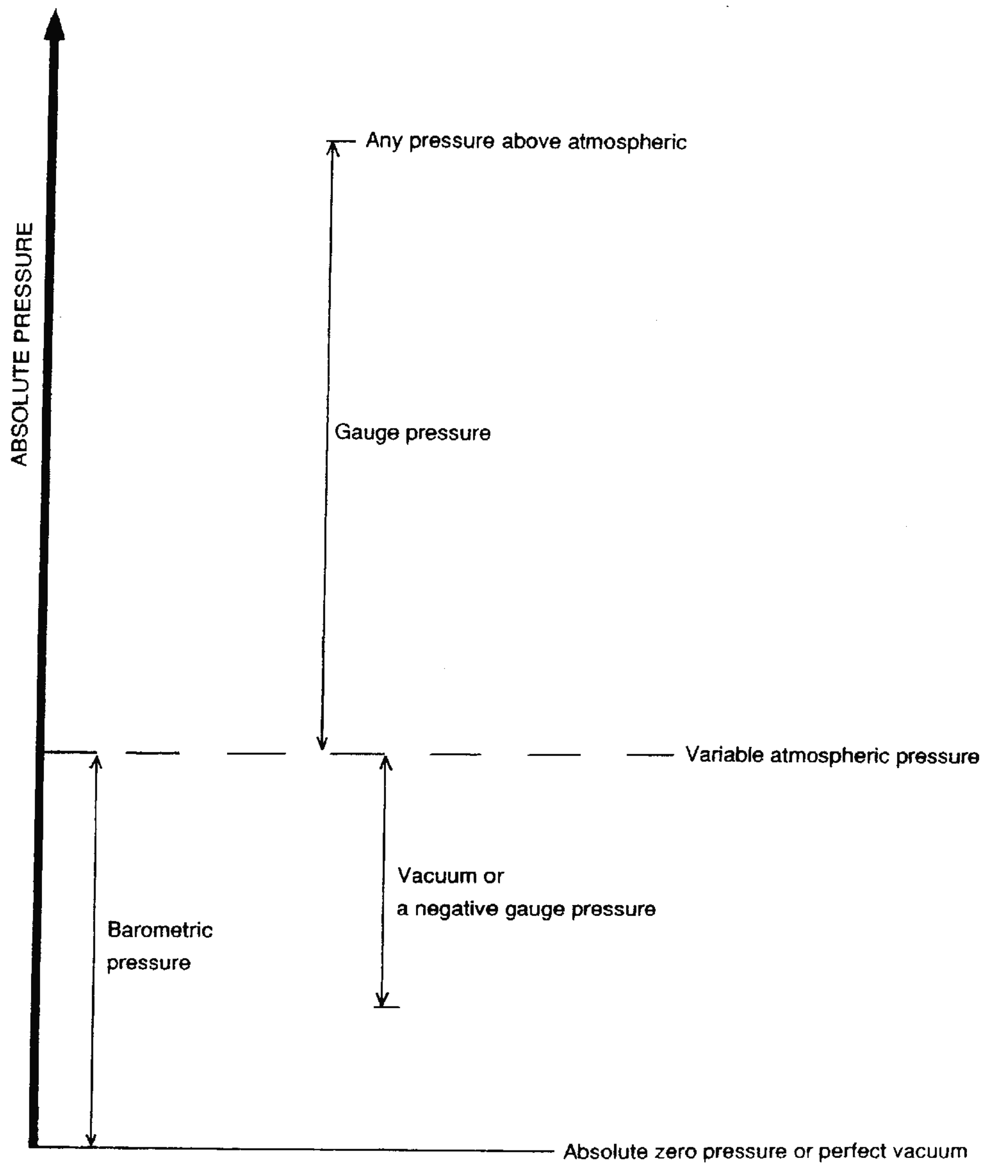
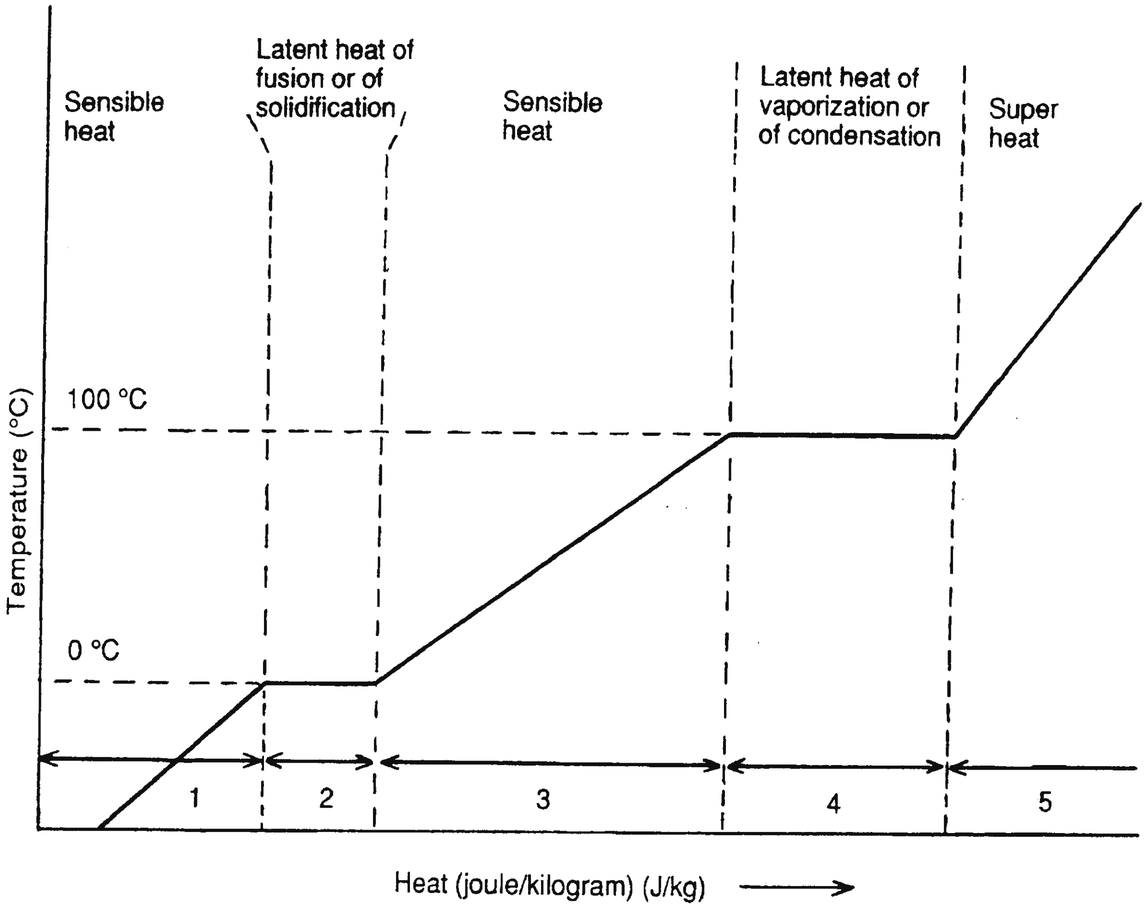


Figure 9: Illustration of different pressures

		bar	At. (kp/cm²)	Atm.	p.s.i.	mmHg	Wg (mmH_2O)	Pa
1 bar	=	1	1.020	0.9869	14.50	750.1	10 197	100 000
1 At. (kp/cm^2)	=	0.9807	1	0.9678	14.22	735.6	10 000	98 067
1 Atm. (760 mmHg)	=	1.0133	1.033	1	14.70	760	10 333	101 325
1 p.s.i. (lb/in^2)	=	0.068 95	0.070 31	0.068 05	1	51.71	703.1	6 895
1 mmHg (Torr)	=	0.001 333	0.001 360	0.001 316	0.019 34	1	13.60	133.3
1 mm water column (Wg)	=	0.9807×10^{-4}	1×10^{-4}	0.9678×10^{-4}	0.001 422	0.073 56	1	9.807

The basal unit in the S.I. system is the pascal (Pa) = 1 $N/m^2 = 10^{-5}$ bar
1 kp/cm^2 (1 At.) is called a 'technical atmosphere', while 1 Atm. (760 mmHg) is called a 'physical atmosphere'
mmHg = millimetre of mercury column

Figure 10: Pressure units



1 Ice
2 Ice + water
3 Water
4 Water + steam
5 Steam

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 11: States of aggregation (temperature/heat)

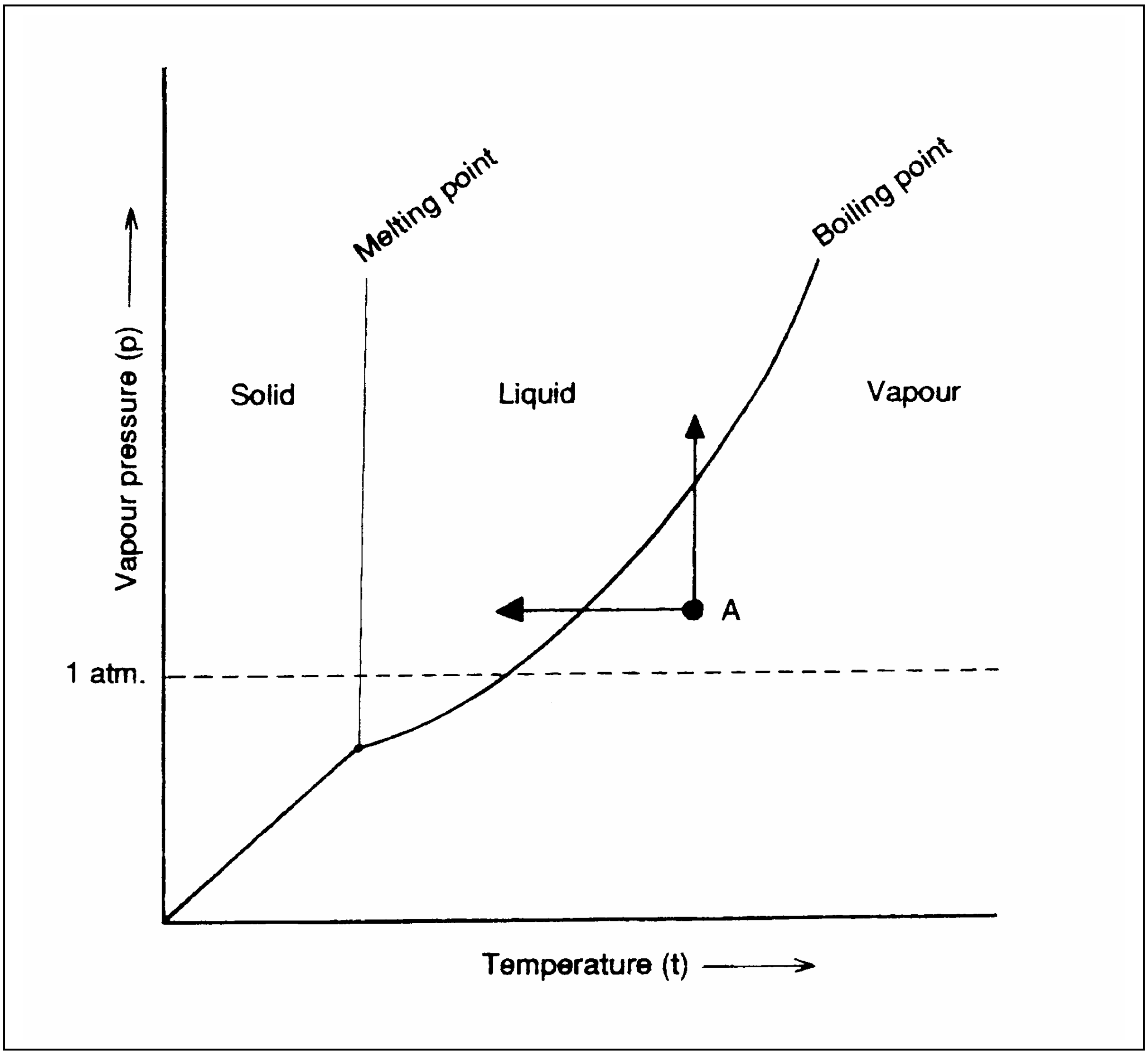


Figure 12: States of aggregation (pressure/temperature)

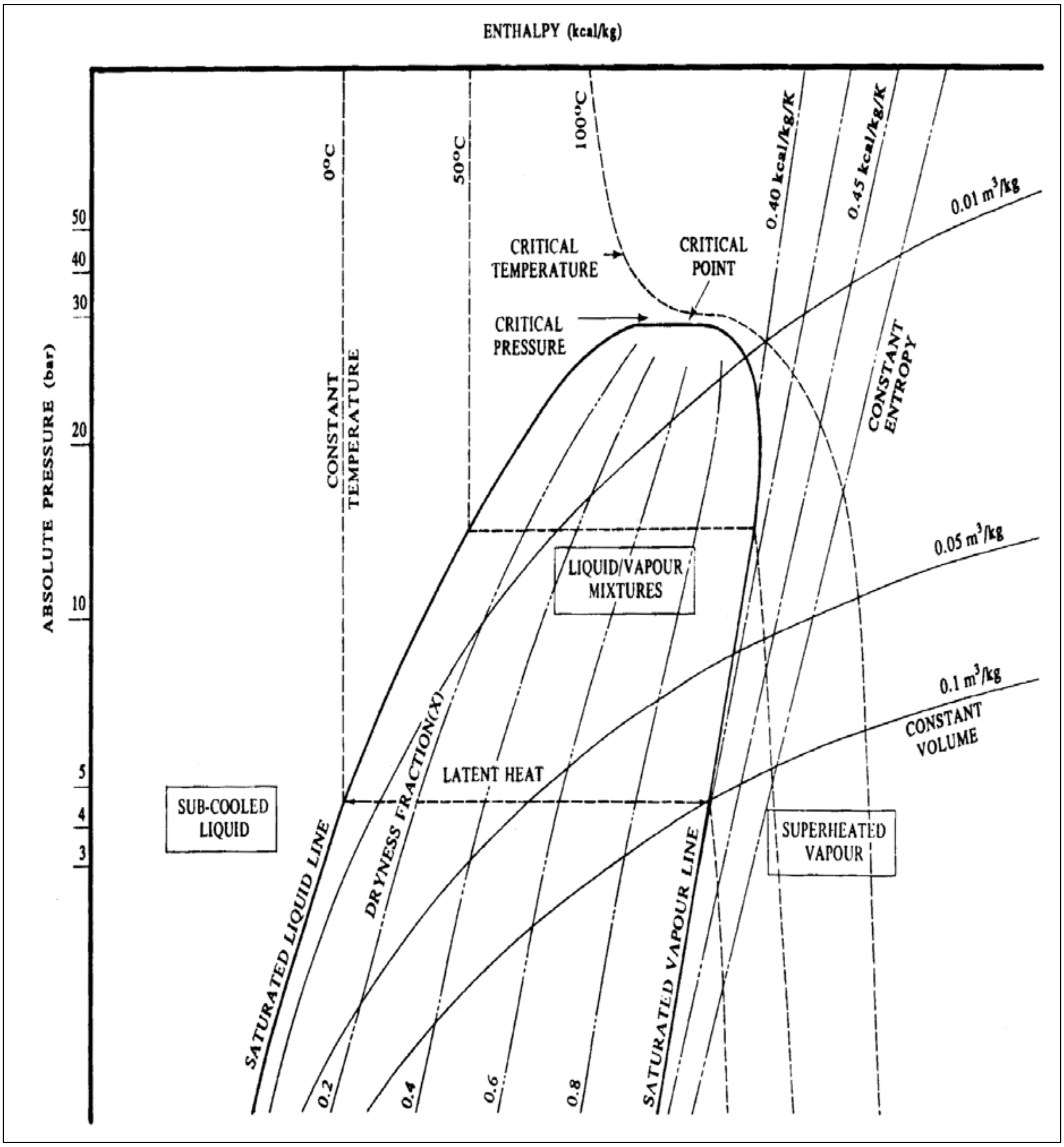


Figure 13: A schematic Mollier diagram

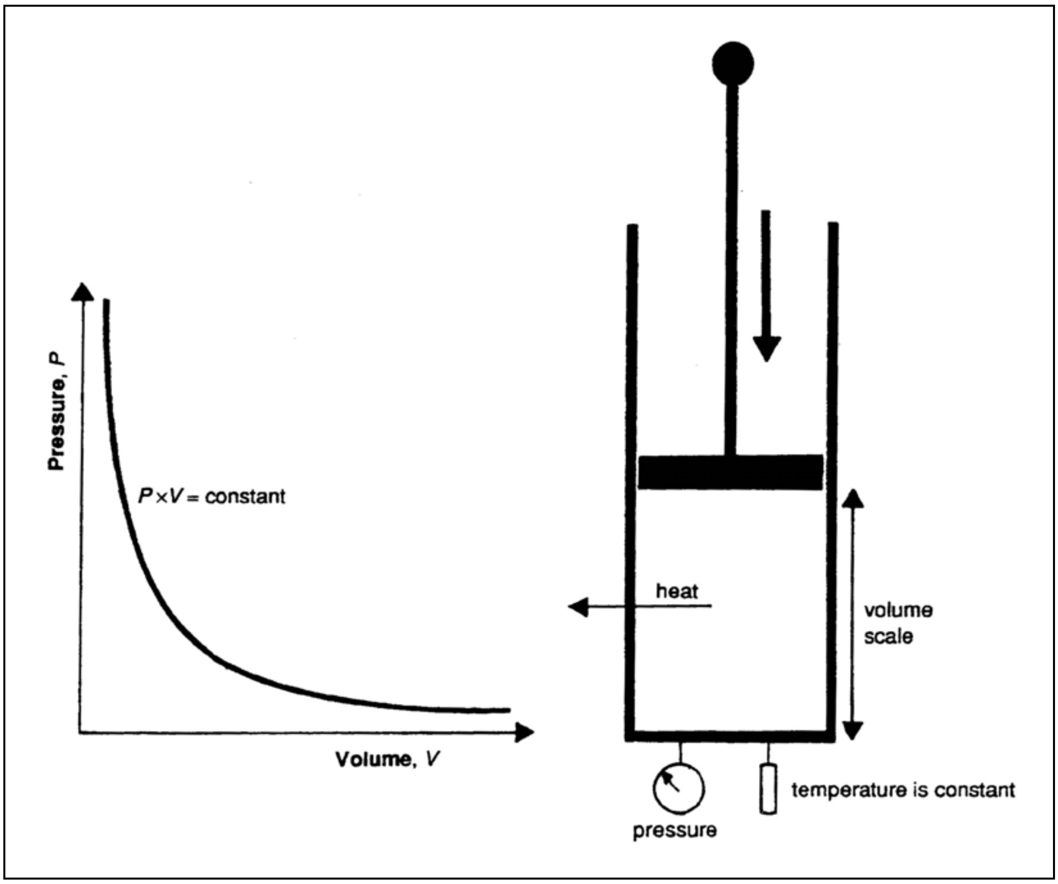


Figure 14: Illustration of Boyle's law for ideal gases

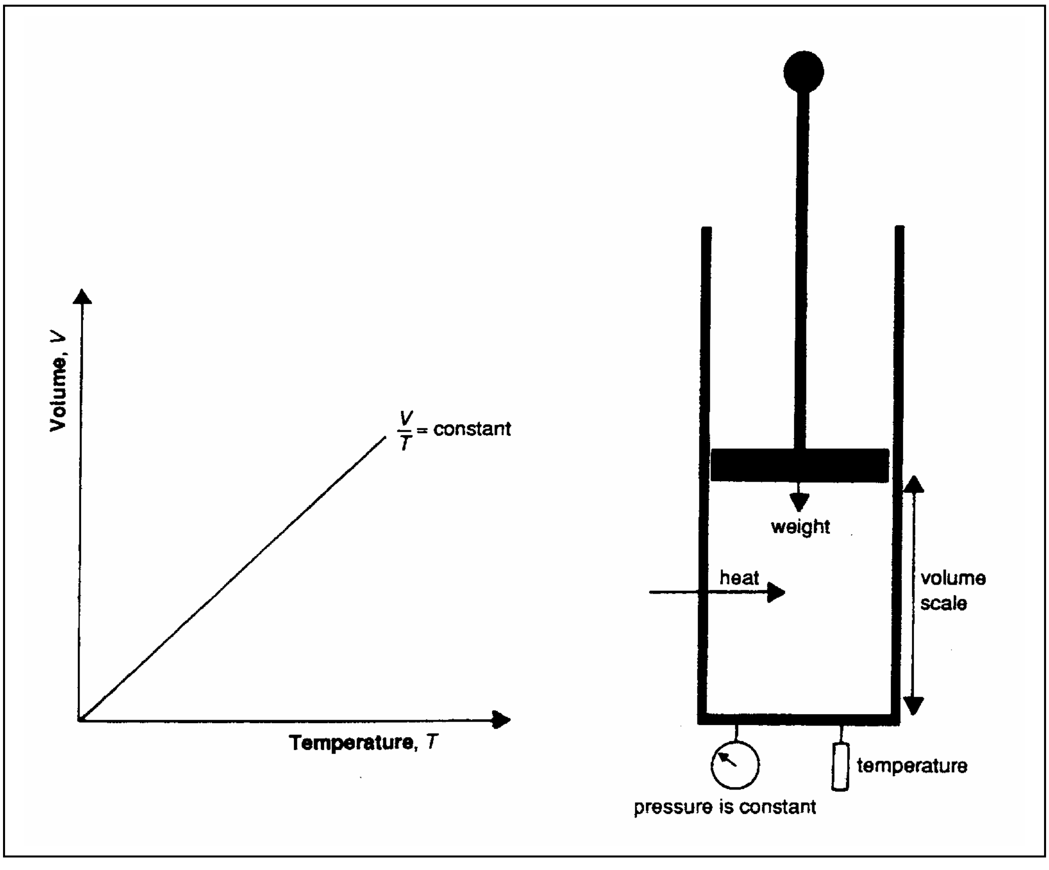
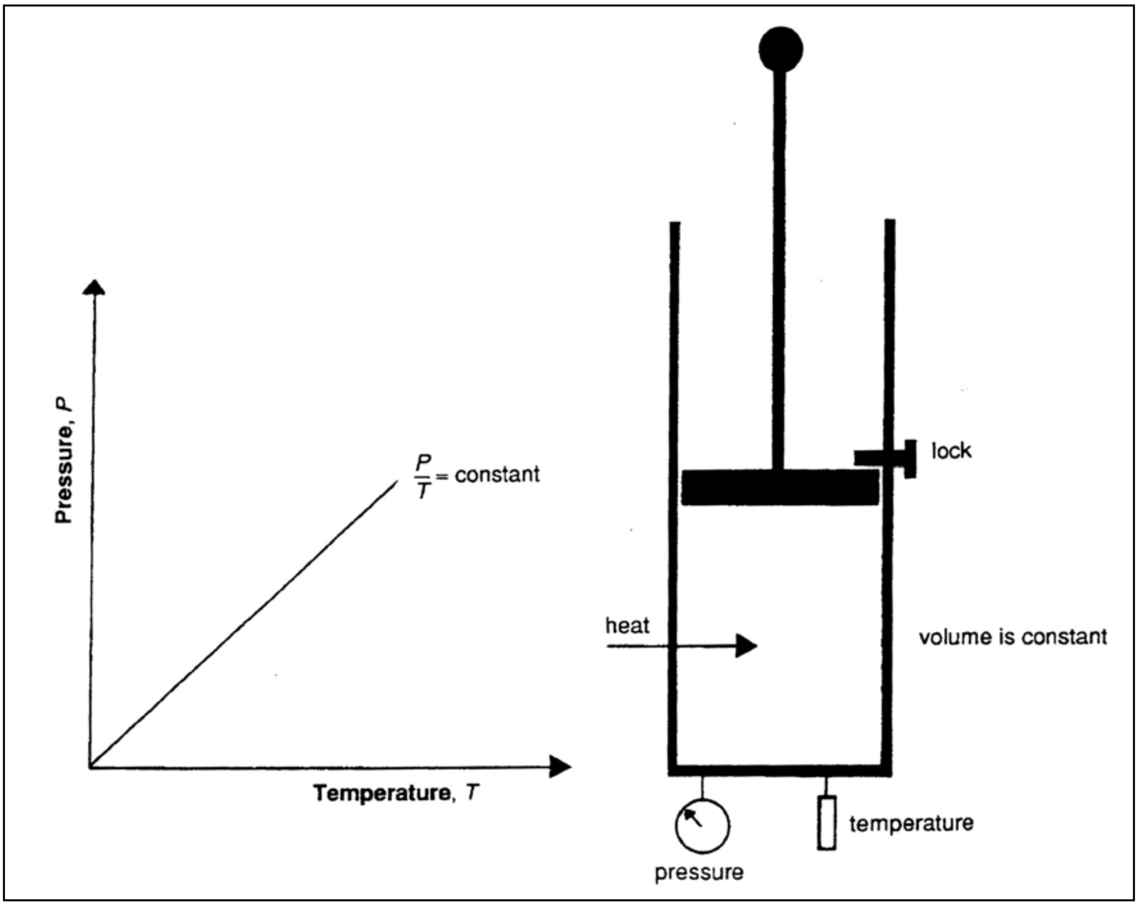


Figure 15: Illustration of Charles law for ideal gases

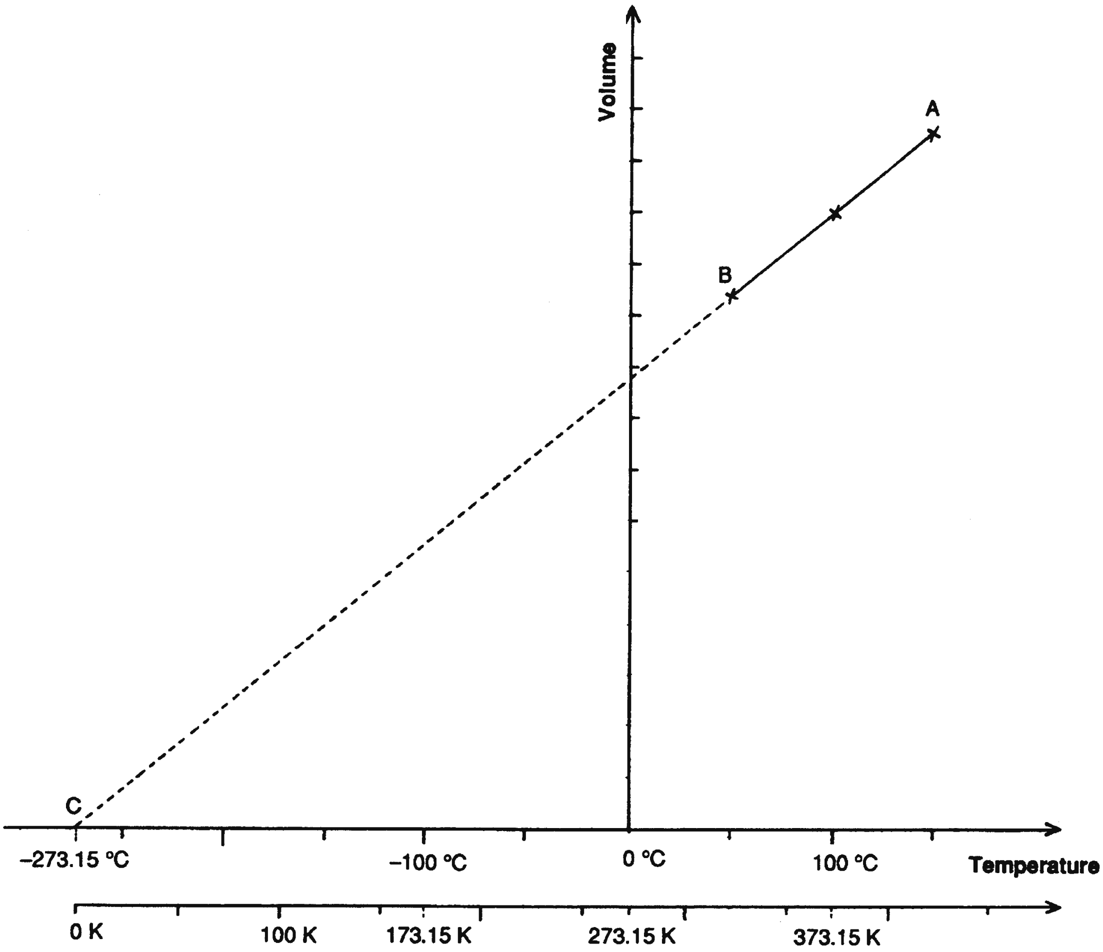


$$\frac{P_1 \times V_1}{T} \quad \frac{P_2 \times V_2}{T_2}$$

The standard volume is the volume at 0 °C and at 1 bar atm

The general gas equation

Figure 16: Illustration of the pressure law for ideal gases



The line between A and B is the result of a real experiment.
The line between B and C is an expected continuation of the line AB.
The point C is the intersection of the expected line and the temperature scale in degrees Celsius.
Start the absolute temperature scale at this point.

Figure 17: Illustration of “absolute temperature” resulting from an experiment based on work by Charles

No. 19

FORMULA CH_4
U.N. NUMBER 2043
FAMILY Hydrocarbon
APPEARANCE Colourless
ODOUR Odourless

METHANE

"fire damp"
"marsh gas"
LNG

THE MAIN HAZARD
FLAMMABLE.

EMERGENCY PROCEDURES

FIRE	Stop gas supply. Extinguish with dry powder, Halon or CO_2. Cool surrounding area with water spray.
LIQUID IN EYE	DO NOT DELAY. Flood eye gently with clean fresh/sea water. Force eye open if necessary. Continue washing for at least 15 minutes. Obtain medical advice/assistance.
LIQUID ON SKIN	DO NOT DELAY. Treat patient gently. Remove contaminated clothing. Immerse frostbitten area in warm water until thawed (see Chapter 9). Obtain medical advice/assistance.
VAPOUR INHALED	Remove victim to fresh air. If breathing has stopped, or is weak/ irregular, give mouth-to-mouth/nose resuscitation.
SPILLAGE	Stop the flow. Avoid contact with liquid or vapour. Extinguish sources of ignition. Flood with large amounts of water to disperse spill and prevent brittle fracture. Inform Port Authorities of any major spill.

PHYSICAL DATA

BOILING POINT @ ATMOSPHERIC PRESSURE	−161.5°C	**RELATIVE VAPOUR DENSITY**	0.554
VAPOUR PRESSURE kg/cm² (A)	See graphs	**MOLECULAR WEIGHT**	16.04
SPECIFIC GRAVITY	0.42	**ENTHALPY (kcal/kg)**	*Liquid*: 7.0 @ −165°C; 68.2 @ −100°C. *Vapour*: 130.2 @ −165°C; 140.5 @ −100°C
COEFFICIENT OF CUBIC EXPANSION	0.0026 per °C @ −165°C	**LATENT HEAT OF VAPORISATION (kcal/kg)**	See graphs

FIRE AND EXPLOSION DATA

FLASH POINT −175°C (approx.) **FLAMMABLE LIMITS** 5.3 - 14% **AUTO-IGNITION TEMPERATURE** 595°C

HEALTH DATA

TLV 1000 ppm **ODOUR THRESHOLD** Odourless.

EFFECT OF LIQUID	Frostbite to eyes and skin. Not absorbed through skin.
EFFECT OF VAPOUR	Asphyxiation – headache, dizziness, drowsiness. Possible low temperature damage to lungs, skin. No chronic effect known.

No. 19 **REACTIVITY DATA** **METHANE**

AIR	No reaction.
WATER (Fresh/Salt)	No dangerous reaction. Insoluble. May freeze to form ice or hydrates.
OTHER LIQUIDS/ GASES	Dangerous reaction possible with chlorine.

CONDITIONS OF CARRIAGE

NORMAL CARRIAGE CONDITIONS	Fully refrigerated.	**GAUGING**	Closed, indirect.
SHIP TYPE	2G.	**VAPOUR DETECTION**	Flammable.

MATERIALS OF CONSTRUCTION

UNSUITABLE	SUITABLE
Mild steel.	Stainless steel, aluminium, 9 or 36% nickel steel, copper.

SPECIAL REQUIREMENTS

Figure 18:

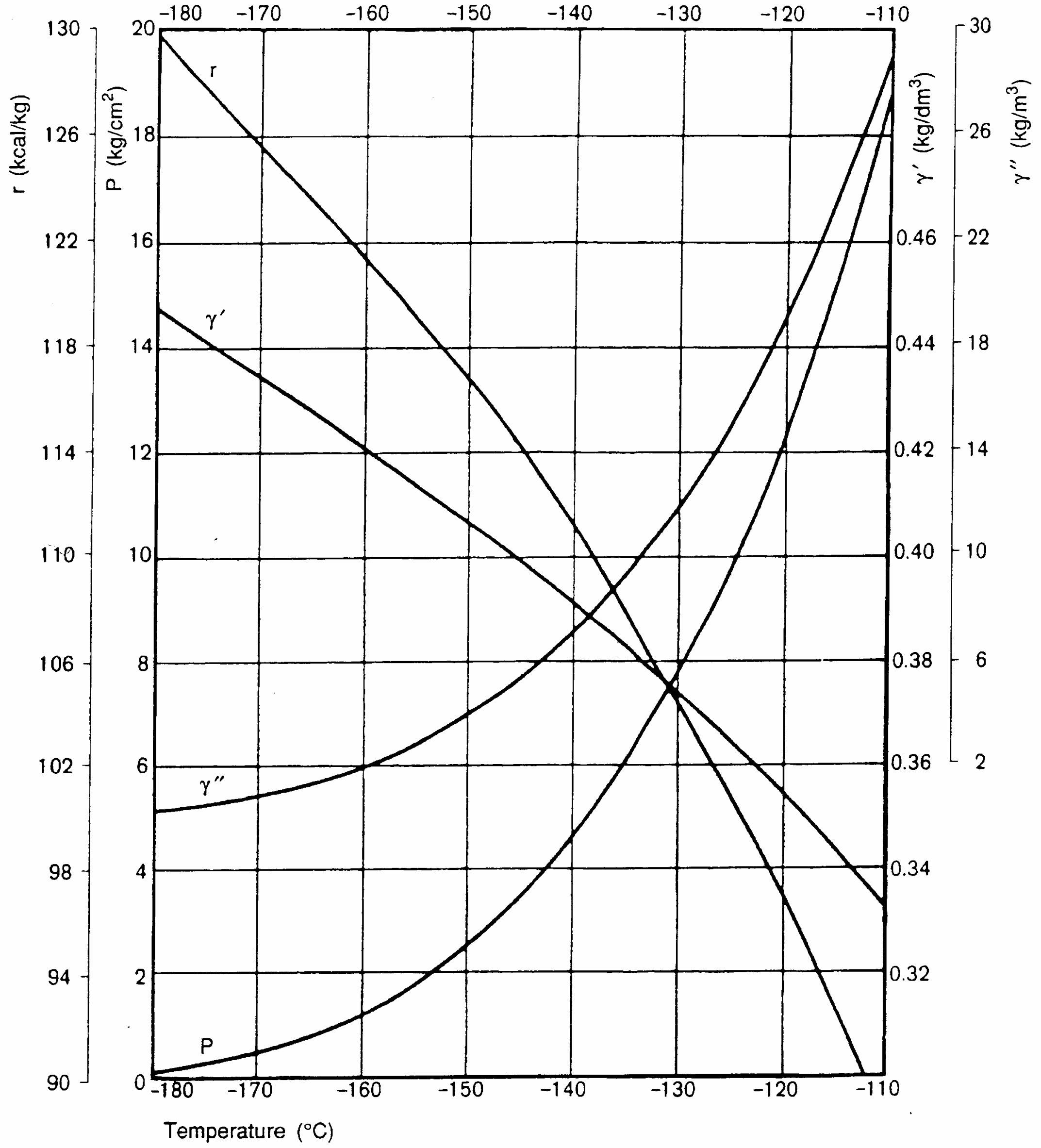


Figure 19: ICS Cargo Data Sheet for methane

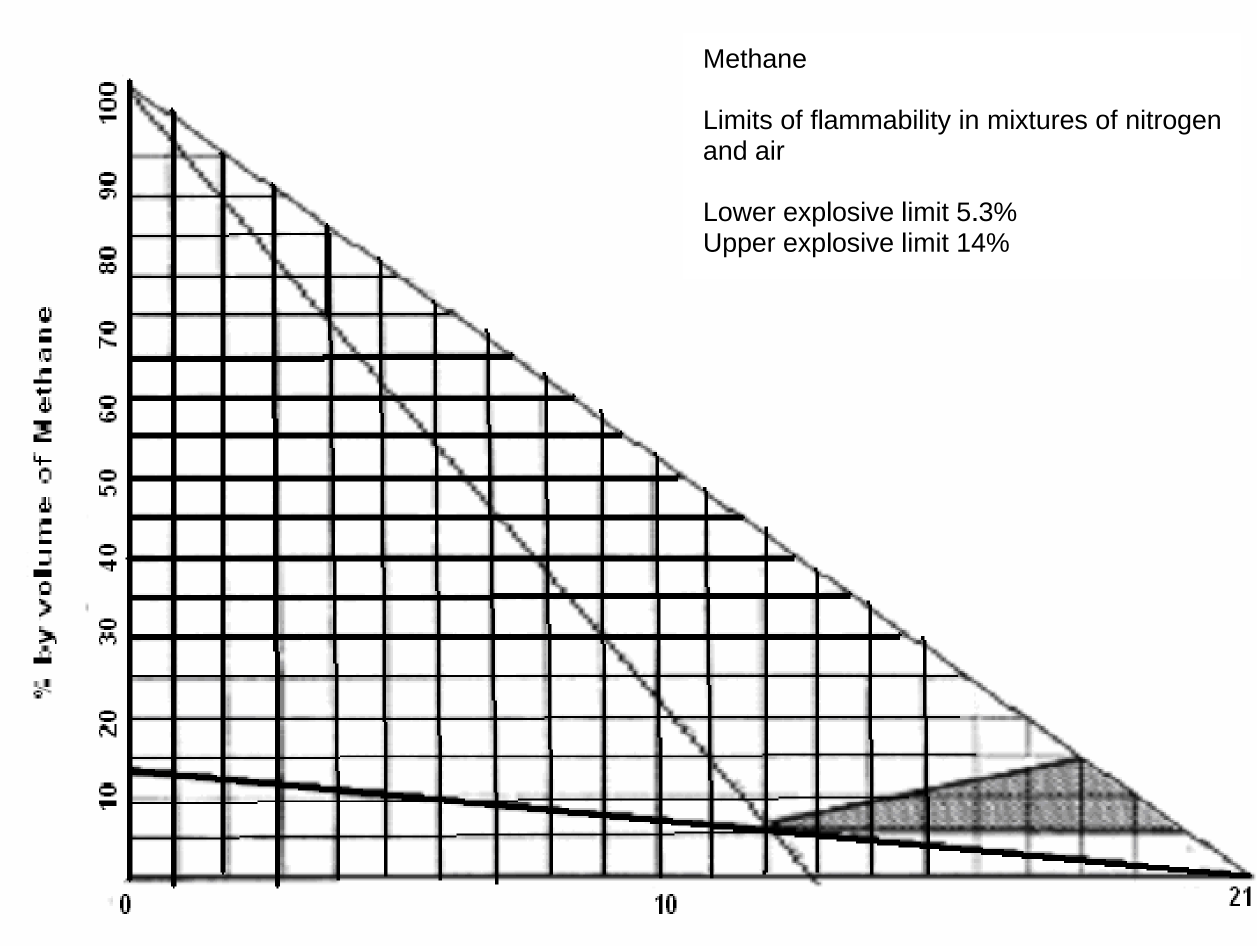


Figure 20: ICS Cargo Data Sheet for methane

	Flammable	Toxic	Polymerizable
Methane	✓		
Ethane	✓		
Propane	✓		
Butane	✓		
Ethylene	✓		
Propylene	✓		
Butylene	✓		
Butadiene/isoprene	✓		✓
Ammonia	✓	✓	
VCM	✓	✓	✓
Ethylene oxide	✓	✓	✓
Propylene oxide	✓	✓	
Chlorine (dry)		✓	

Figure 21: Properties of liquefied gases

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 22: Properties of liquefied gases

	Methane	Ethane	Propane	Butane	Ethylene	Propylene	Butylene	Butadiene /isoprene	Ammonia	VCM	Ethylene oxide	Propylene oxide	Chlorine (dry)	Water vapour	Oxygen	Carbon dioxide	Air
Methane													✖				
Ethane													✖				
Propane													✖				
Butane													✖				
Ethylene													✖				
Propylene													✖				
Butylene													✖				
Butadiene/isoprene													✖	✖	✖		✖
Ammonia											✖	✖	✖	✖		✖	
Vinyl chloride monomer (VCM)													✖		✖		✖
Ethylene oxide									✖						✖		✖
Propylene oxide									✖								
Chlorine (dry)	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖				✖			
Water vapour								✖	✖				✖				
Oxygen								✖		✖	✖						
Carbon dioxide									✖								
Air								✖		✖	✖						

Note: Reference should be made to the Data Sheets in Appendix 1 to the ICS *Tanker Safety Guide (Liquefied Gas)*

✖ = incompatible

Figure 23: Compatibility diagram for some liquefied gases

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 24: Flammability data for some liquefied gases

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 Special requirements
Acetaldehyde	1089	2G/ 2PG	–	Inert	F + T	C	14.4.3, 14.4.4, 17.4.1, 17.6.1
Ammonia, anhydrous	1005	2G/ 2PG	–	–	T	C	14.4.2, 14.4.3, 14.4.4, 17.2.1, 17.13
Butadiene	1010	2G/ 2PG	–	–	F	R	17.2.2, 17.4.2, 17.4.3, 17.6, 17.8
Butane	1011	2G/ 2PG	–	–	F	R	
Butane-propane mixtures	1011/ 1978	2G/ 2PG	–	–	F	R	
Butylenes	1012	2G/ 2PG	–	–	F	R	
Chlorine	1017	1G	Yes	Dry	T	I	14.4, 17.3.2, 17.4.1, 17.5, 17.7, 17.9, 17.14
Diethyl ether*	1155	2G/ 2PG	–	Inert	F + T	C	14.4.2, 14.4.3, 17.2.6, 17.3.1, 17.6 1, 17.10, 17.11, 17.15
Dimethylamine	1032	2G/ 2PG	–	–	F + T	C	14.4.2, 14.4.3, 14.4.4, 17.2.1
Ethane	1961	2G	–	–	F	R	
Ethyl chloride	1037	2G/ 2PG	–	–	F + T	R	
Ethylene	1038	2G	–	–	F	R	
Ethylene oxide	1040	1G	Yes	Inert	F + T	C	14.4.2, 14.4.3, 14.4.4, 14.4.6, 17.2.2, 17.3.2, 17.4.1, 17.5, 17.6.1, 17.16
Ethylene oxide-propylene oxide mixtures with ethylene oxide content of not more than 30% by weight	2983	2G/ 2PG	–	Inert	F + T	C	14.4.3, 17.3.1, 17.4.1, 17.6.1, 17.10, 17.11, 17.20
Isoprene*	1218	2G/ 2PG	–	–	F	R	14.4.3, 17.8. 17.10, 17.12
Isopropylamine*	1221	2G/ 2PG	–	–	F + T	C	14.4.2, 14.4.3, 17.2.4, 17.10, 17.11 17.12, 17.17
Methane (LNG)	1972	2G	–	–	F	C	
Methyl acetylene-propadiene mixtures	1060	2G/ 2PG	–	–	F	R	17.18
Methyl bromide	1062	1G	Yes	–	F + T	C	14.4, 17.2.3, 17.3.2, 17.4.1, 17.5, 17.9
Methyl chloride	1063	2G/ 2PG	–	–	F + T	C	17.2.3
Monoethylamine*	1036	2G/ 2PG	–	–	F + T	C	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	17.19
Propane	1978	2G/ 2PG	–	–	F	R	

* This cargo is covered also by the IBC Code.

Figure 25: (IGC Code) Summary of minimum requirements

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 Special requirements
Propylene	1077	2G/ 2PG	–	–	F	R	
Propylene oxide*	1280	2G/ 2PG	–	Inert	F + T	C	14.4.3, 17.3.1, 17.4.1, 17.6.1, 17.10, 17.11, 17.20
Refrigerant gases (see notes)	–	3G	–	–	–	R	
Sulphur dioxide	1079	1G	Yes	Dry	T	C	14.4, 17.3.2, 17.4.1, 17.5, 17.7, 17.9
Vinyl chloride	1086	2G/ 2PG	–	–	F + T	C	14.4.2, 14.4.3, 17.2.2, 17.2.3, 17.3.1, 17.6, 17.21
Vinyl ethyl ether*	1302	2G/ 2PG	–	Inert	F + T	C	14.4.2, 14.4.3, 17.2.2, 17.3.1, 17.6.1, 17.8, 17.10, 17.11, 17.15
Vinylidene chloride*	1303	2G/ 2PG	–	Inert	F + T	R	14.4.2, 14.4.3, 17.2.5, 17.6.1, 17.8, 17.10, 17.11

* This cargo is covered also by the IBC Code.

Explanatory notes to the summary of minimum requirements

UN Numbers — The UN numbers as listed in the table of chapter 19 are intended for information only.

Vapour detection required (column f)
- F — Flammable vapour detection
- T — Toxic vapour detection
- O — Oxygen analyser
- F + T — Flammable and toxic vapour detection

Gauging – types permitted (column g)
- I — Indirect or closed, as described in 13.2.2.1 and .2
- C — Indirect, or closed, as described in 13.2.2.1, .2 and .3
- R — Indirect, closed or restricted, as described in 13.2.2.1, .2, .3 and .4

Refrigerant gases — Non-toxic and non-flammable gases such as:

dichlorodifluoromethane (1028)

dichloromonofluoromethane (1029)

dichlorotetrafluoroethane (1958)

monochlorodifluoromethane (1018)

monochlorotetrafluoroethane (1021)

monochlorotrifluoromethane (1022)

Unless otherwise specified, gas mixtures containing less than 5% total acetylenes may be transported with no further requirements than those provided for the major components.

Product name	UN number	Ship type	Independent tank type C required	Control of vapour space within cargo tanks	Vapour detection	Gauging	Special requirements
No specific chapter	*No specific chapter*	Chapter 2 Ship survival capability and location of cargo tanks	*No specific chapter*	Chapter 9, Environmental control	Chapter 13, Instrumentation	Chapter 13, Instrumentation	Chapter 14, Personnel protection Chapter 17, Special requirements

Figure 26: Columns in Chapter 19 of IGC Code related to chapters in the Code

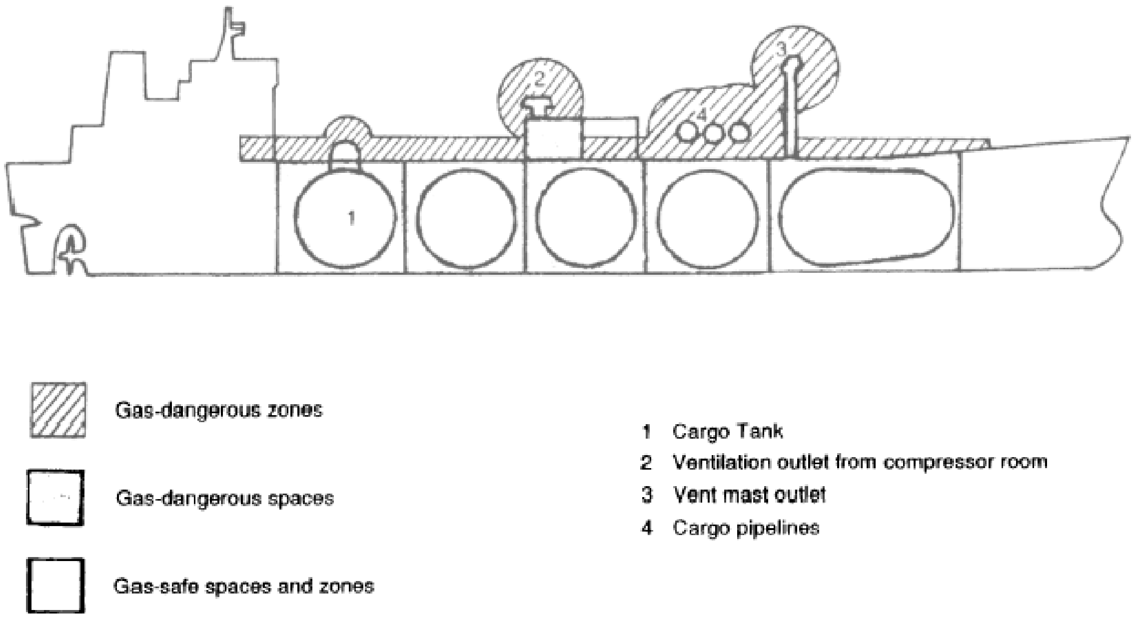


Figure 27: Gas – dangerous spaces and zones

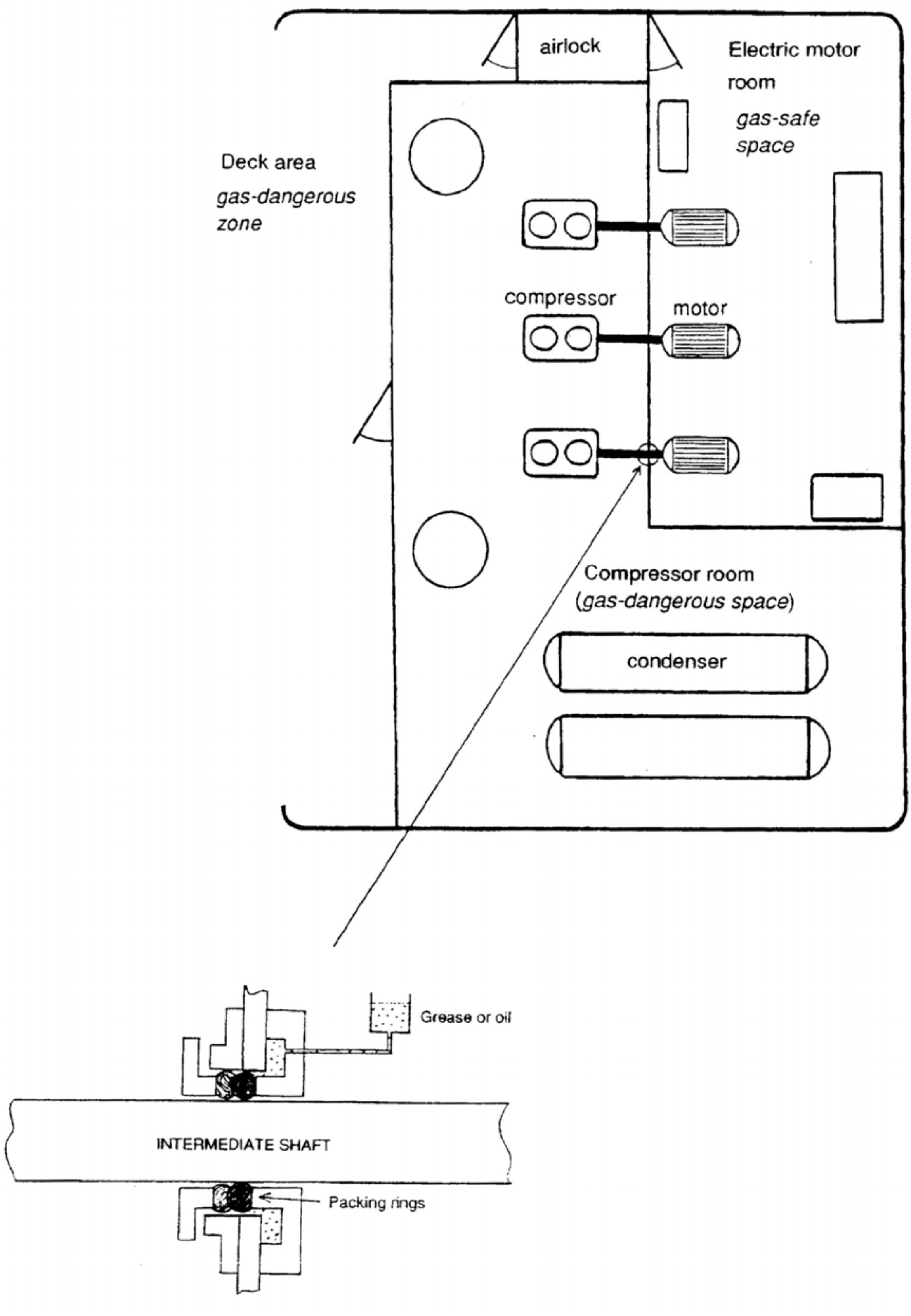


Figure 28: Arrangement of a deck-house and an example of a gas-tight arrangement around an intermediate shaft

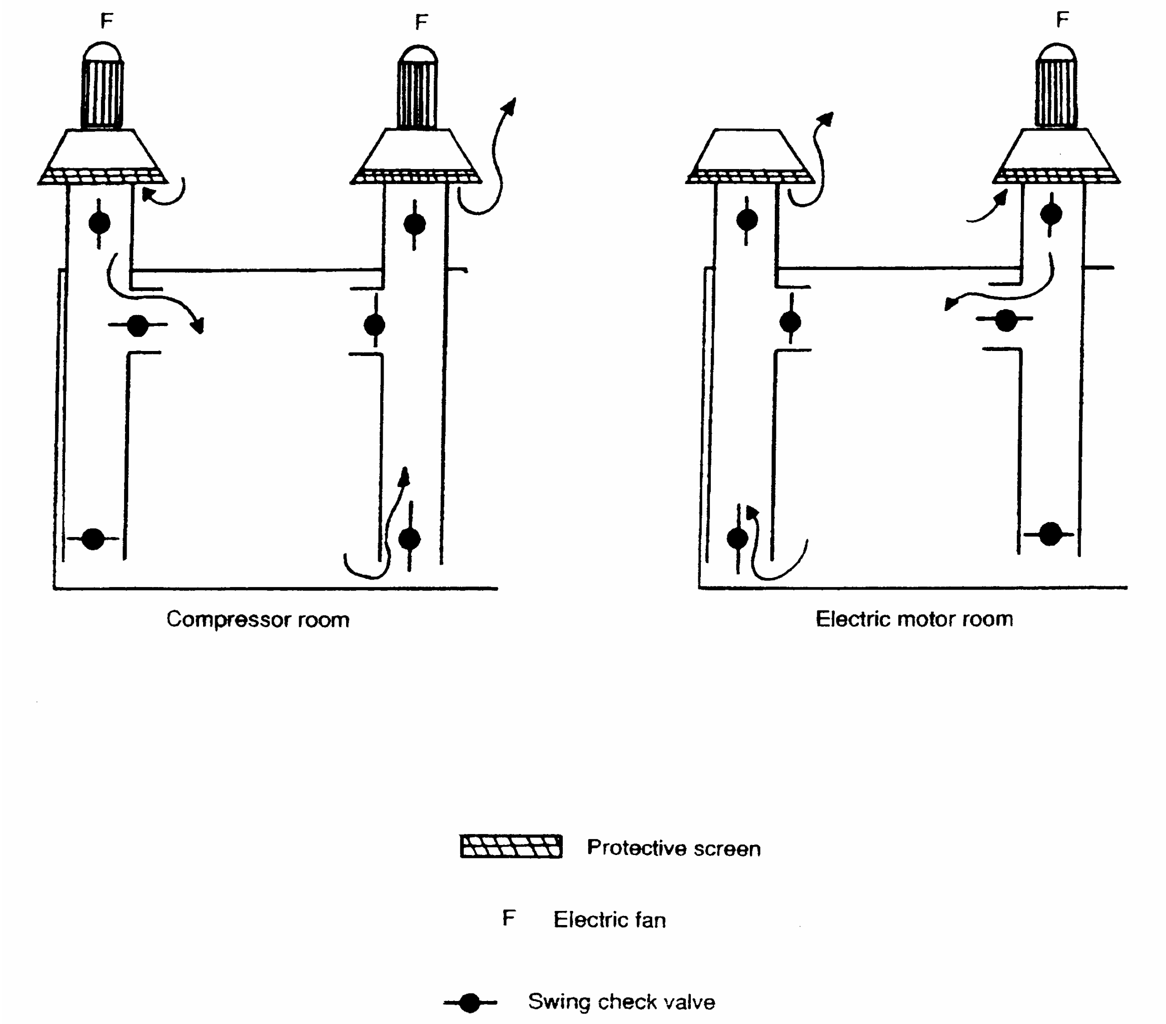


Figure 29: Ventilation arrangement of a deck-house

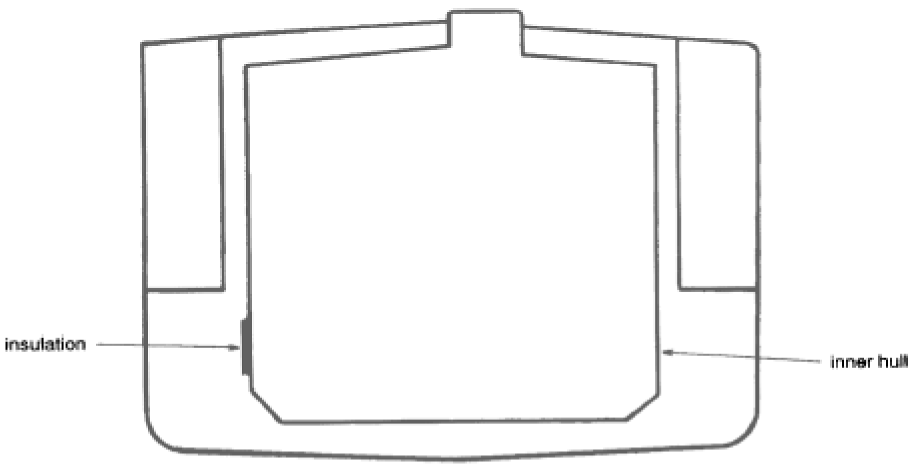


Figure 30: An integral tank

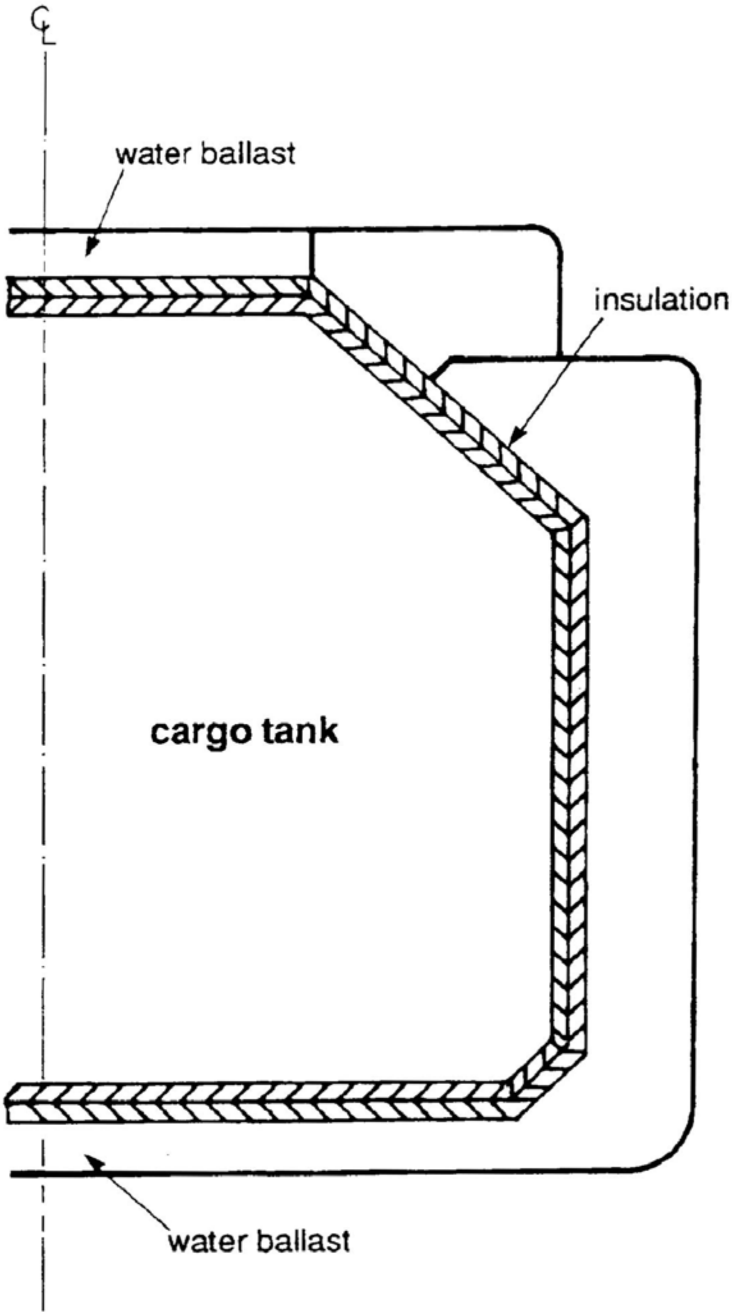
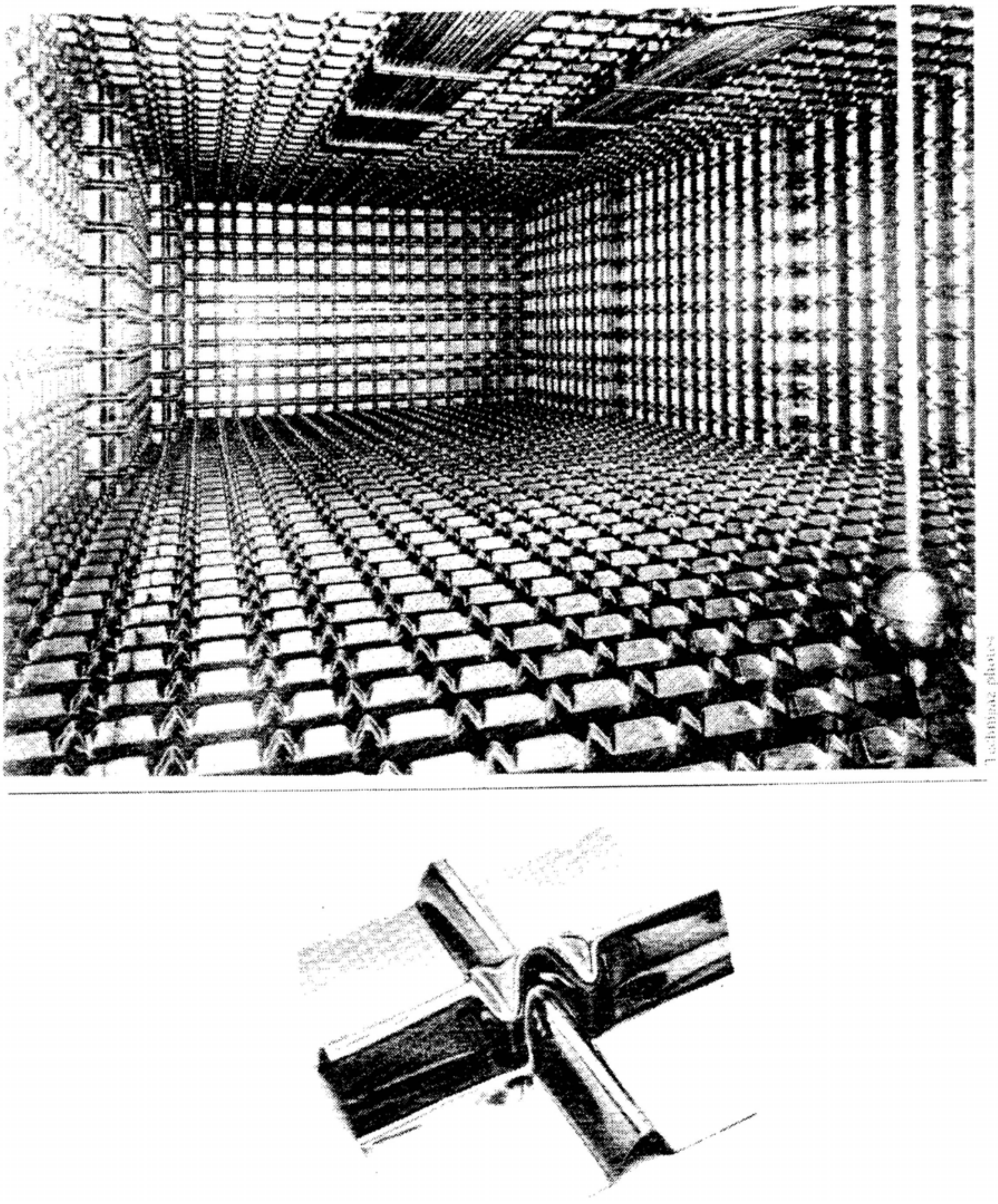


Figure 31: A Gas Transport membrane tank



Section of
primary barrier

Figure 32: A Technigaz membrane tank

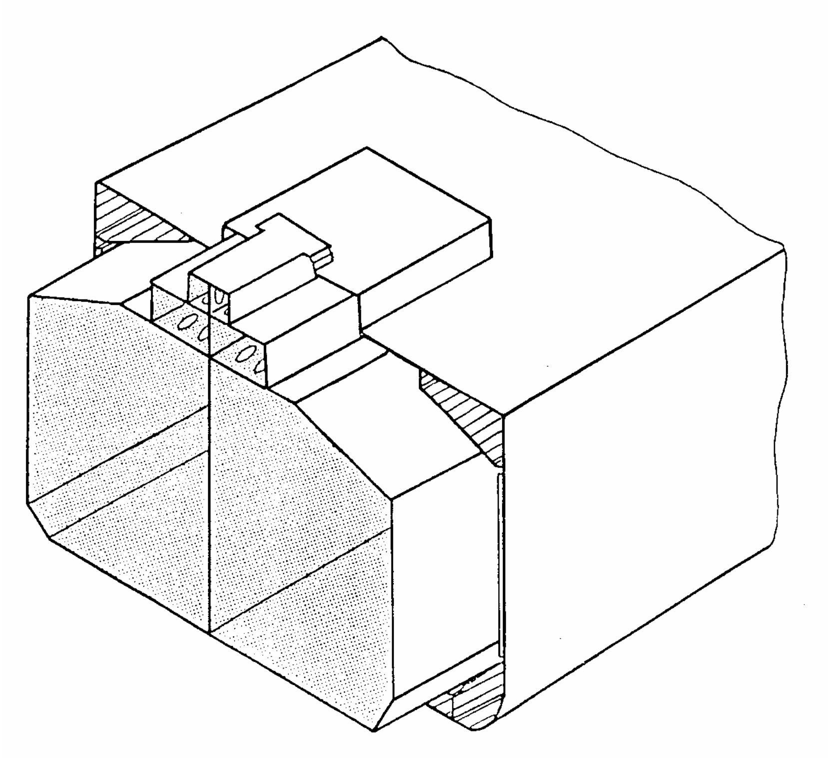


Figure 33: An independent tank

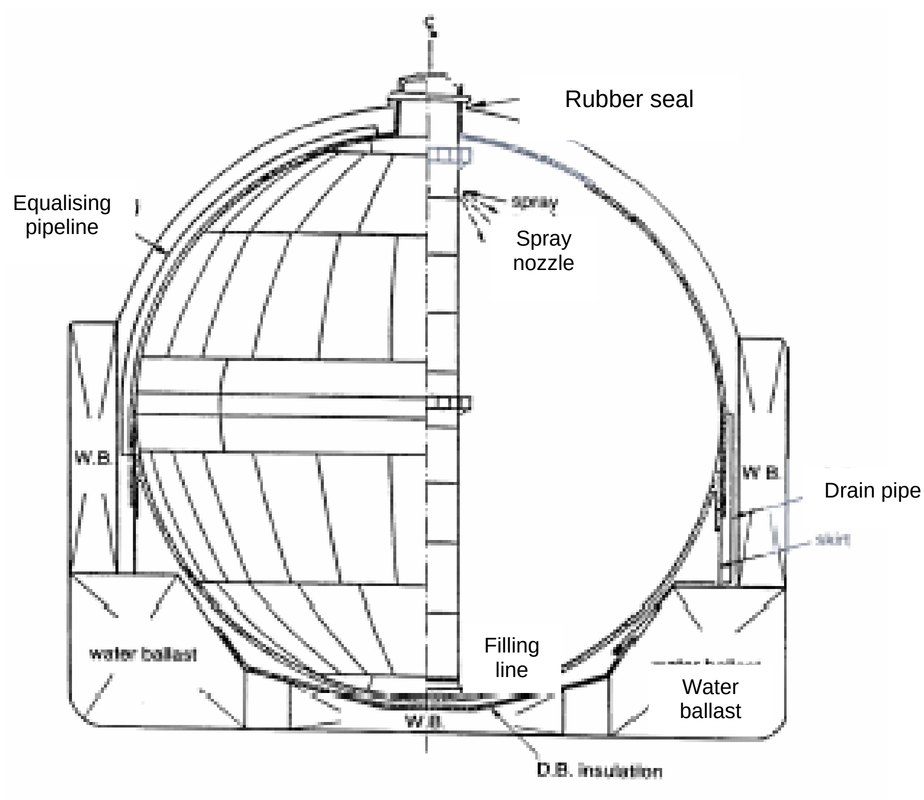


Figure 34: An independent tank for LNG

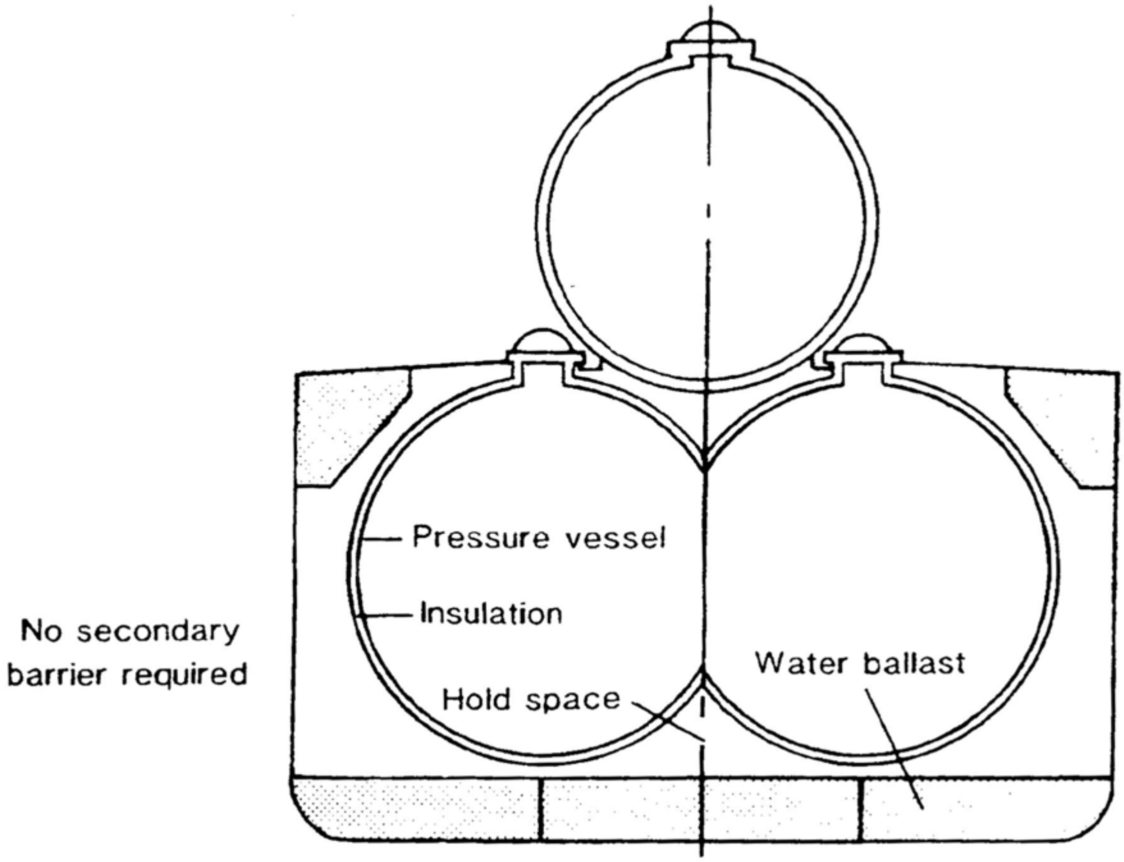


Figure 35: Examples of other independent tanks

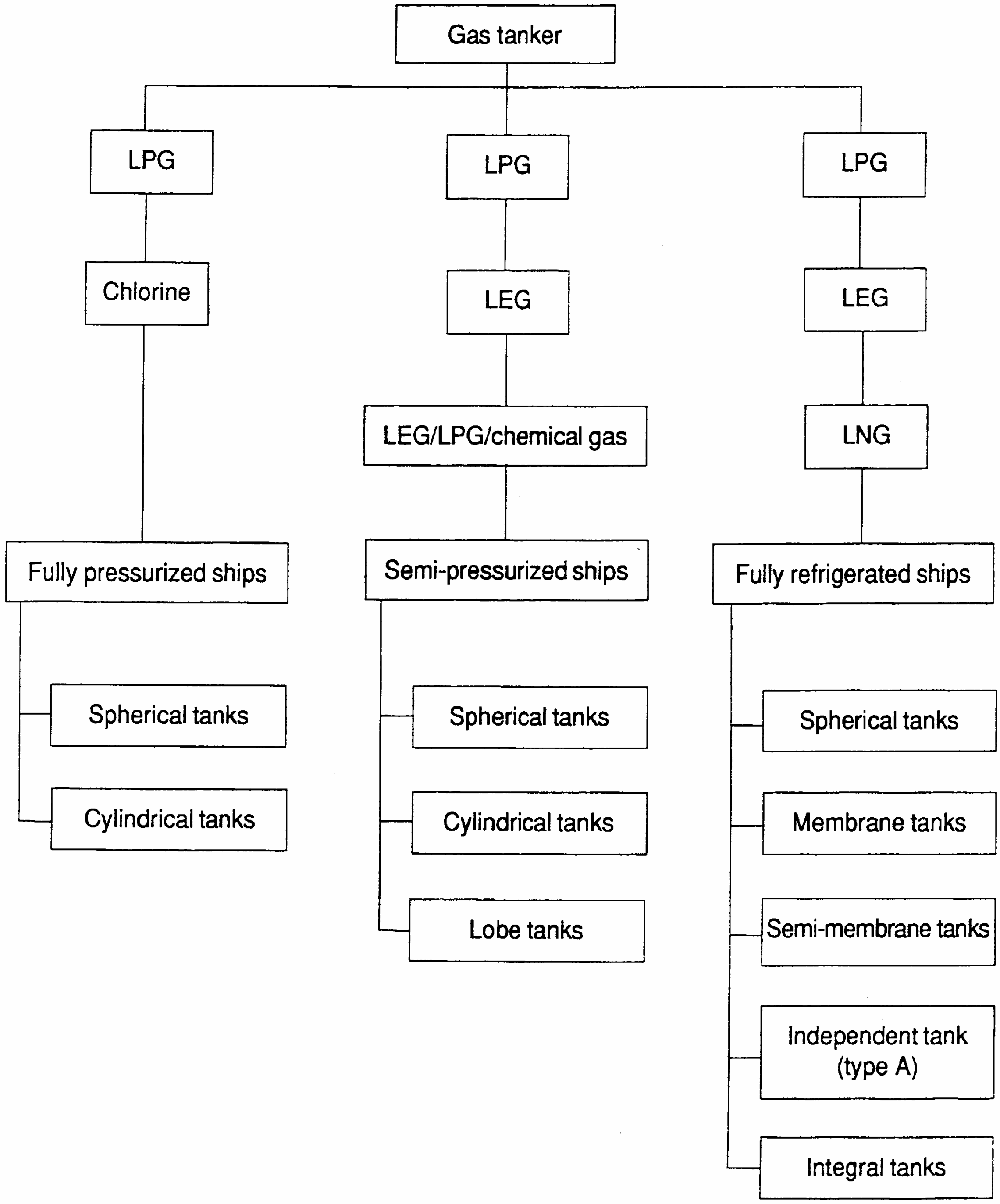


Figure 36: Block diagram describing gas tanker types and the relationship between the cargo carried, condition and the cargo-containment system normally used

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

Figure 37: Secondary barrier requirements

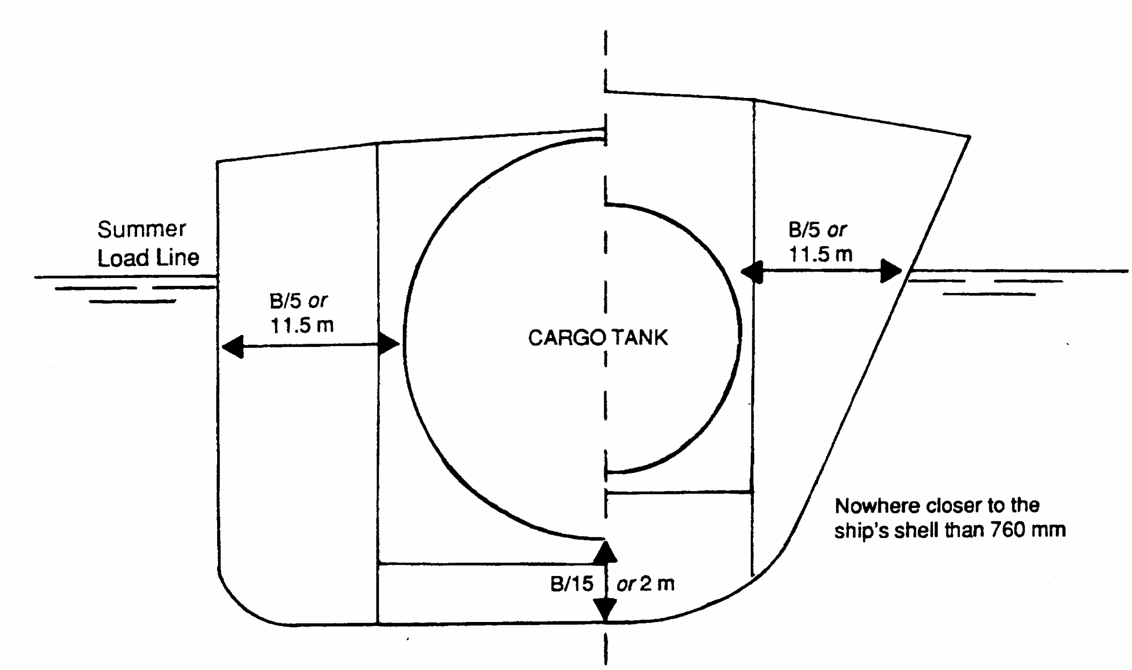


Figure 38: Location of cargo tanks in a ship of type 1G

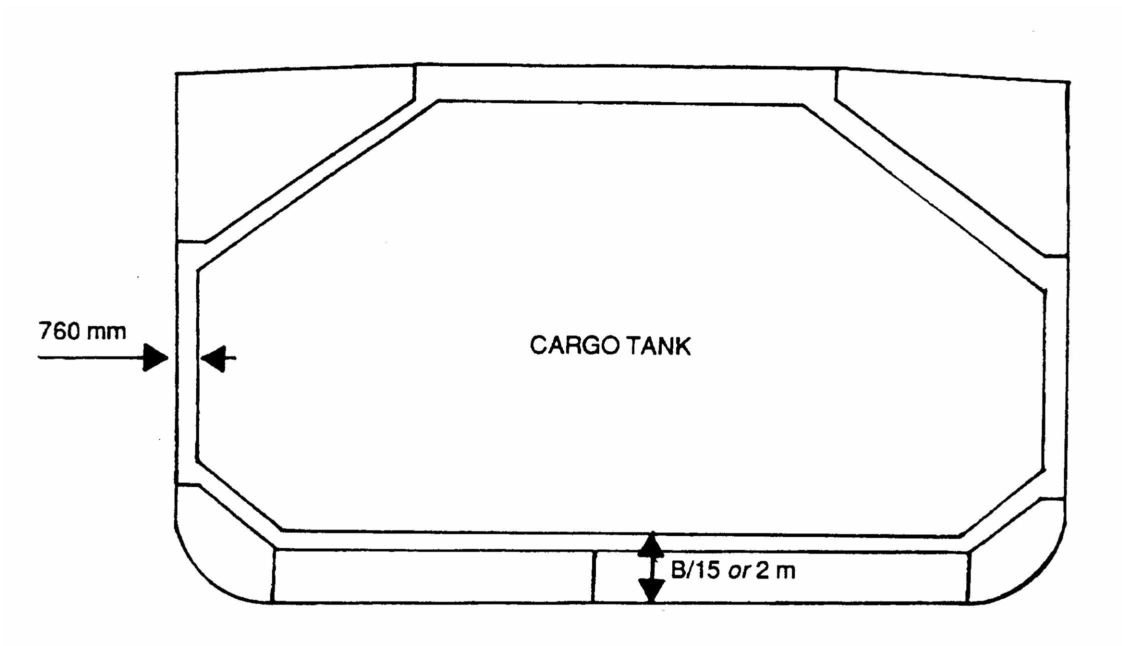


Figure 39: Location of cargo tanks in a ship of type 2G, 2PG and 3G

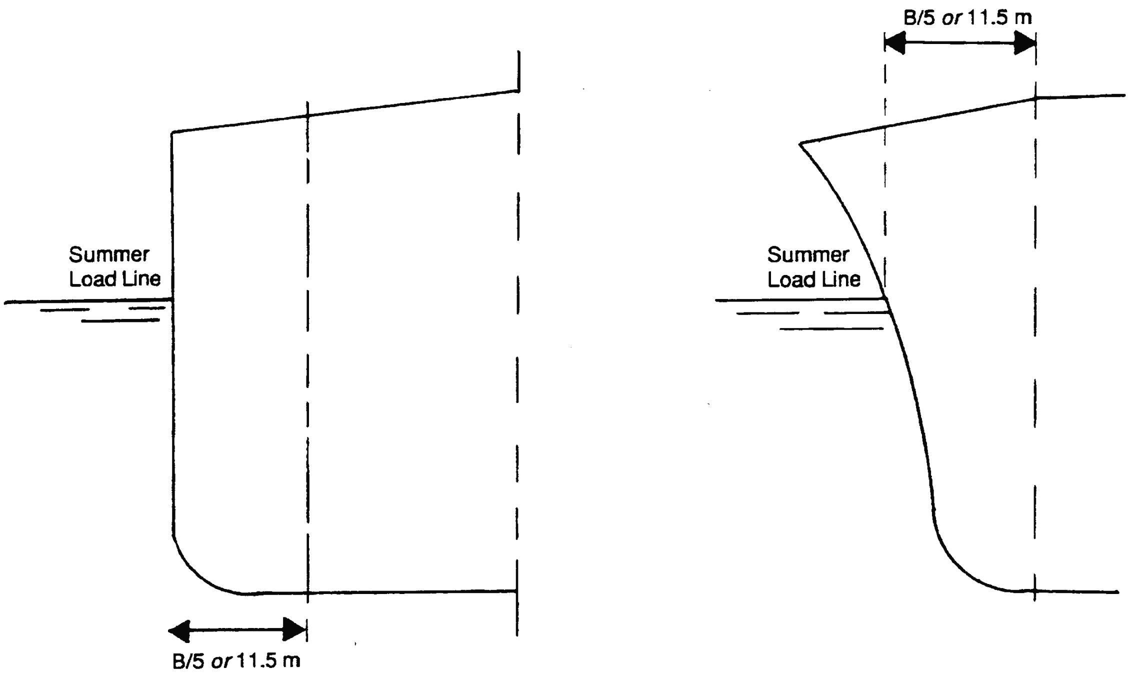
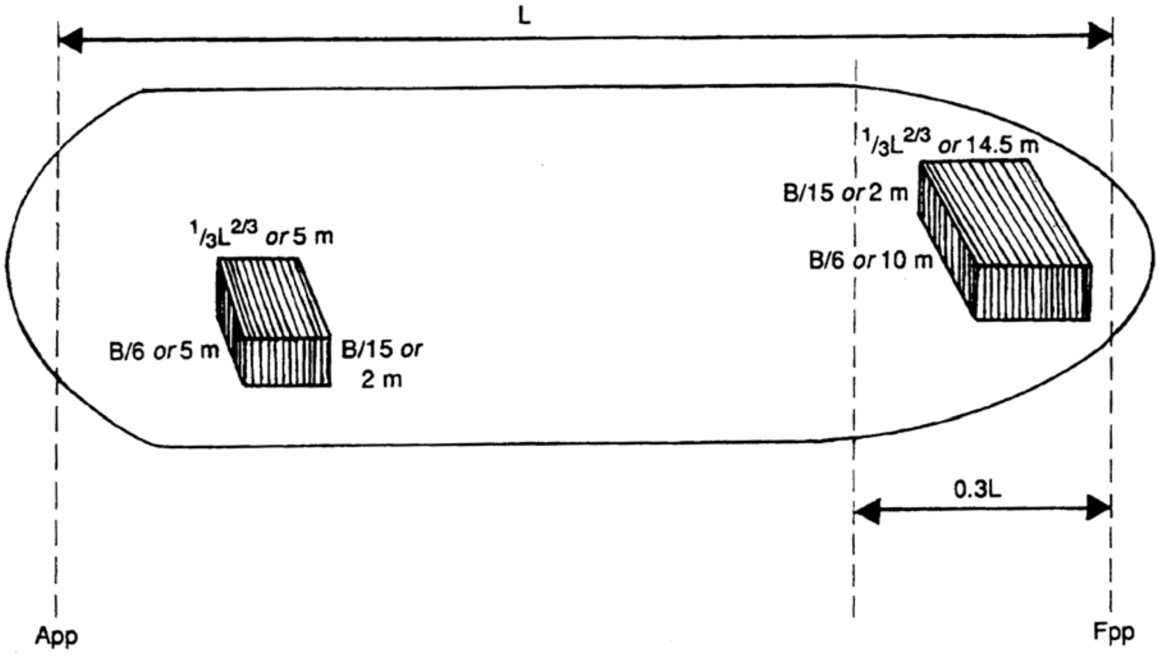


Figure 40: Assumed maximum extent of side damage



"L" and "B" are as defined in
Reg. 3 of the Load Line Convention

Figure 41: Assumed maximum extent of bottom damage

Ships should be capable of surviving defined damage with the flooding assumptions to the determined by the ship's type according to the following standards:		
1G	Sustain damage anywhere in its length	
2G	Sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft	Sustain damage anywhere in its length
2PG	Sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage	
3G	Sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage involving machinery space located aft	Sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage
		← 150 m or more in length ← 125 m or more in length

Figure 42: Standard of damage

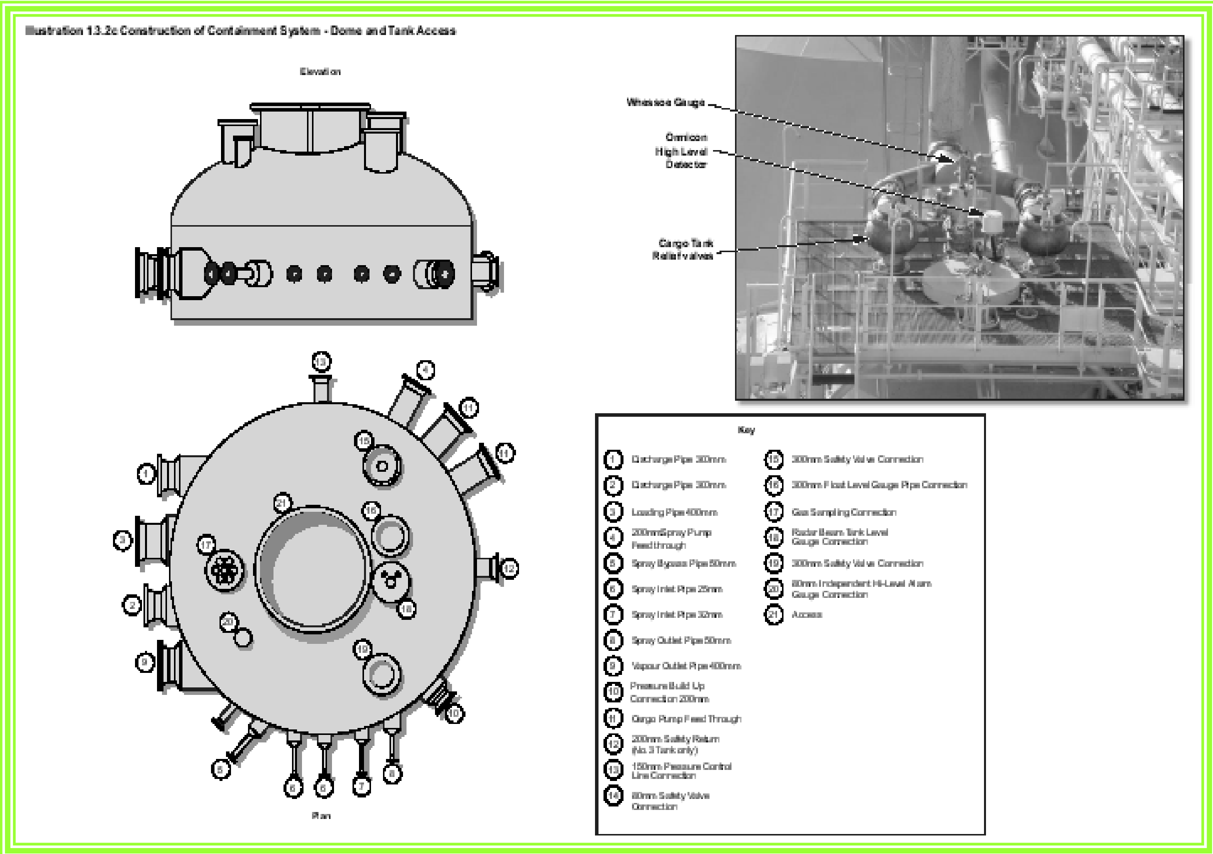


Figure 43: Arrangement of the pipes and valves of a cargo tank

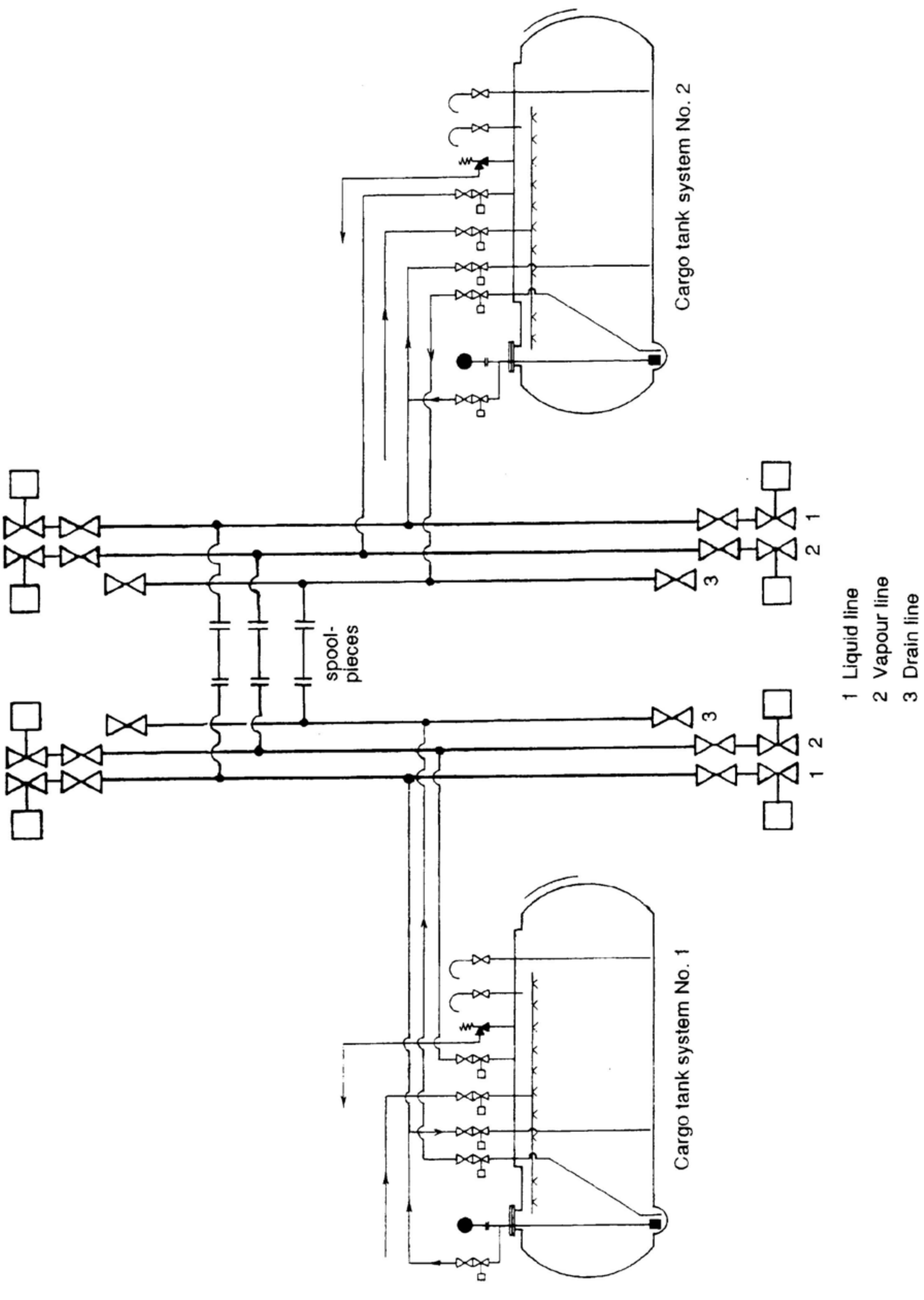


Figure 44: Simplified diagram of the arrangement of cargo piping

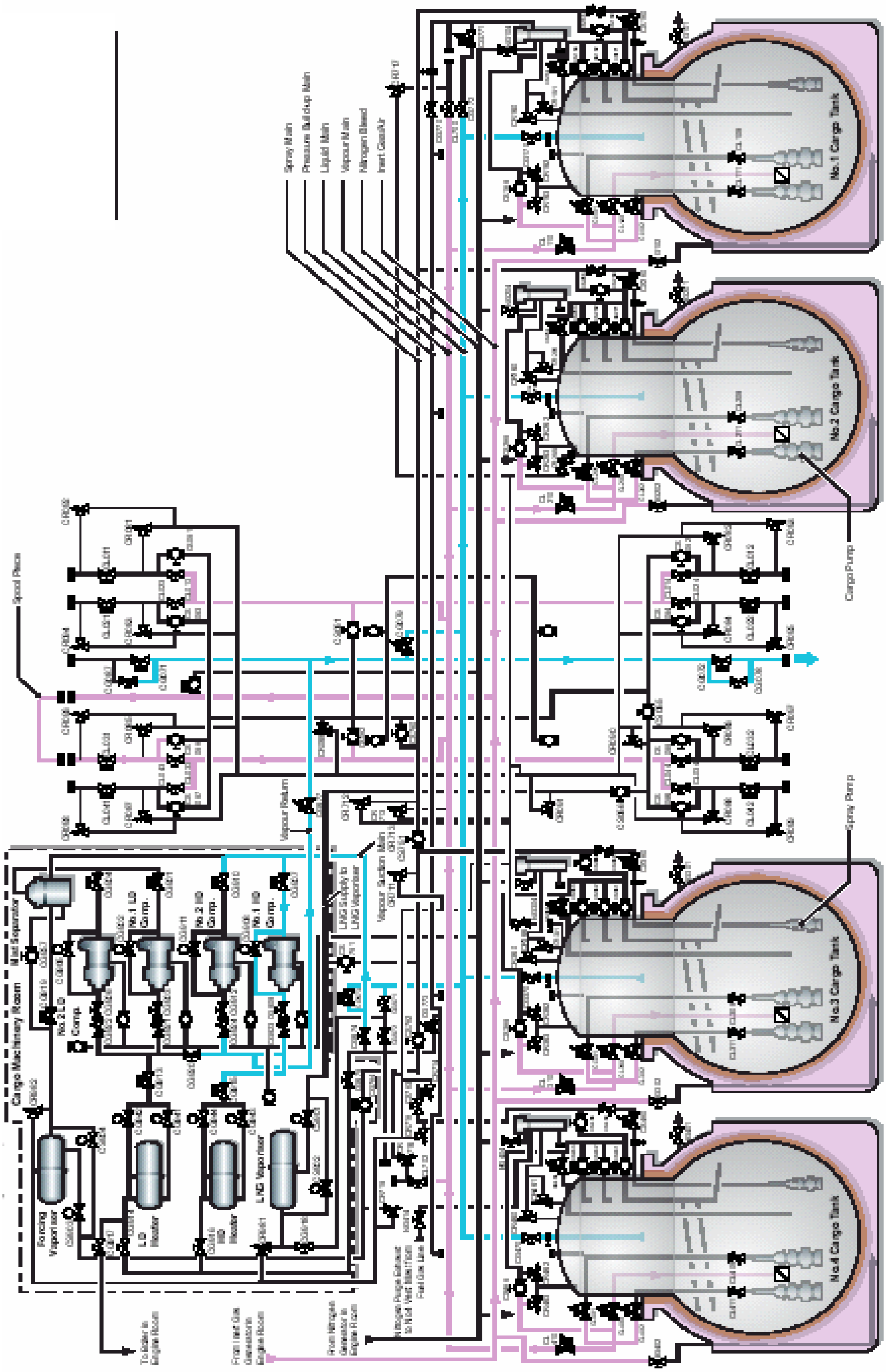


Figure 45: Complete cargo handling arrangement for an LNG Tanker

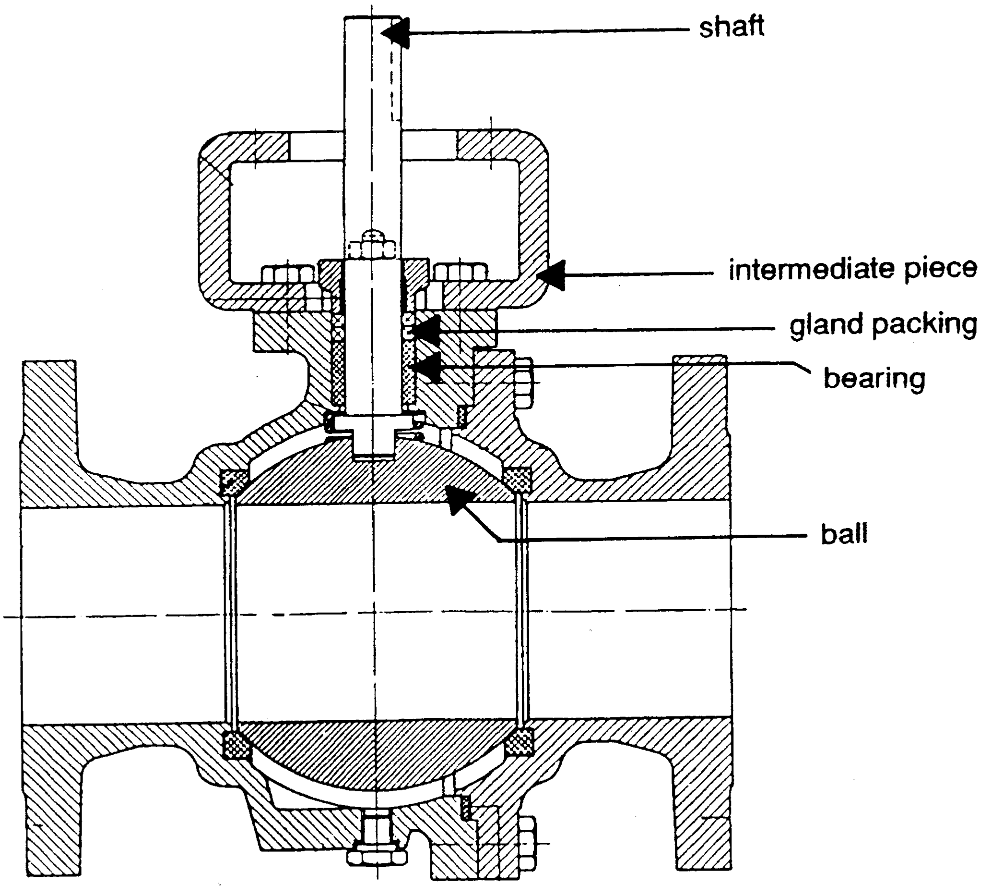


Figure 46: Example of a ball valve

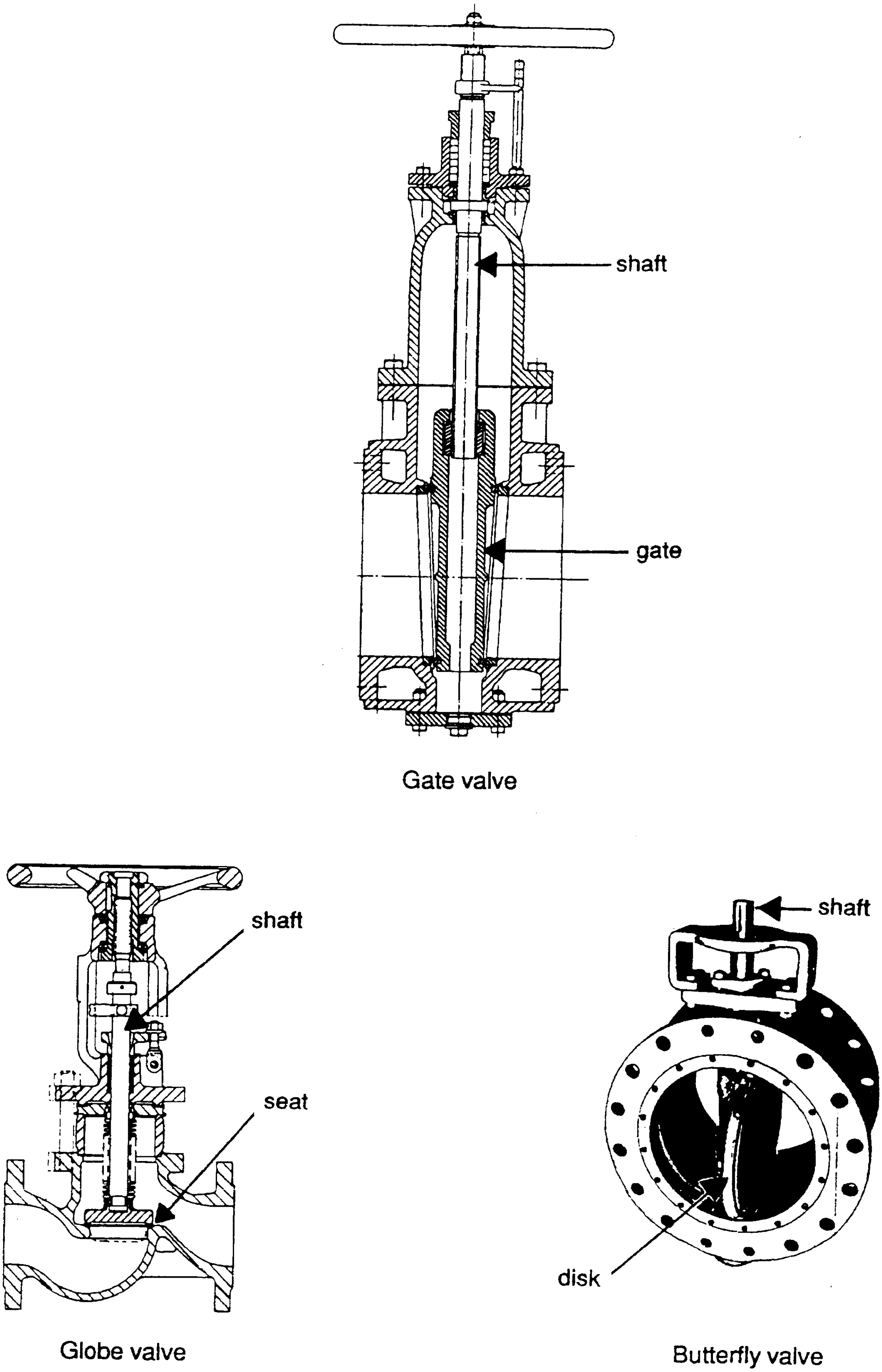


Figure 47: Example of gate globe and butterfly valves

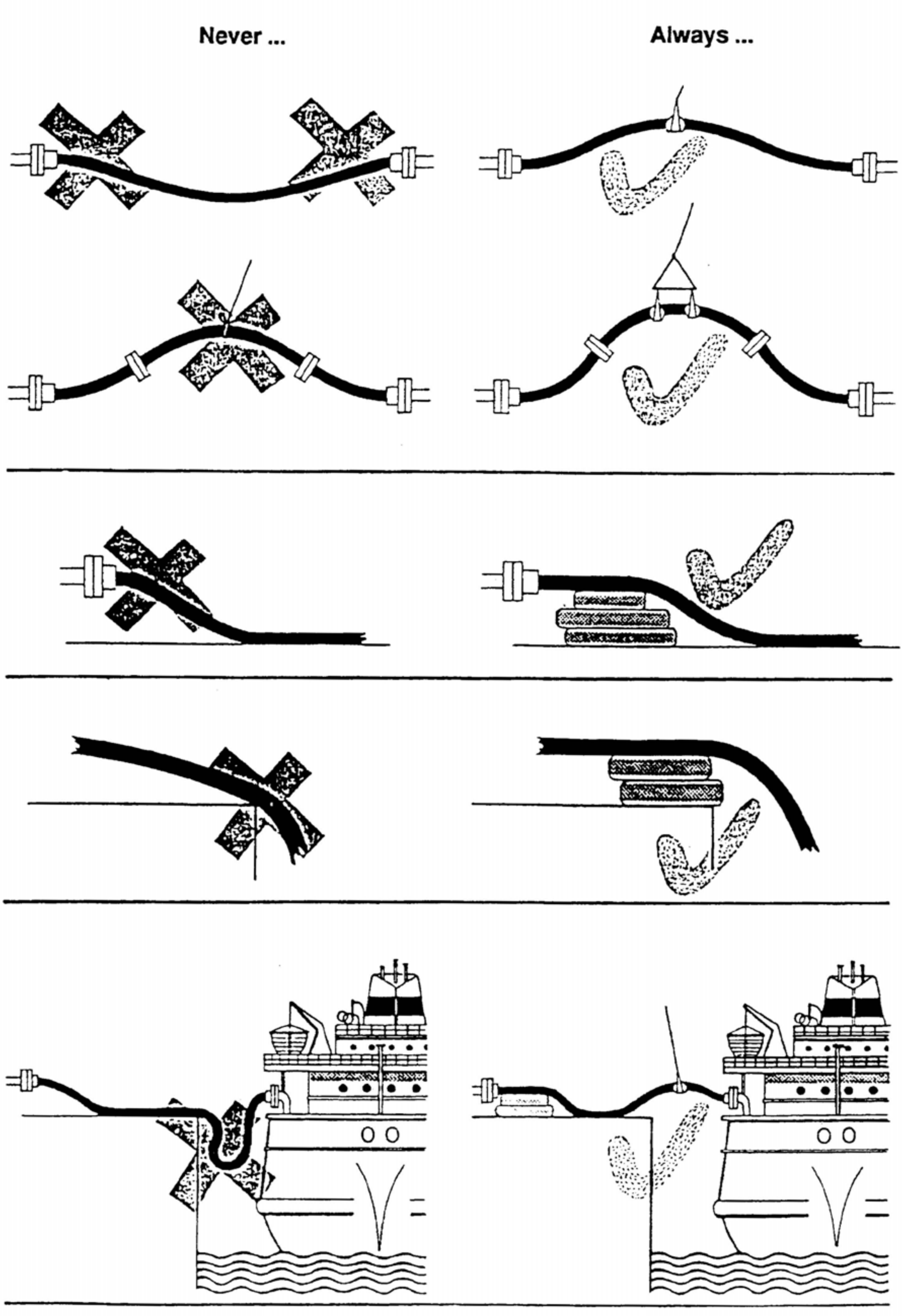


Figure 48: Handling a cargo hose

LIQUEFIED GAS-CARGO HOSE FORM

SHIP:

HOSE IDENTIFICATION:

1.	MAXIMUM WORKING PRESSURE	(This should be stencilled or marked on hose)
2.	MAXIMUM & MINIMUM WORKING TEMPERA TURES..	(These should be stencilled or marked on hose)
3.	SUITABLE FOR CARGOES OF	(This should be stencilled or marked on hose)
4.	TEST PRESSURE & PROCEDURE	(Note method of pressurisation, method of inspection (e.g. measurement of extension, visual inspection for leaks) and any precautions required.)

5.	TESTED (Date)	AT PRESSURE	APPROVED
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
	....	....	....
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Figure 49: Liquefied gas cargo hose form

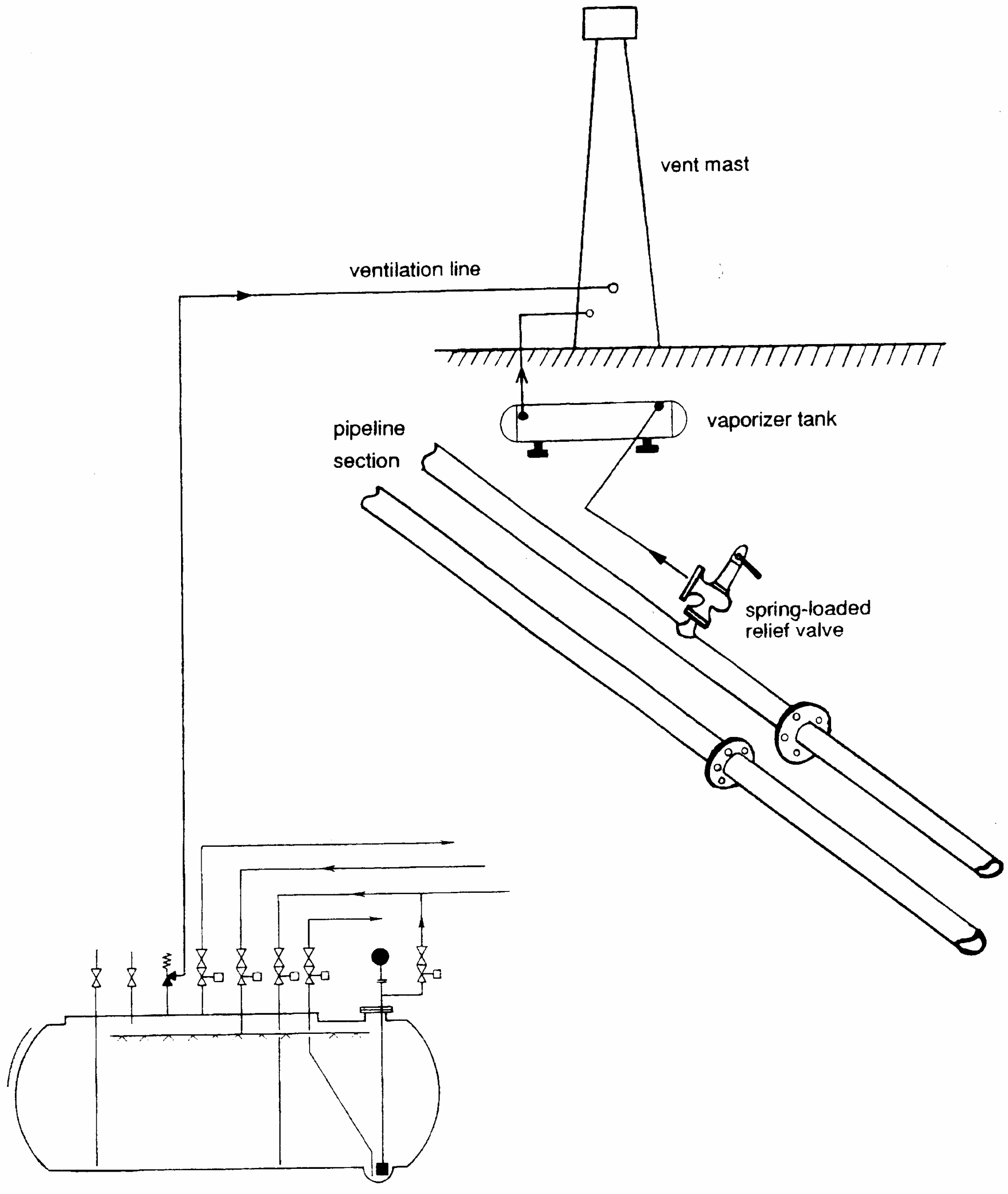


Figure 50: Schematic diagram of a pressure relief system

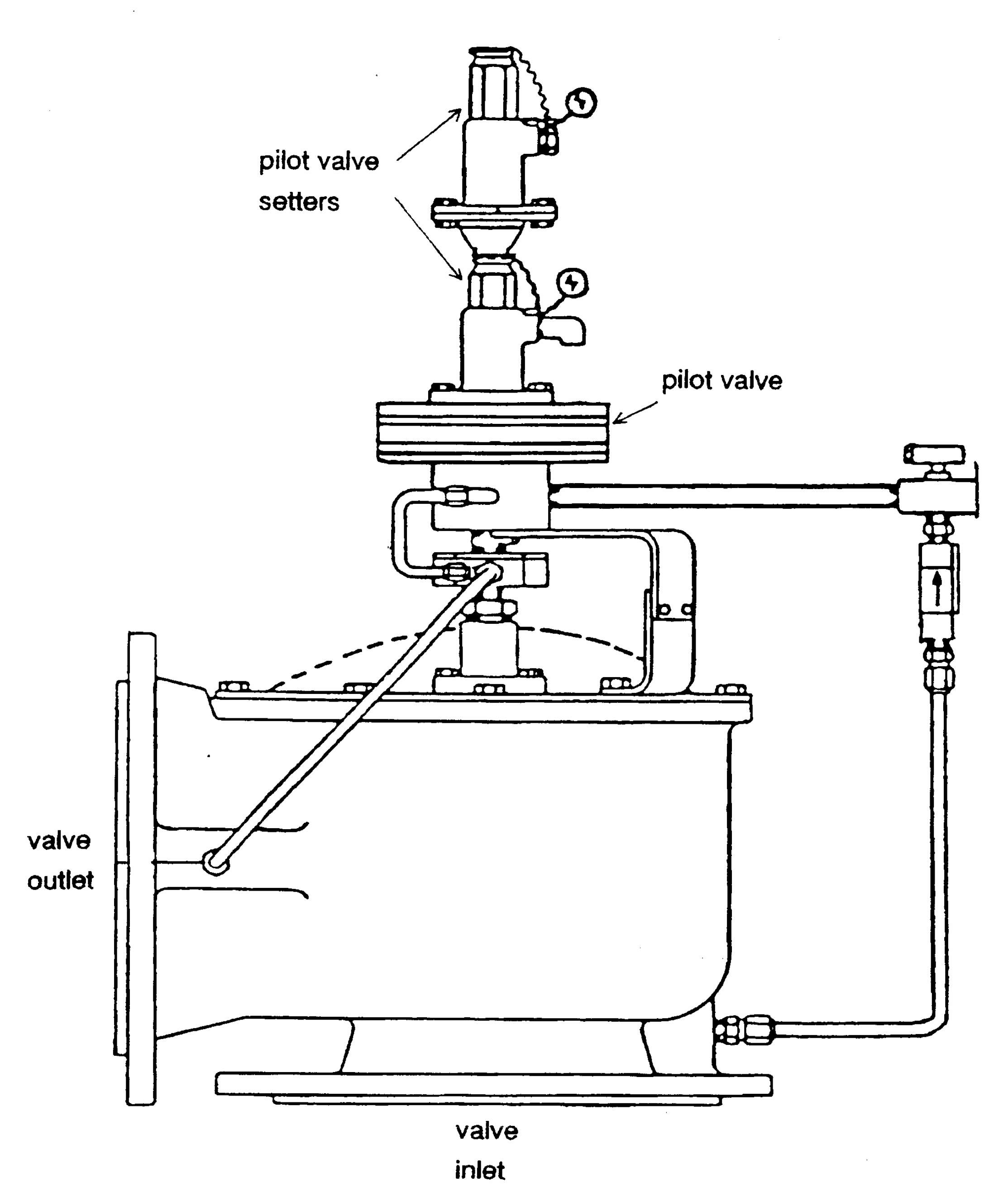


Figure 51: A cargo tank safety relief valve

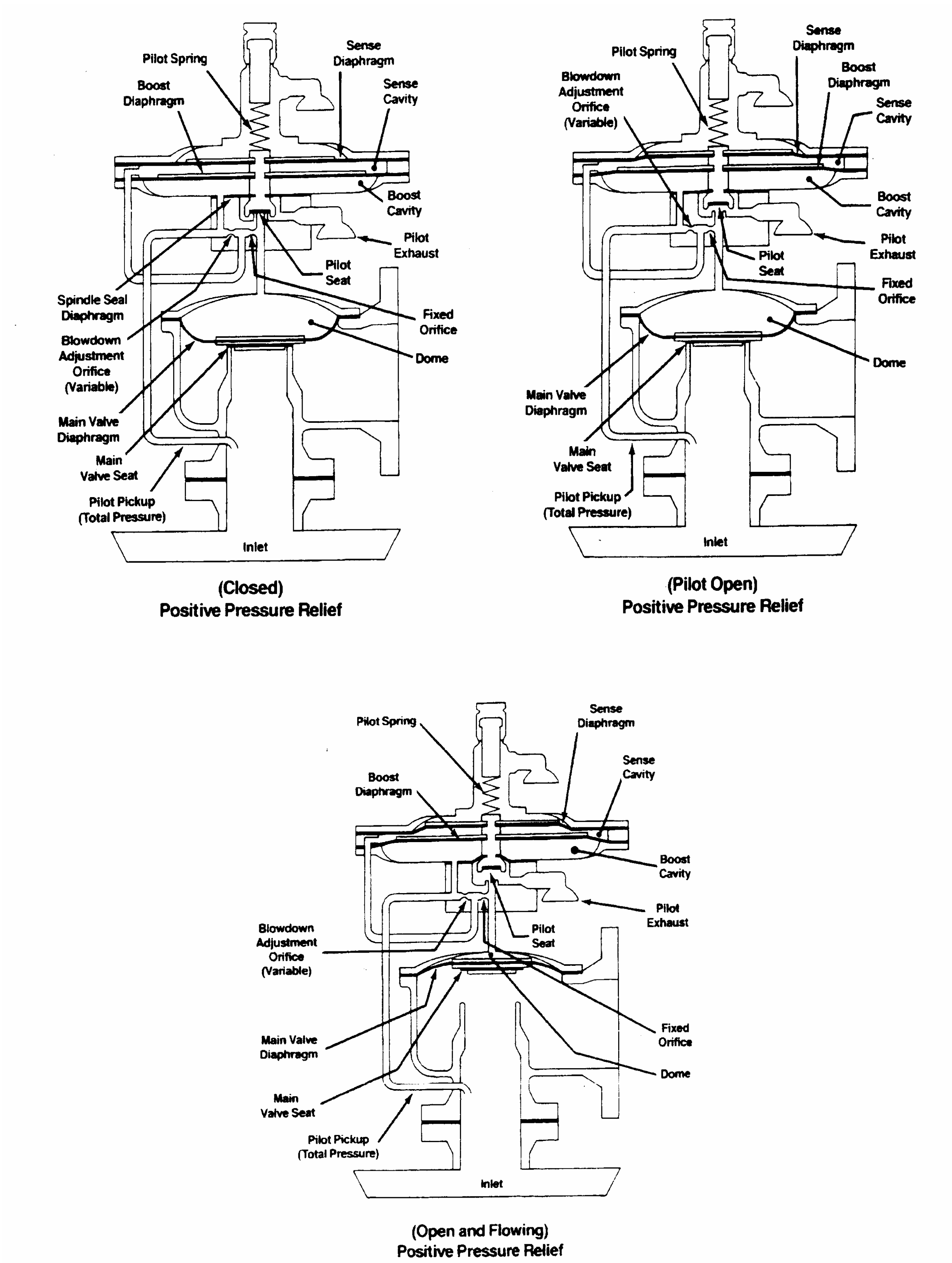


Figure 52: Operational principle of a tank sfety relief vavle (AGCO)

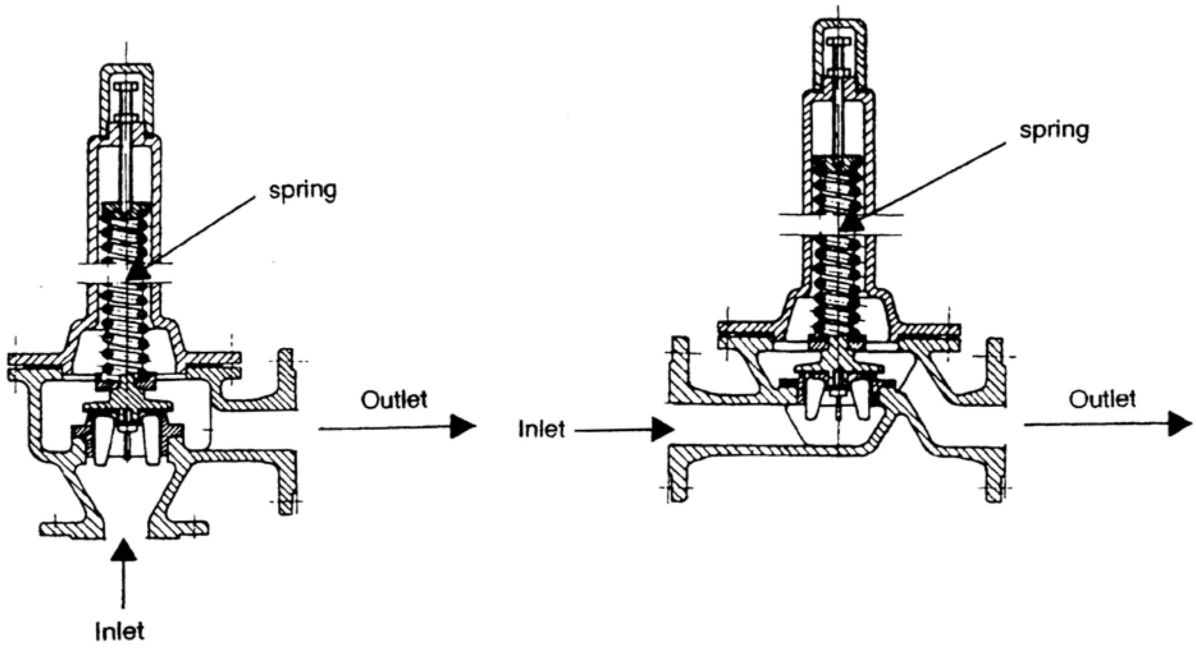


Figure 53: Spring-loaded relief valves

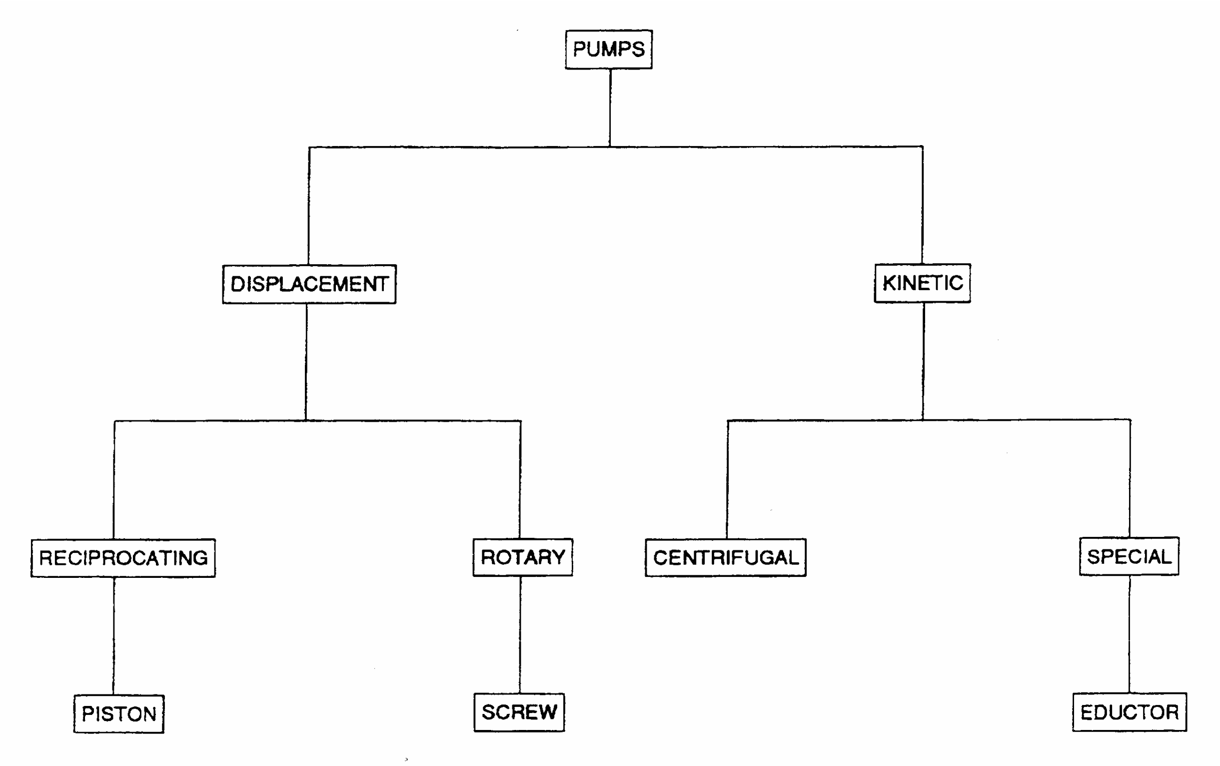


Figure 54: Pump types

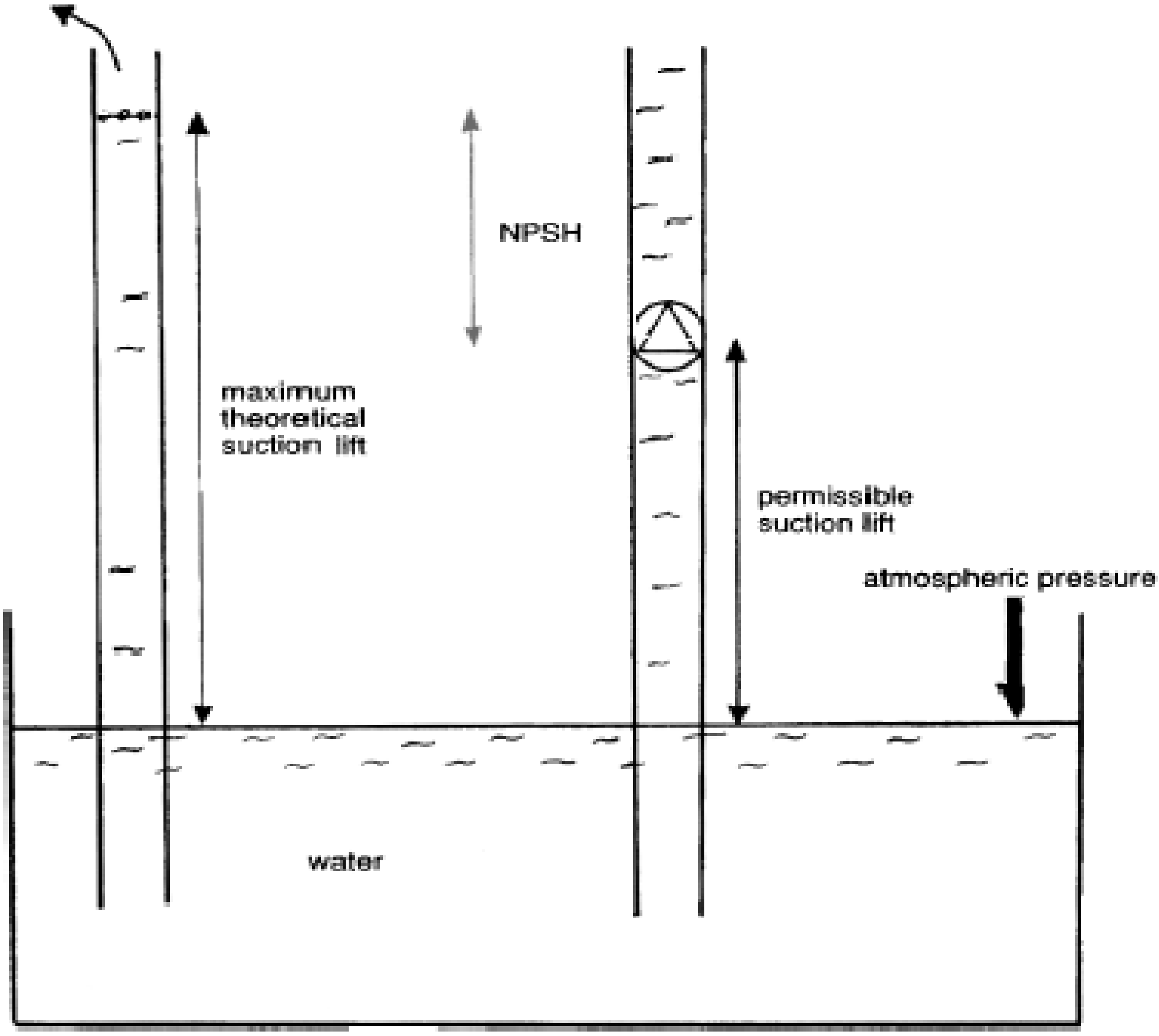


Figure 55: Suction lift

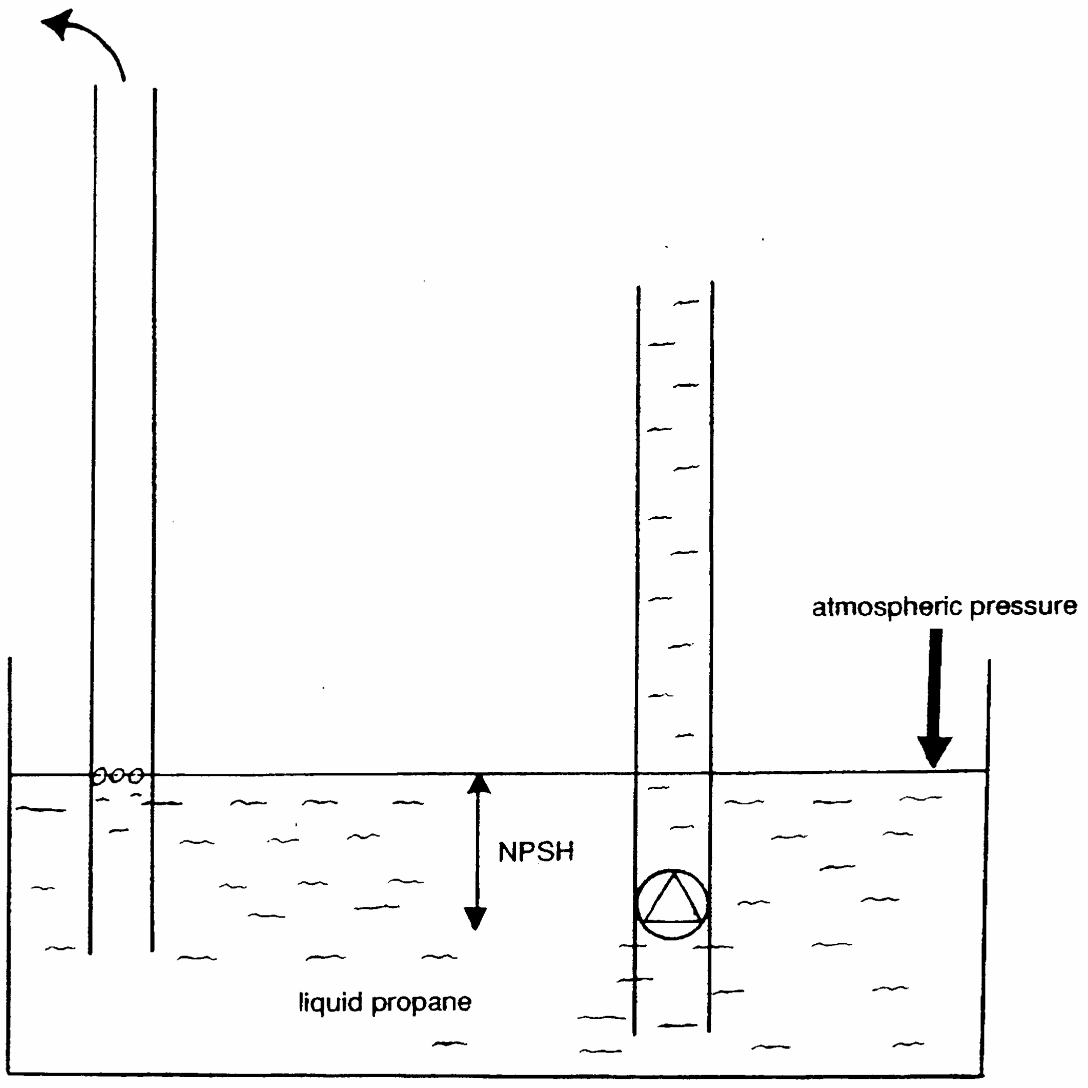


Figure 56: Required suction head

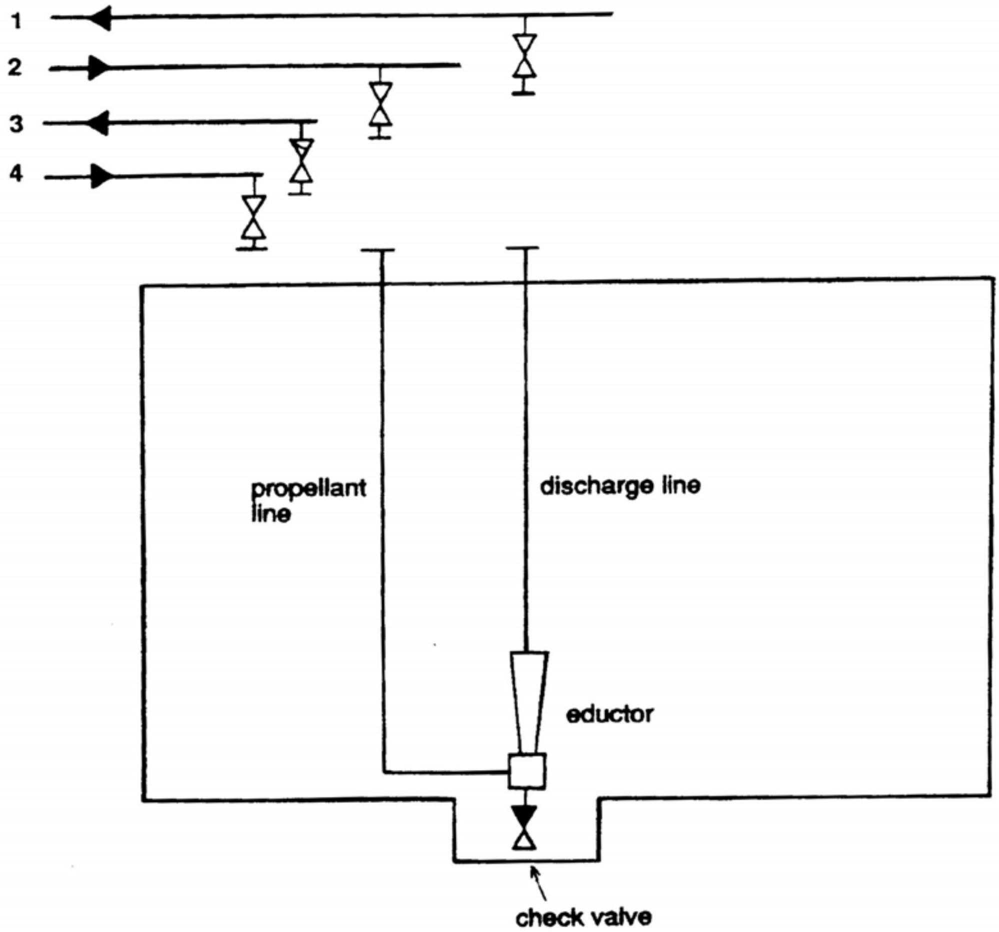


Figure 57: Hold-space bilge system

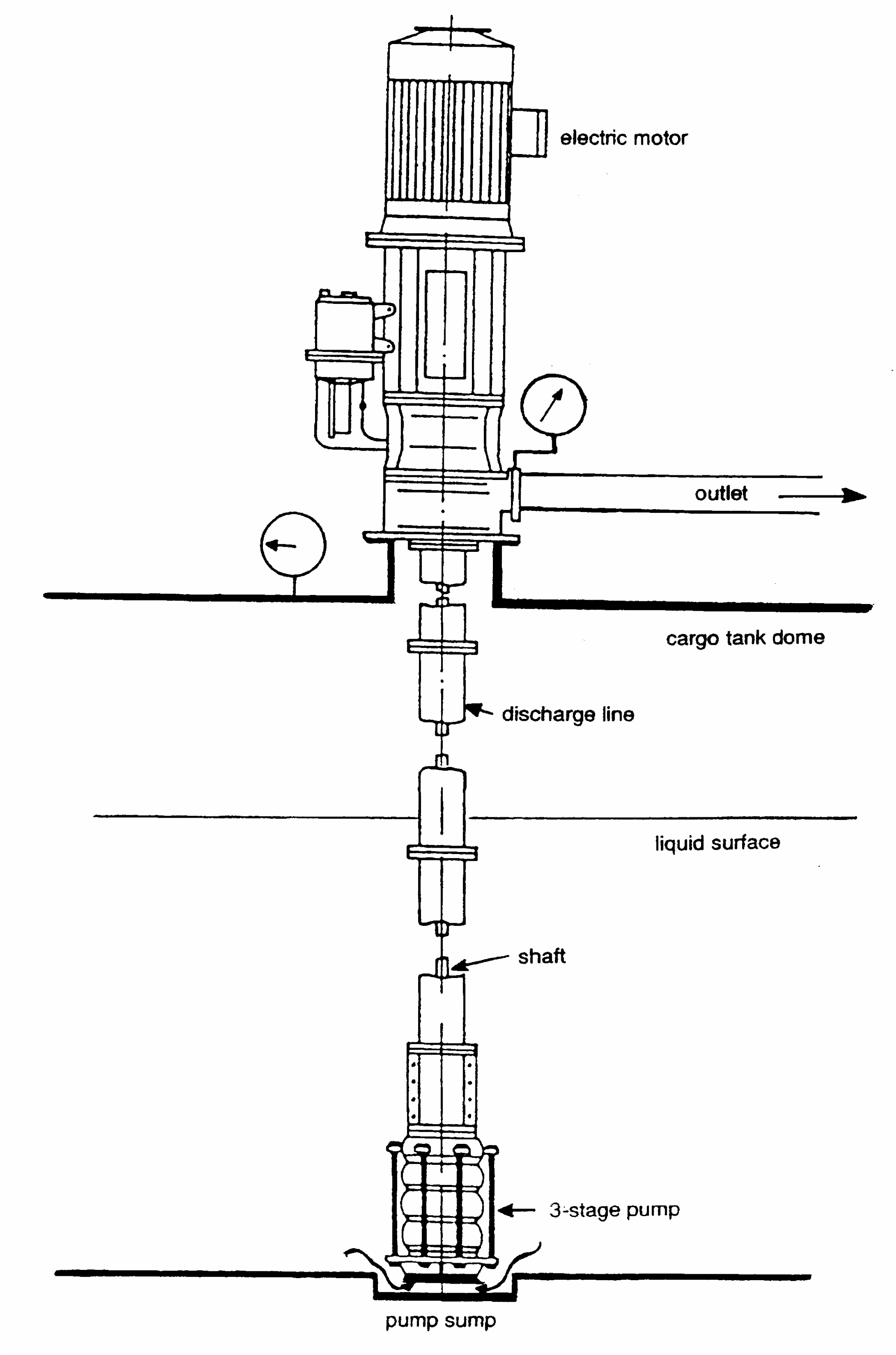


Figure 58: Deepwell pump (1)

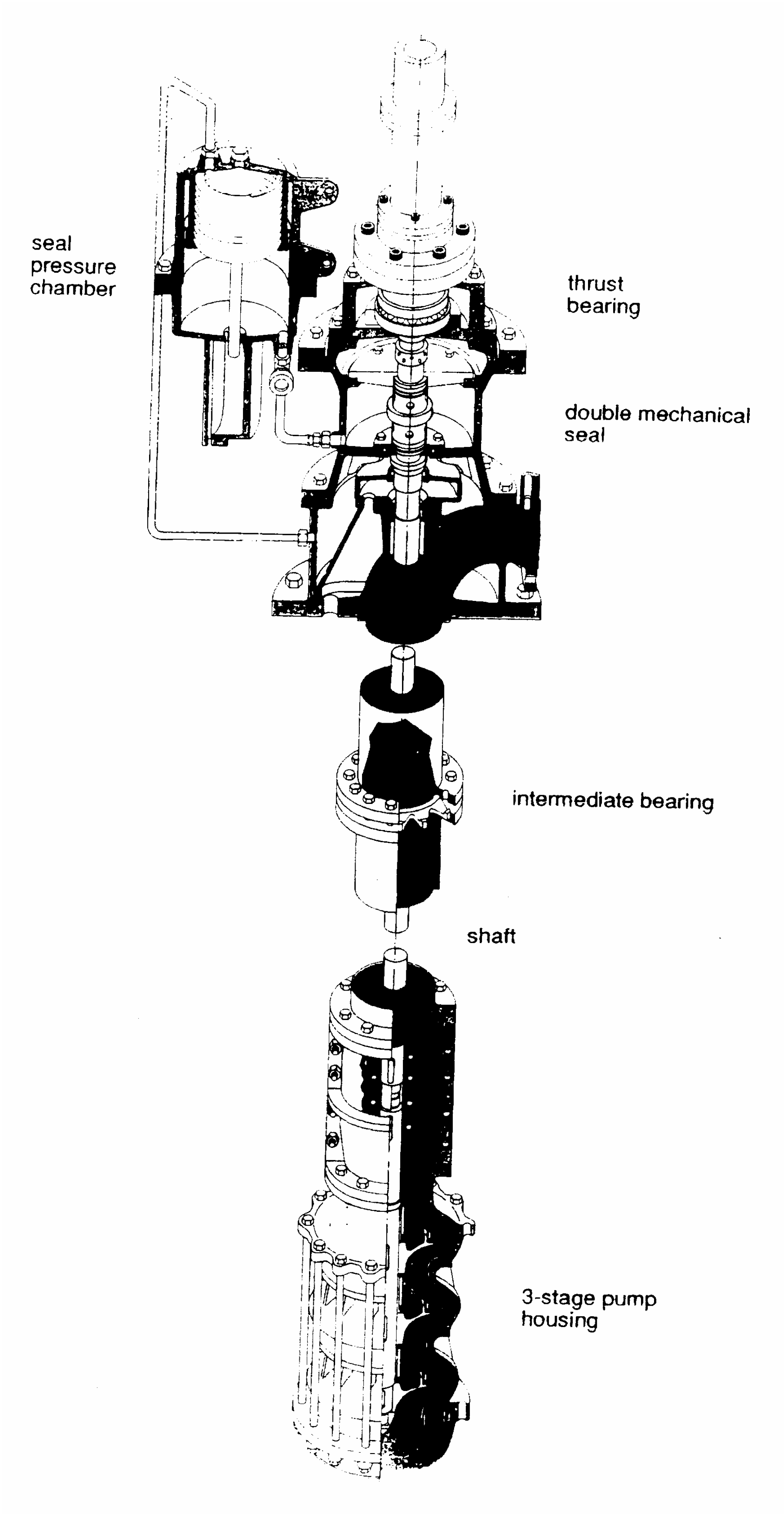


Figure 59: Deepwell pump (2)

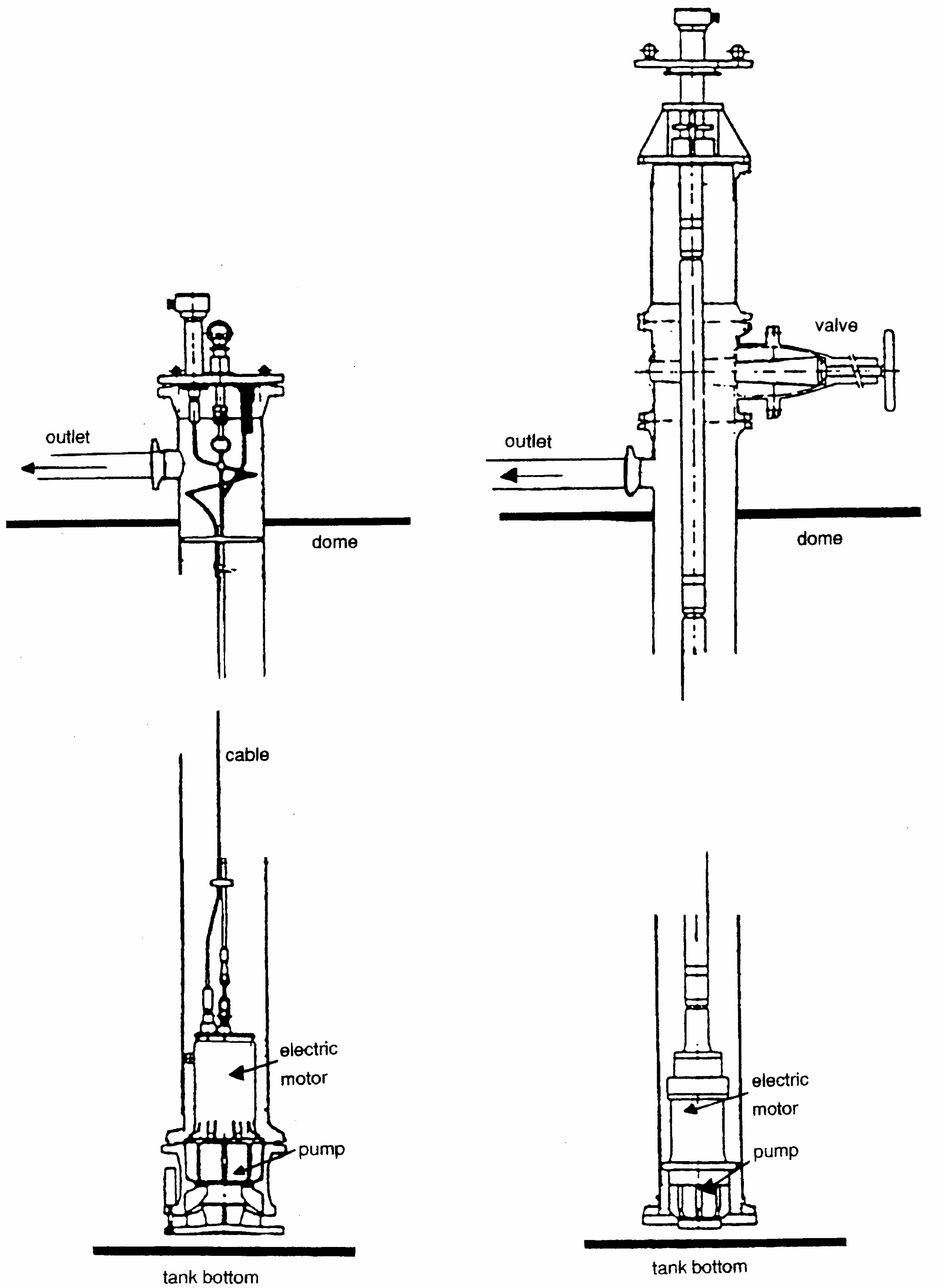
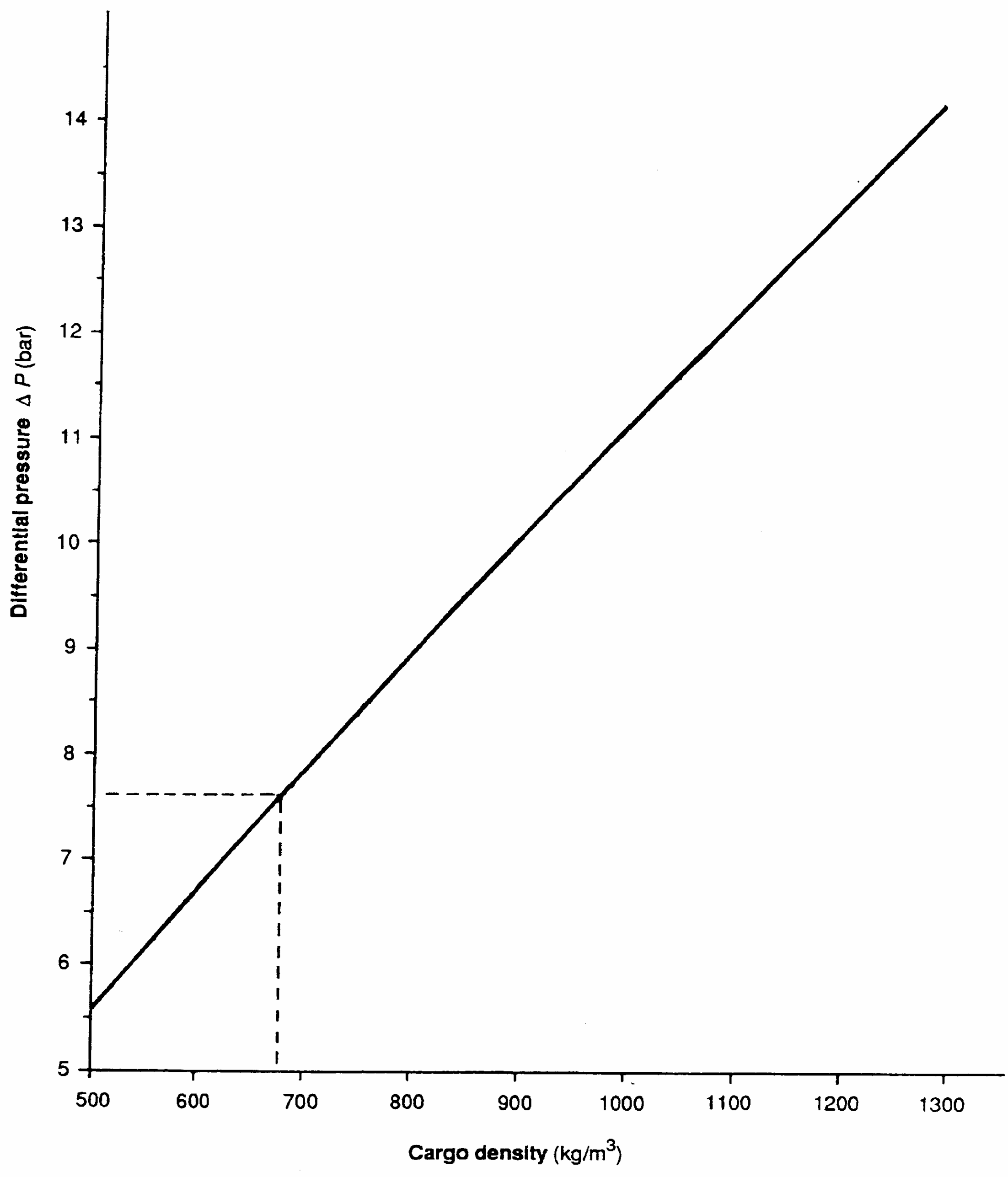


Figure 60: Examples of electrical submerged pumps



Example:

Cargo: ammonia

Temperature: –30 °C
Pressure: 0.2 bar gauge
Density: 678 kg/m^3
Setting: ΔP = 7.6 bar

Figure 61: Differential pressure-density relationship

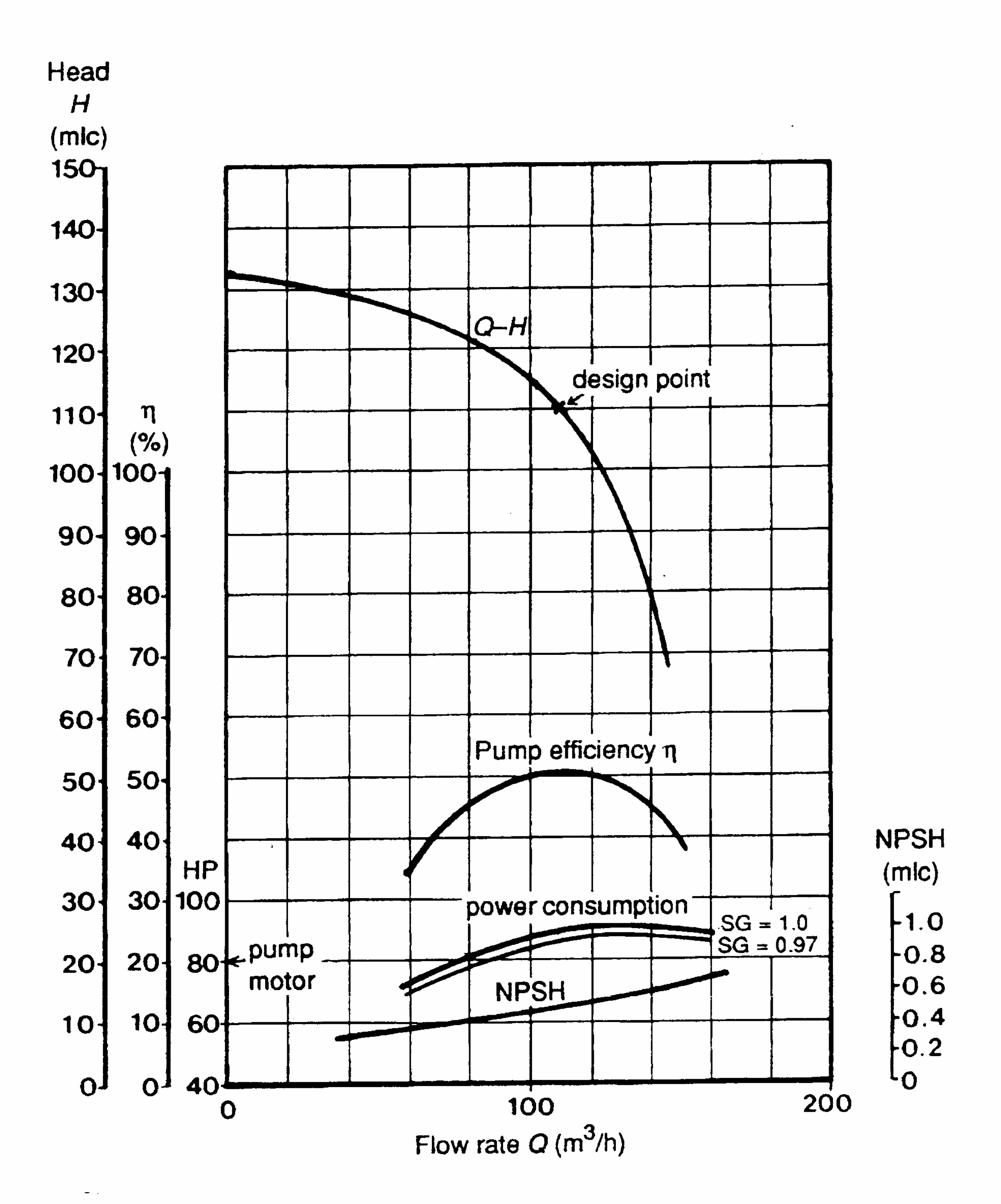


Figure 62: Pump performance curves for a typical deepwell pump

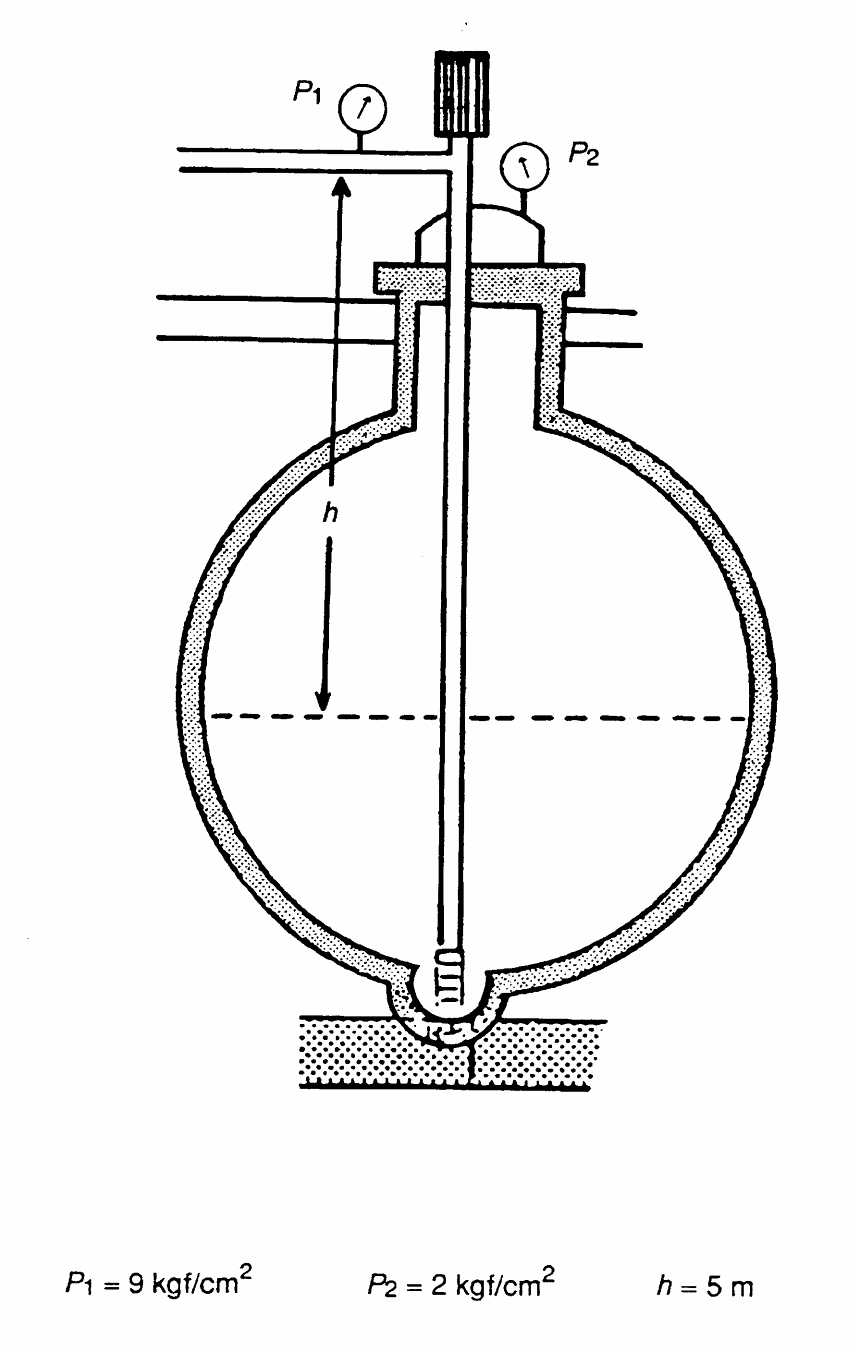


Figure 63: Checking pump flow

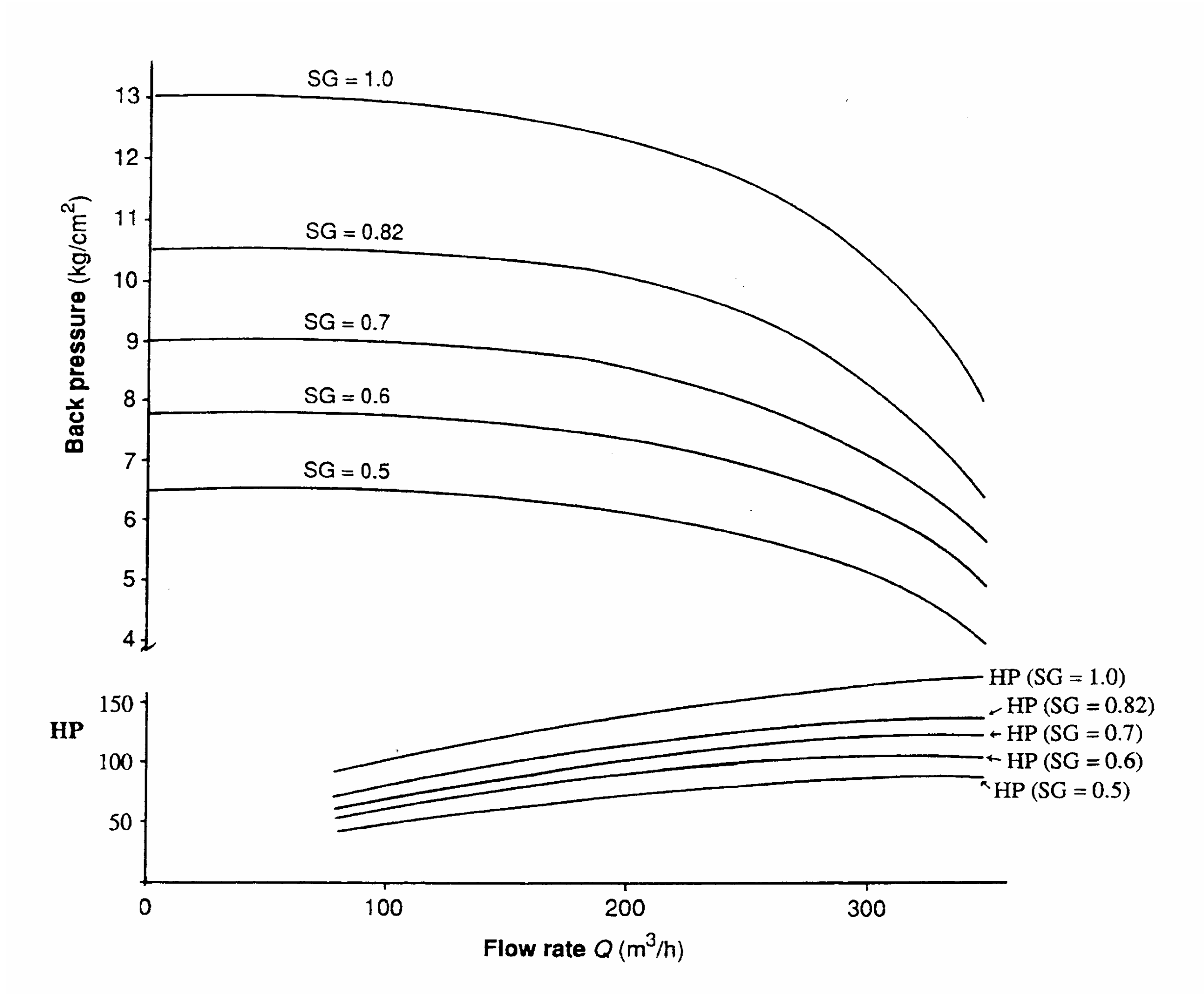
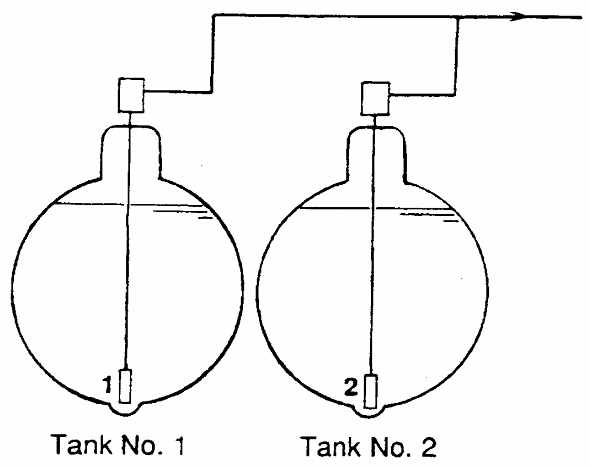


Figure 64: Pump characteristics for different specific gravities of pumped liquids



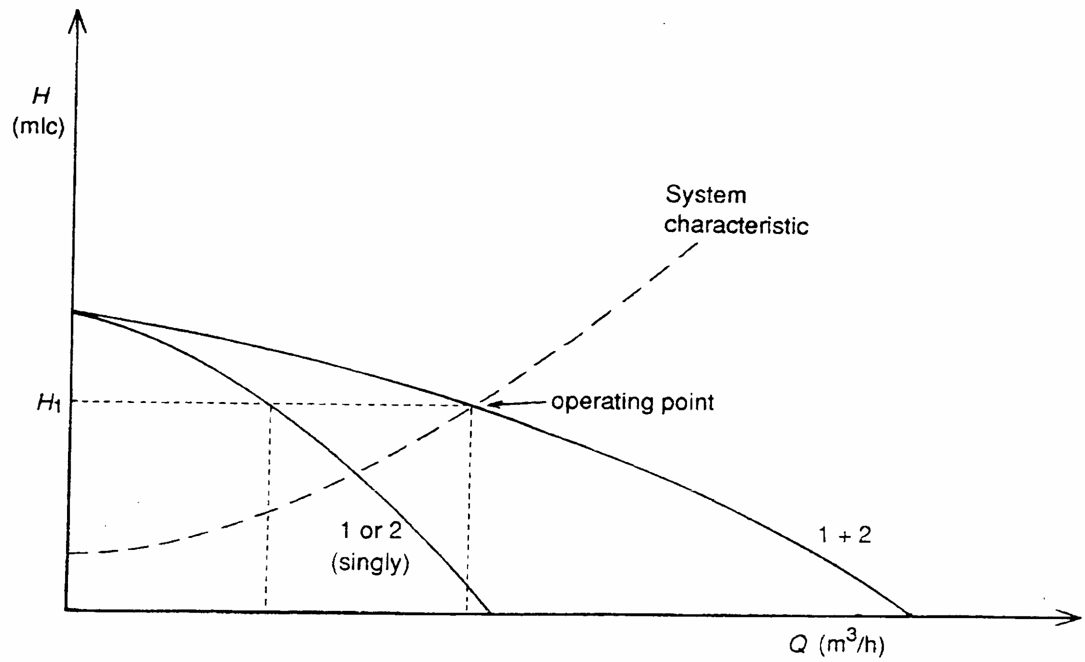
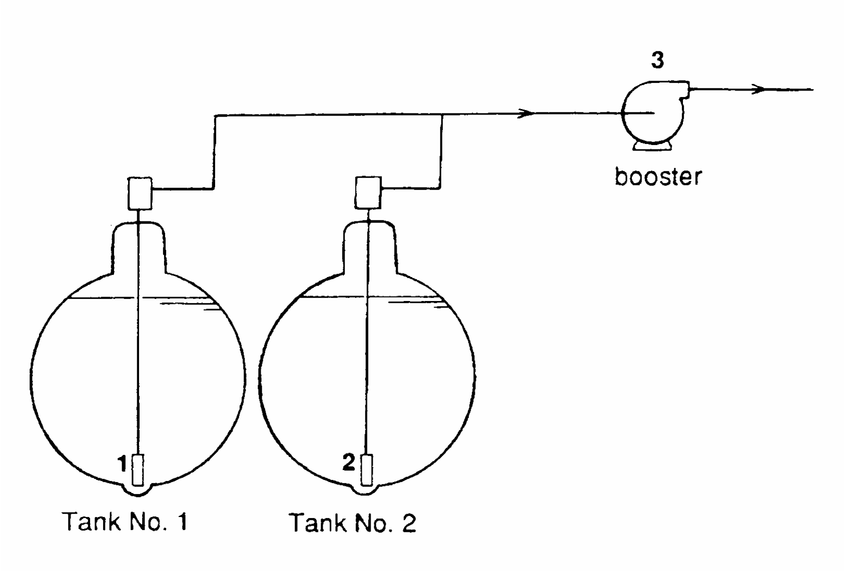


Figure 65: The system characteristic of pumps working in parallel



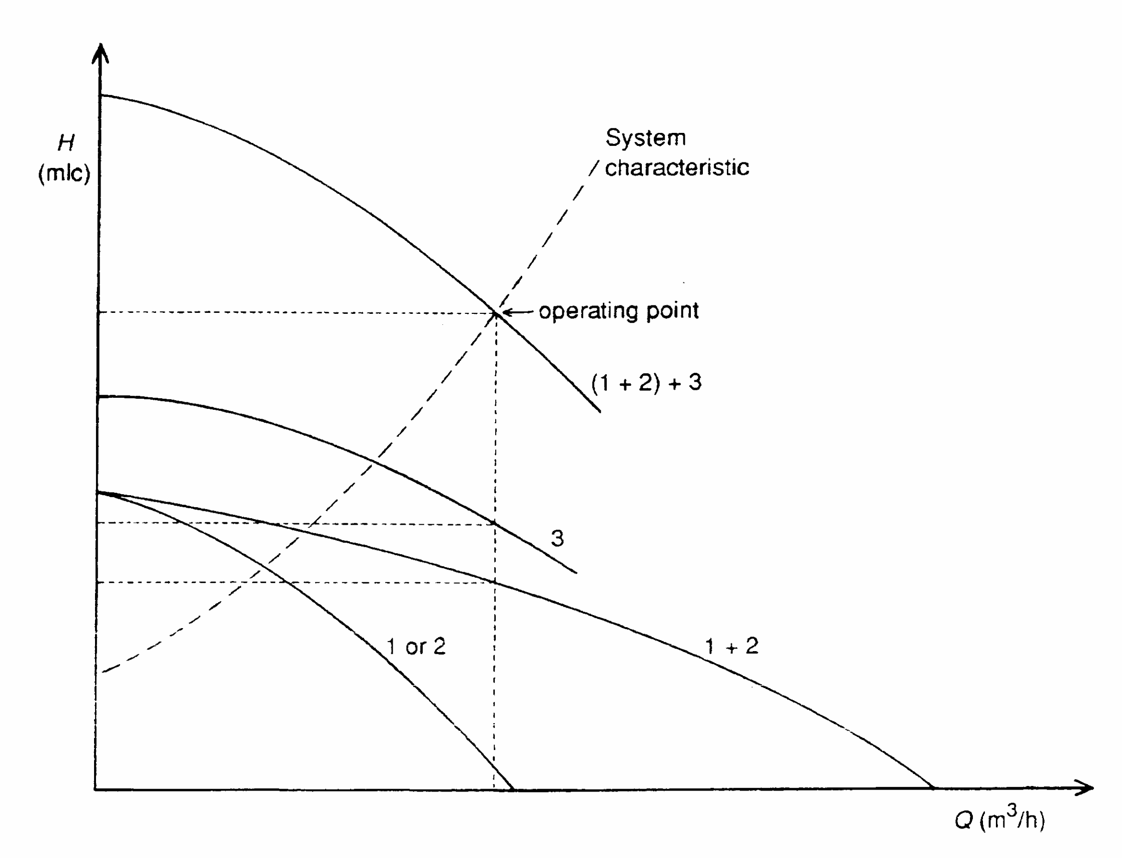


Figure 66: The system characteristic of pumps working in series with a booster pump.

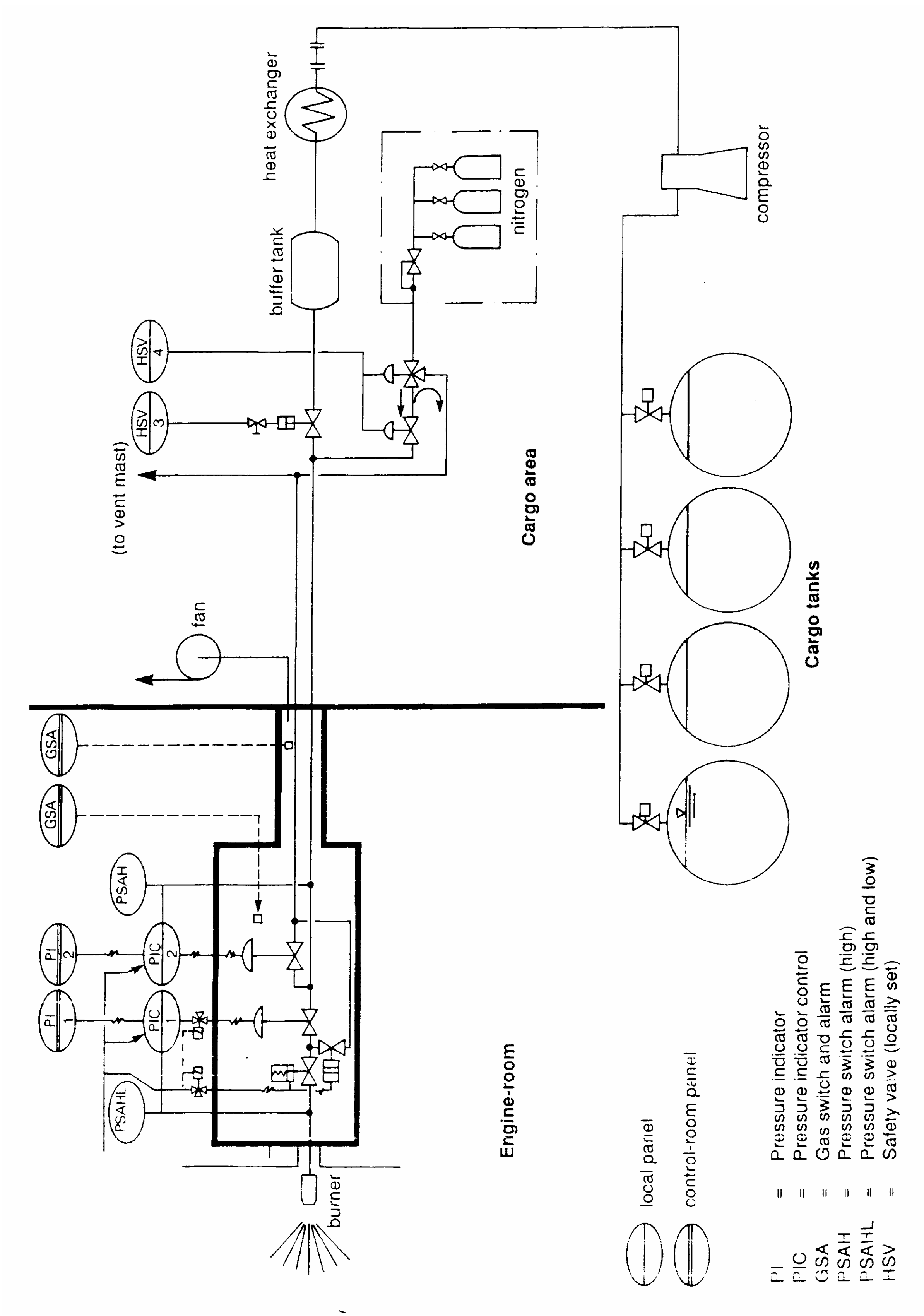
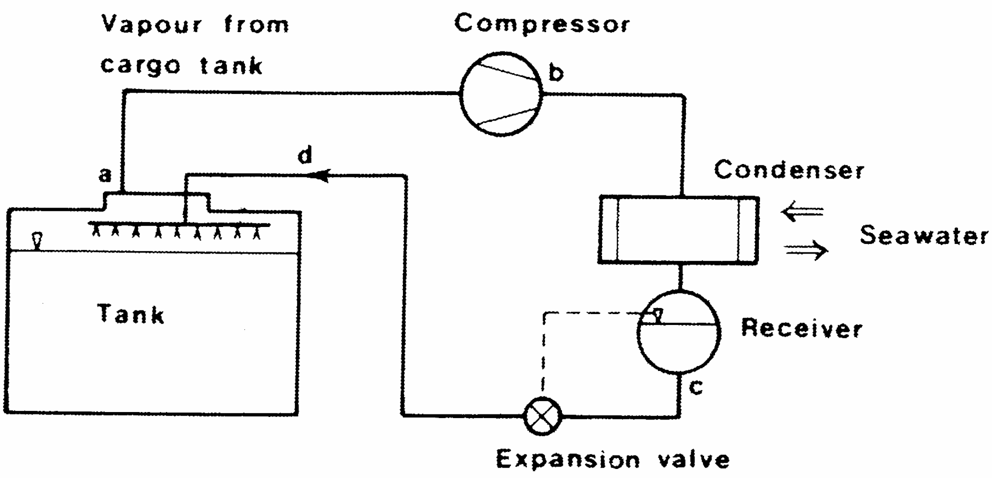

heat exchanger
buffer tank
nitrogen
compressor
HSV 4
HSV 3
(to vent mast)
Cargo area
fan
Cargo tanks
GSA
GSA
PSAH
PI 2
PIC 2
PI 1
PIC 1
PSAHL
burner
Engine-room
local panel
control-room panel
PI = Pressure indicator
PIC = Pressure indicator control
GSA = Gas switch and alarm
PSAH = Pressure switch alarm (high)
PSAHL = Pressure switch alarm (high and low)
HSV = Safety valve (locally set)

Figure 67:



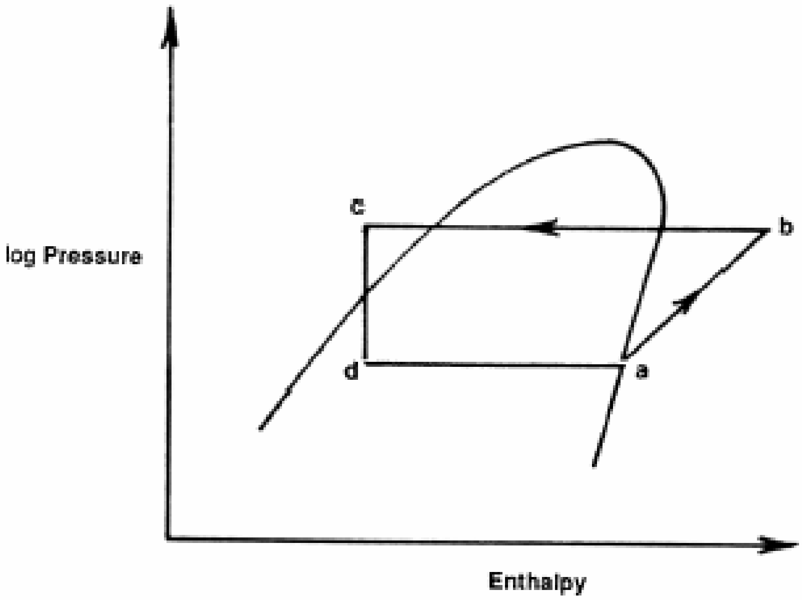


Figure 68: Single-stage direct reliquefaction cycle and a Mollier diagram for the cycle

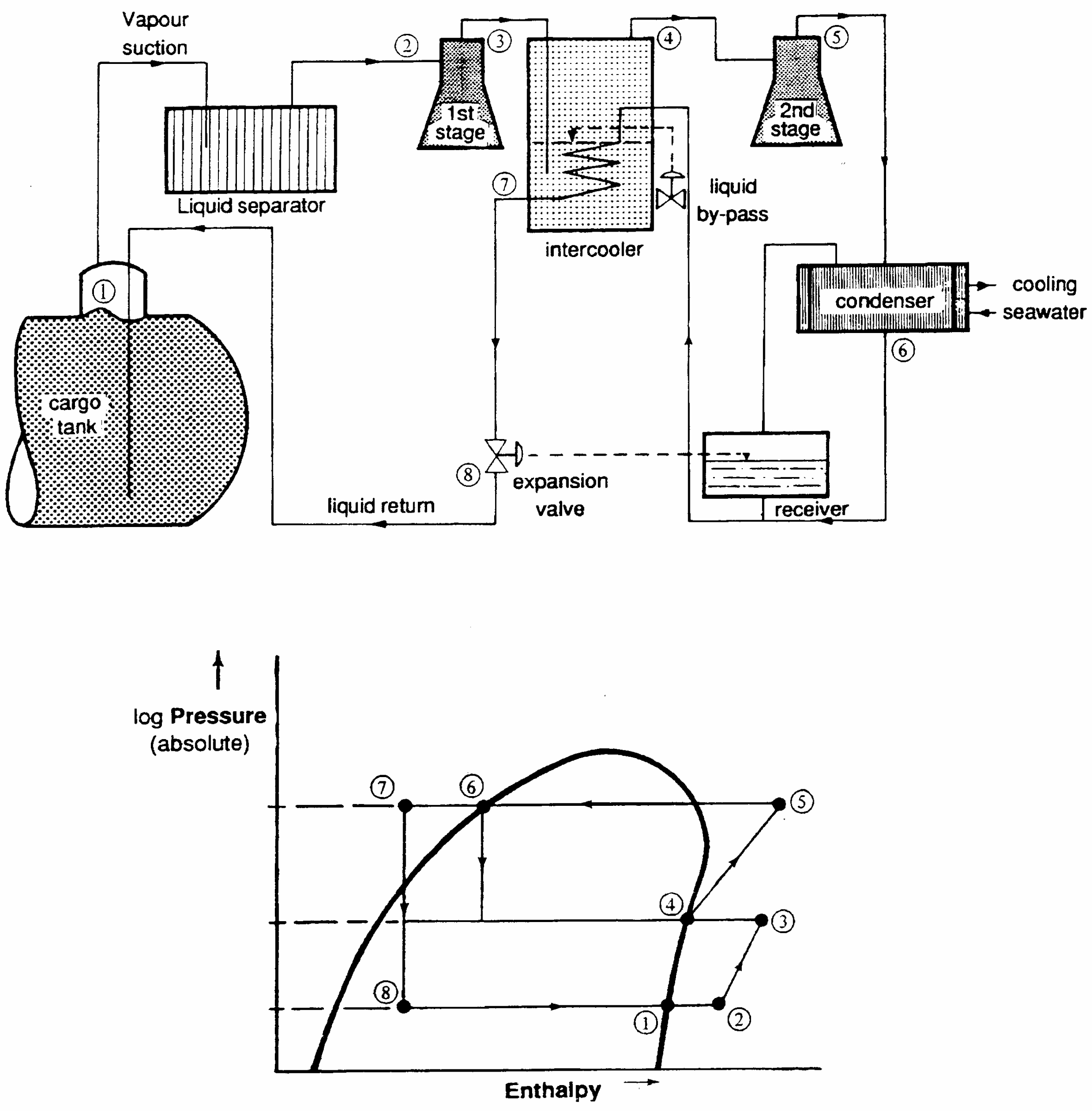


Figure 69: Two-stage direct reliquefaction cycle with interstage cooling and a Mollier diagram for the cycle

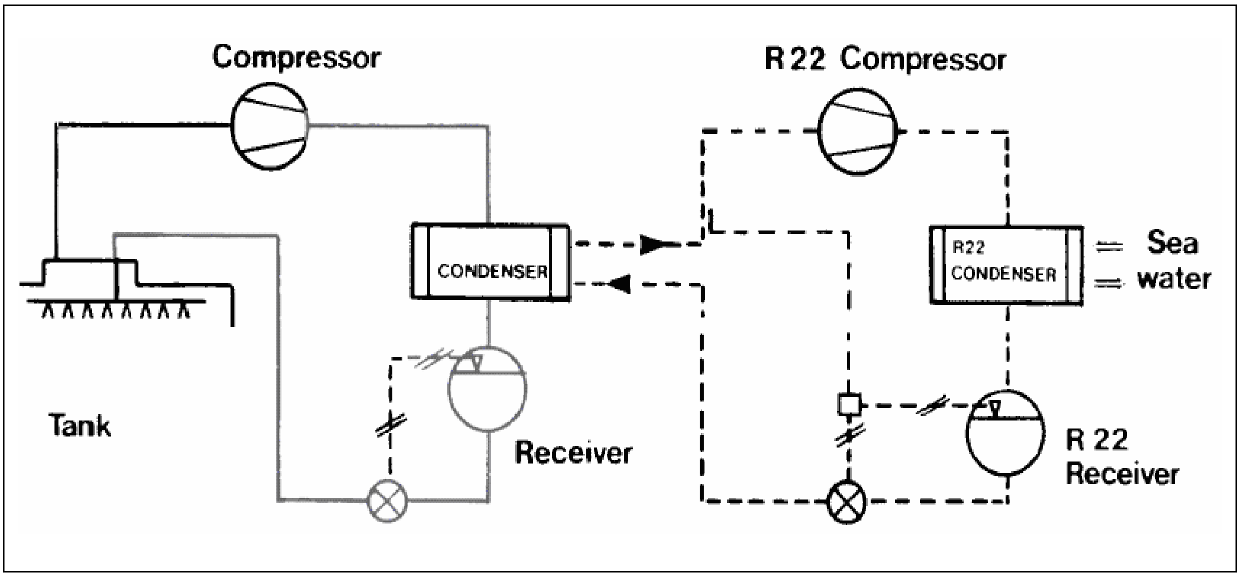


Figure 70: A Simplified cascade reliquefaction cycle

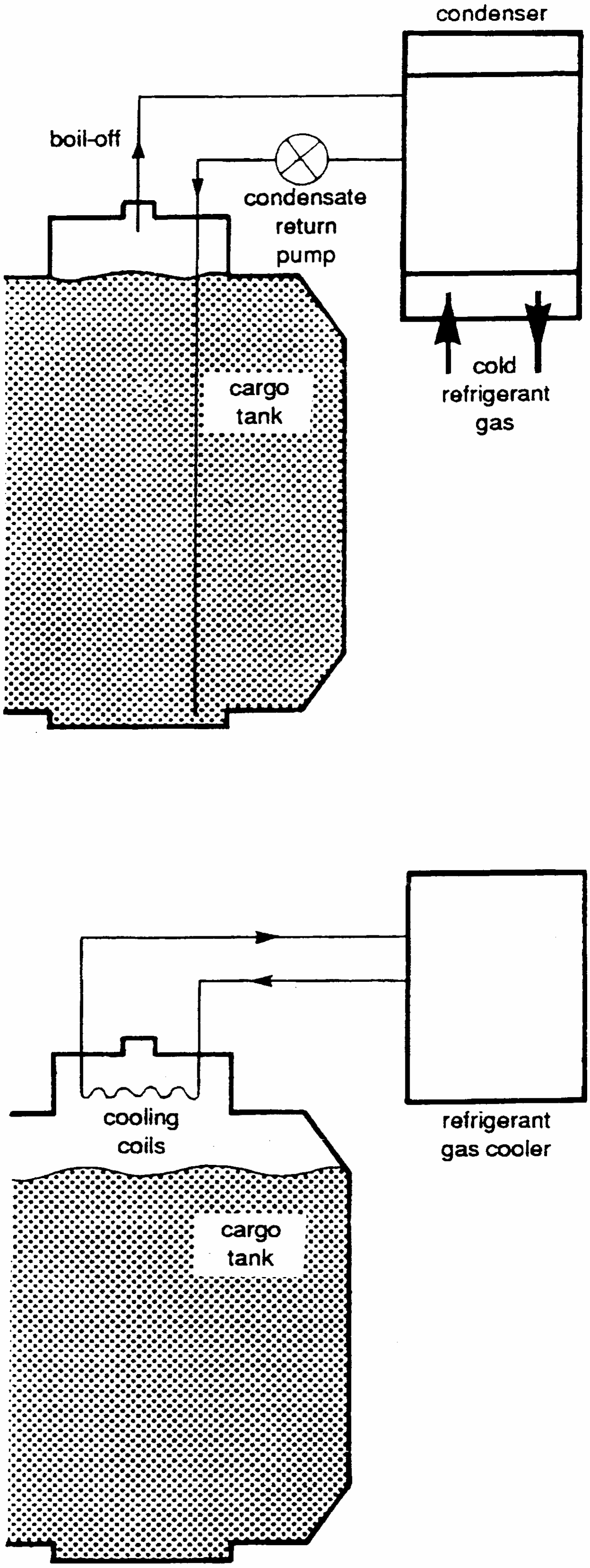


Figure 71: Examples of indirect cooling cycles

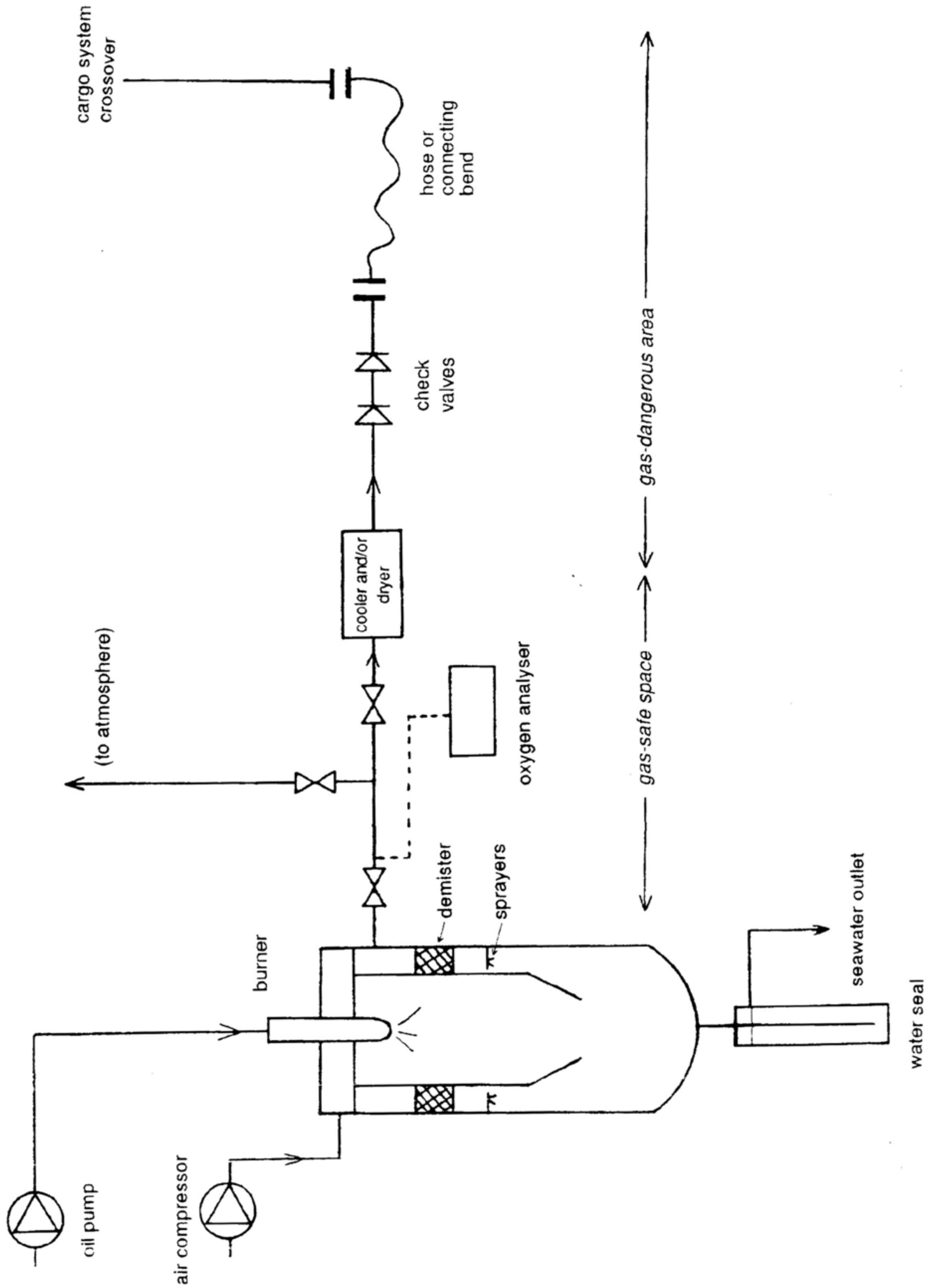


Figure 72: Schematic diagram of an inert gas generator system

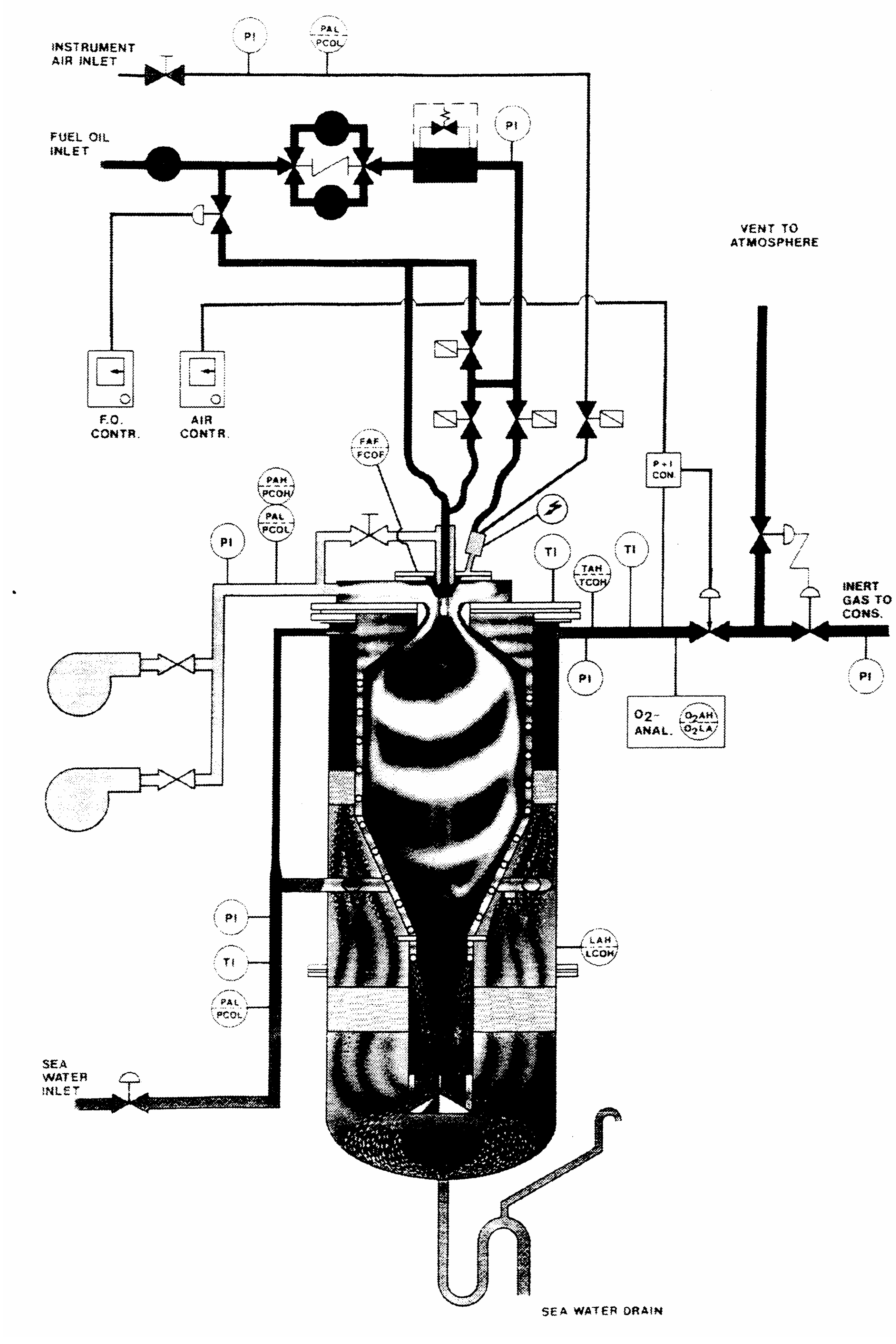


Figure 73: An inert gas generator

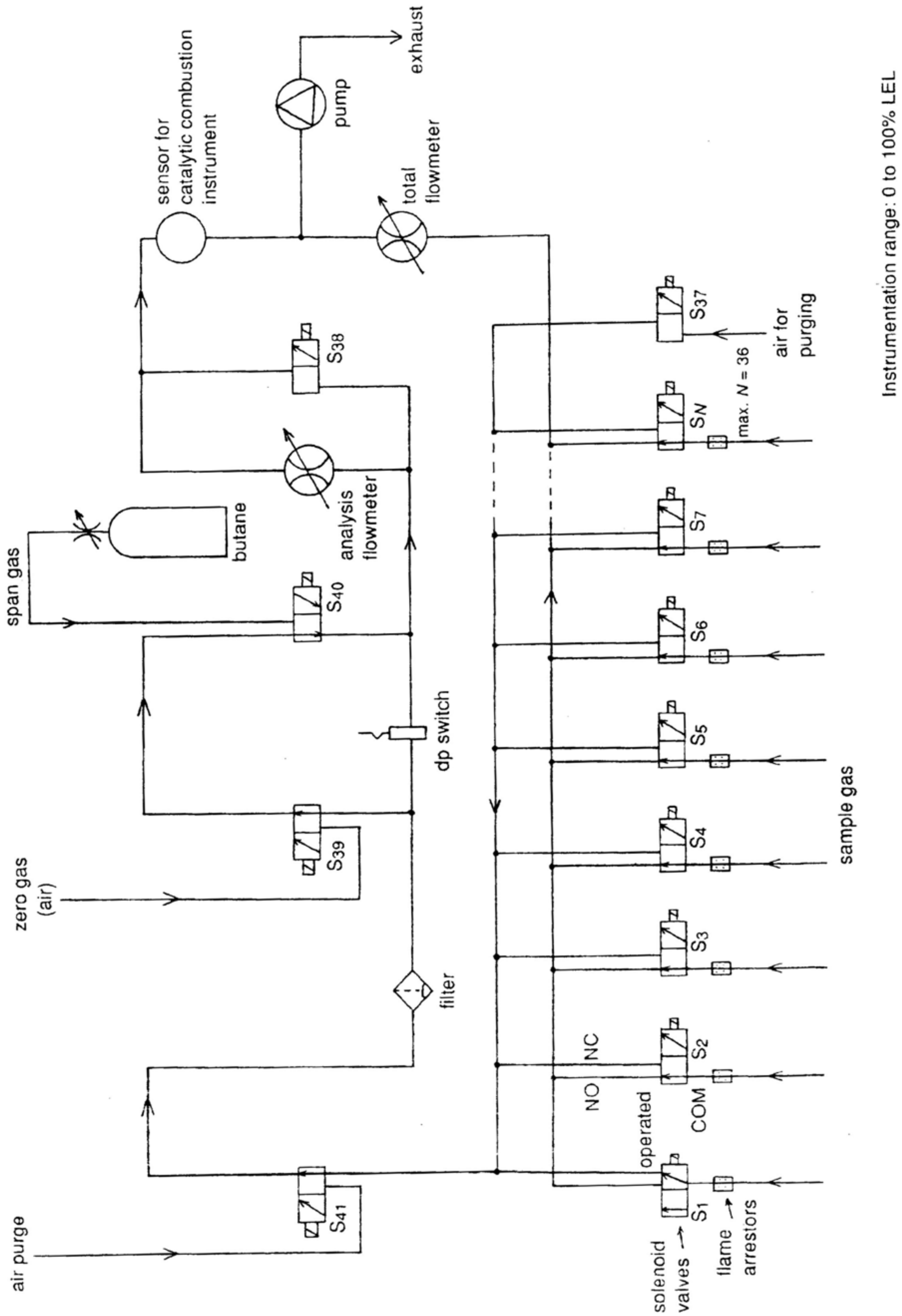


Figure 74: Flow diagram of a fixed gas detecting system

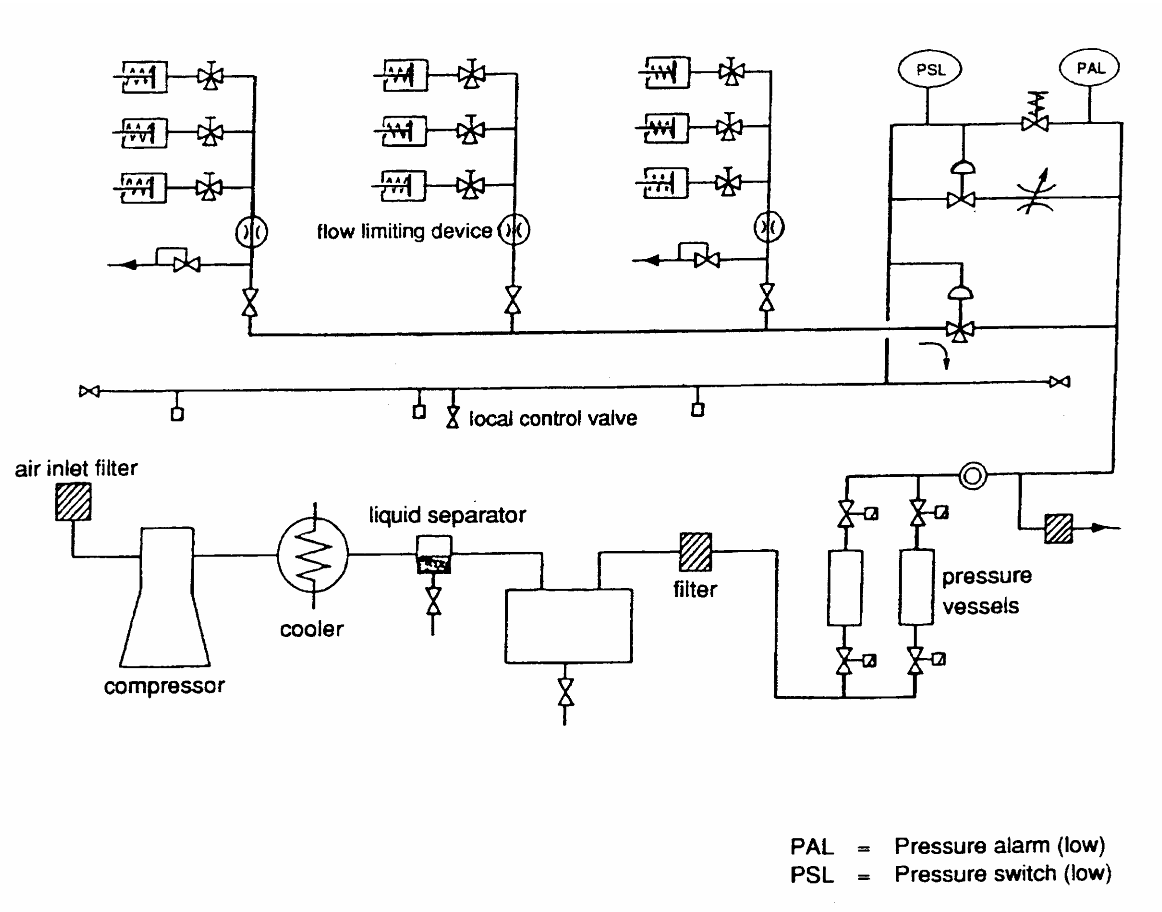


Figure75: A pneumatic emergency shutdown system

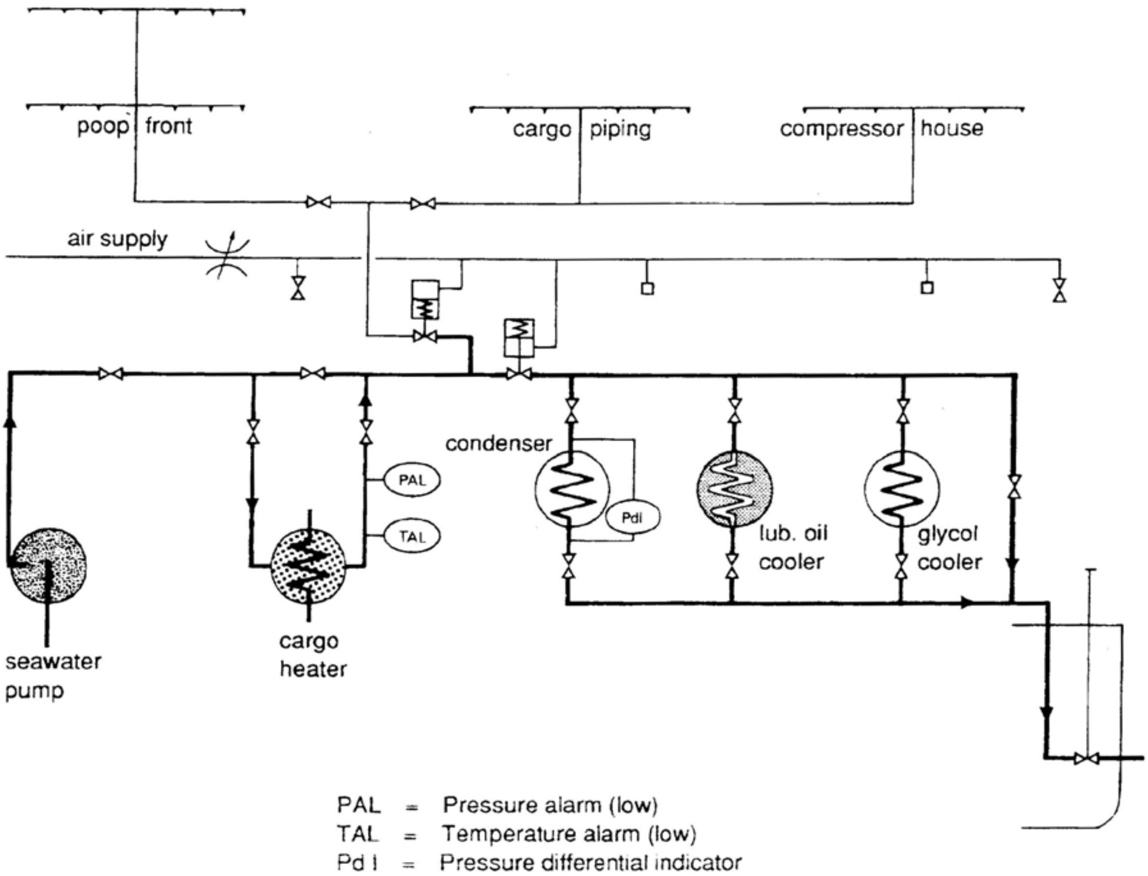
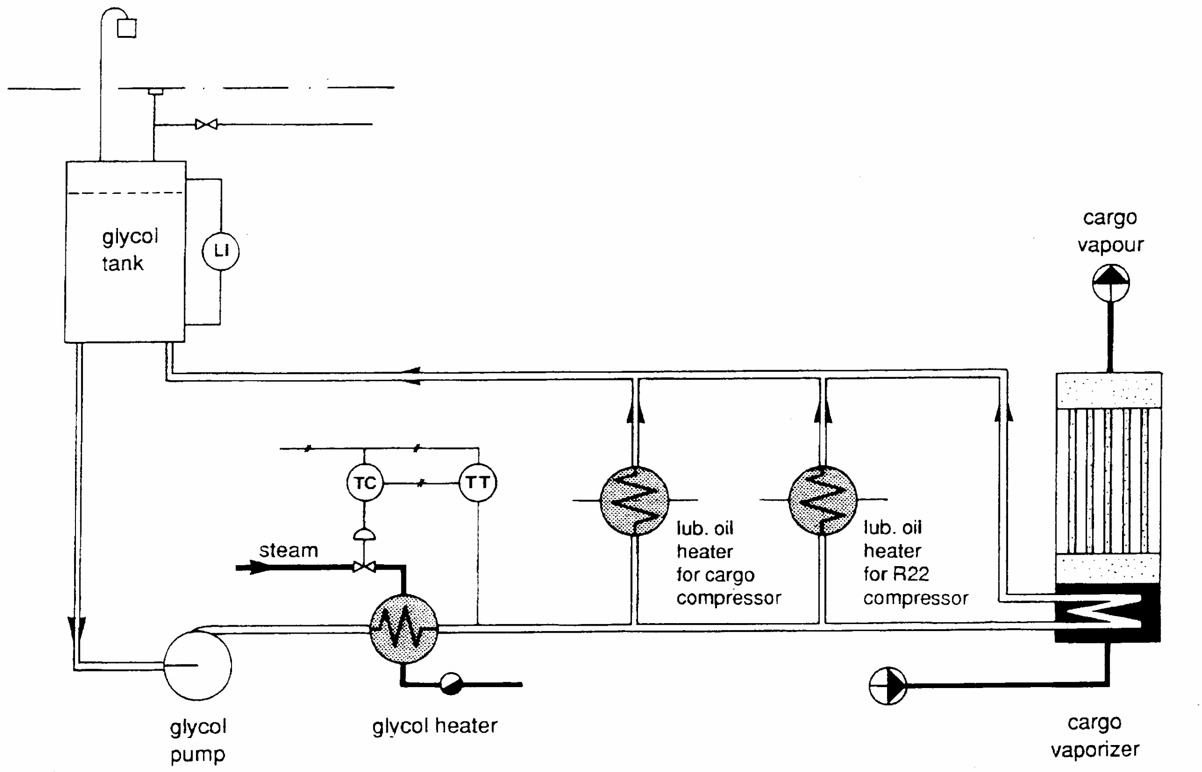


Figure 76: A fixed water-spray system



L I = level indicator
T T = Temperature transmitter
TC = temperature control

Figure 77: Example of glycol heating system

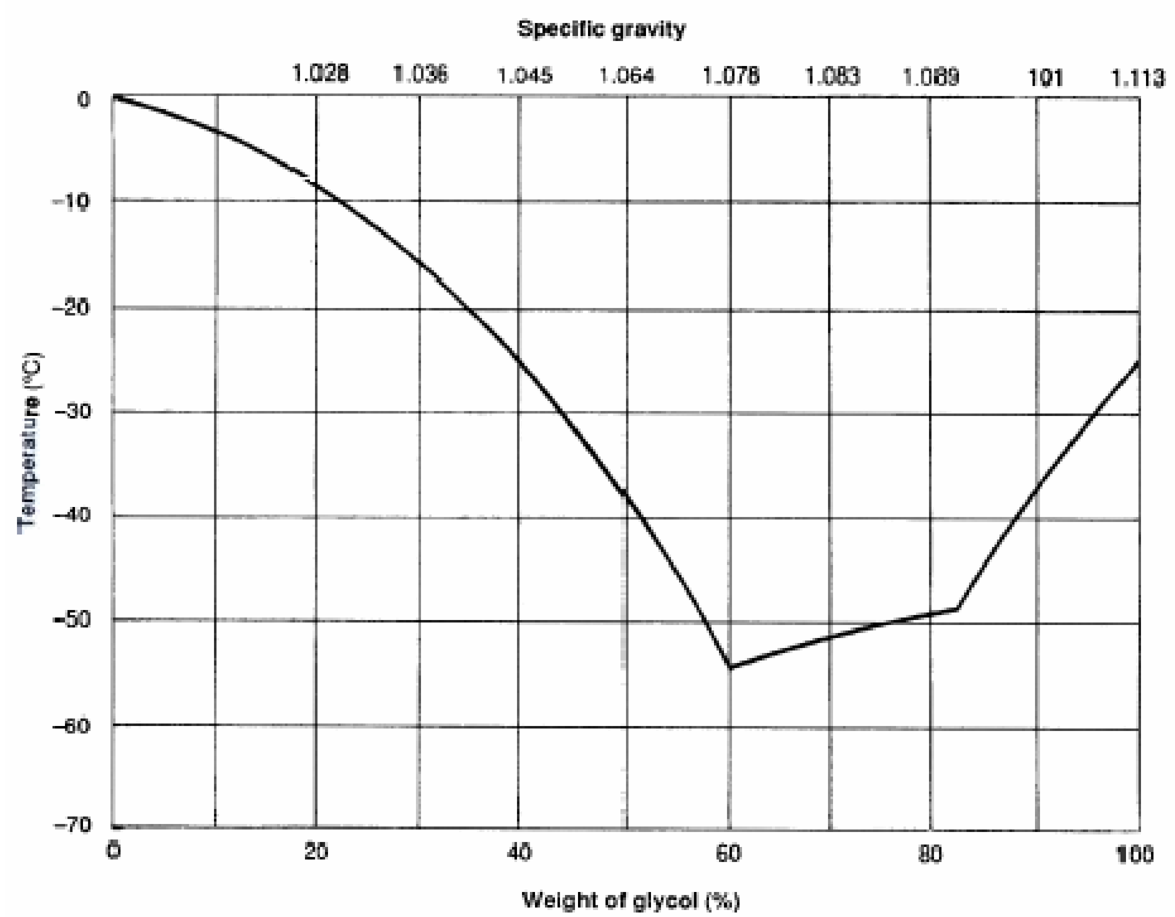


Figure 78: Freezing points for glycol-water solutions

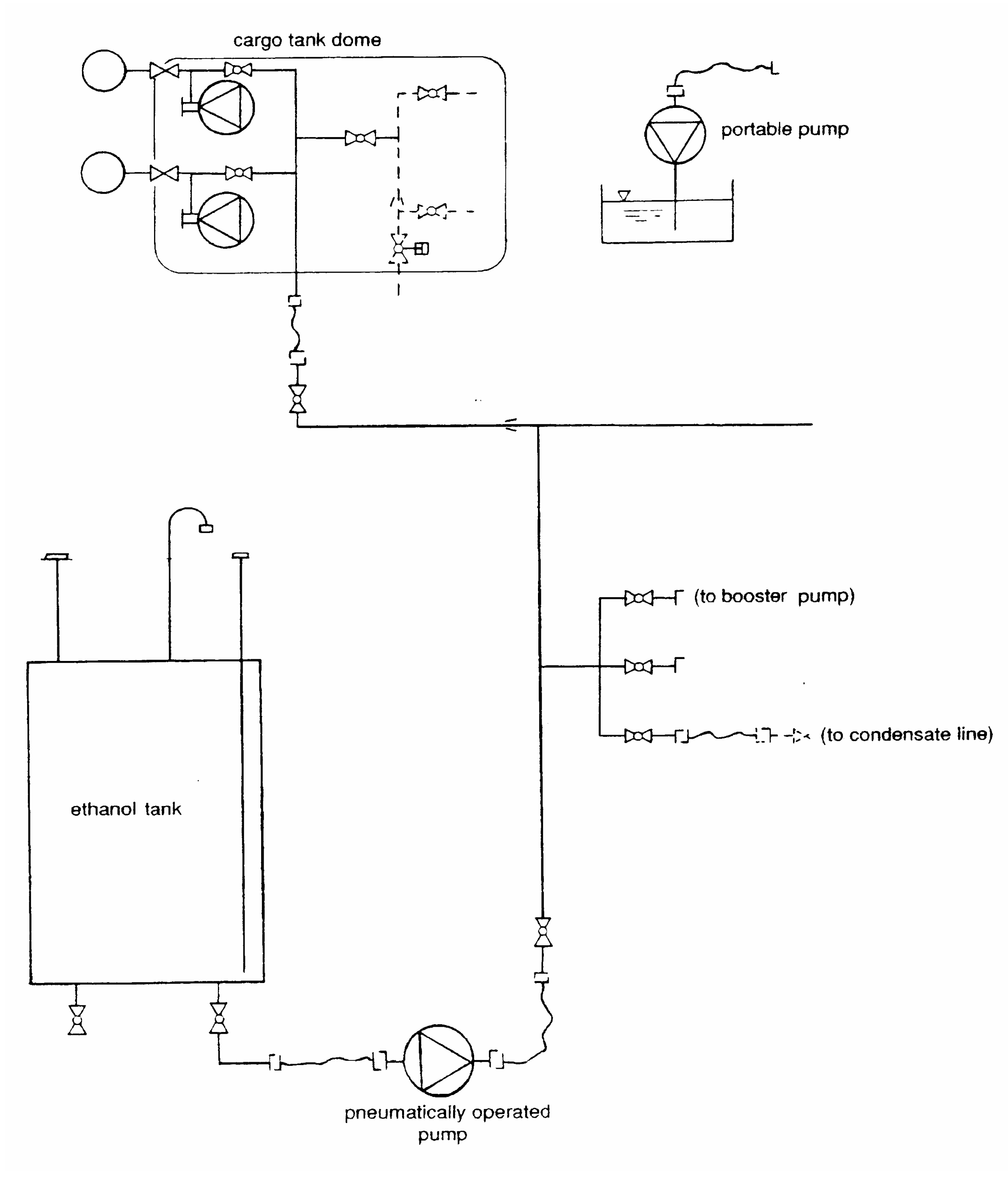


Figure 79: An alcohol injecting system

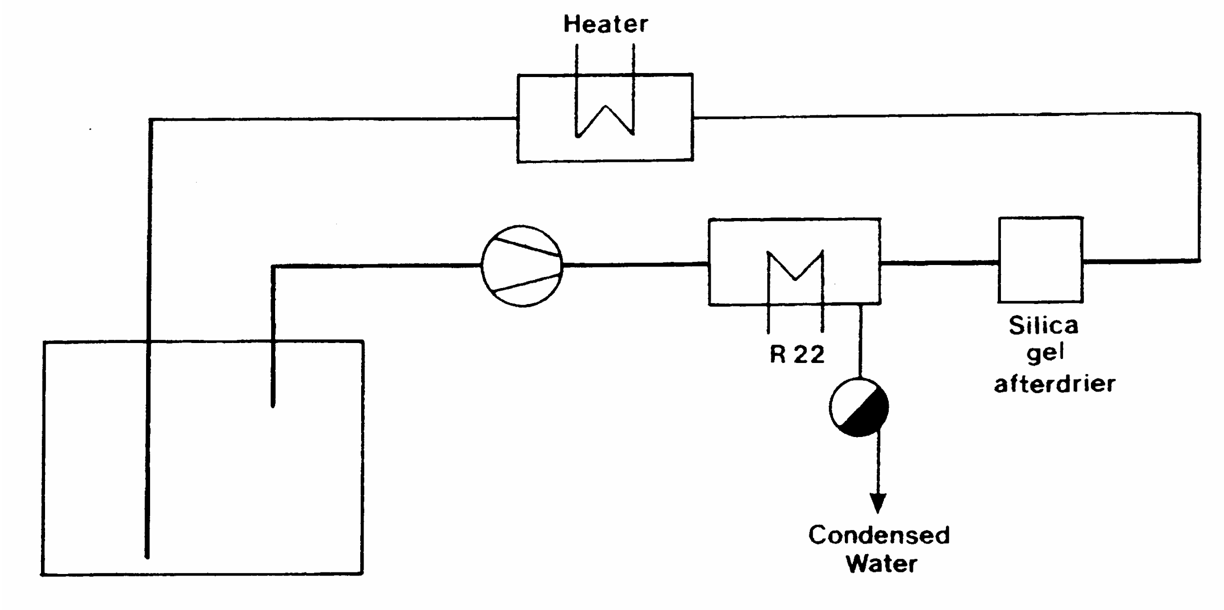


Figure 80: Air-drying operation

Appendix 2: Example of a simulator exercise

The attention of course designers and instructors is drawn to Section A-I/12 of STCW 95 which defines the general performance standards for simulators used in training.

The following is an example of a the format and description of an exercise using a liquid cargo handling simulator.

If a liquid cargo handling simulator is included as a teaching tool in the Specialized Training for Liquefied Natural Gas Tankers a proper structure is essential to link simulator exercises with the lectures and give a comprehensive training programme. An example is given here in which the items necessary for the proper preparation, execution, debriefing and evaluation are stated.

Exercise Name: Familiarization with Cargo Handling Procedure

References

STCW 95 Cargo handling and stowage at the familiarization level.

Plan and ensure safe loading, stowage, securing care during the voyage and unloading of cargoes.

Duration: 4 hours

Objectives

Familiarization with an tanker, LNG its pipelines and valves of the cargo system with loading/unloading procedure being followed.

The trainees will learn to use and practise working with gas data sheet for the cargo to be carried.

Prerequisites

Trainees should have completed the following and have:

- a knowledge of the procedures and temperatures described for a certain cargo for a certain type of tank.
- be familiar with the Gas Carrier Code relevant to their ship and the restrictions indicated from the gas data sheets.

Training materials required

Mimic diagrams of:

- cargo tanks and connections
- the relevant cargo and gas pipeline systems tank plans
- temperature/vapour pressure diagrams

Initial Condition of Simulator

Cargo tanks are gassed up and cooled down.
Ballast tanks are partly full, and the ship has just arrived at, the loading port.

Briefing

Briefing: Before the exercise starts, the instructor should go through the cargo handling system and explain the different auxiliary systems, using drawings and diagrams similar to the simulator display pictures. Pipe dimensions, working pressure, valves and methods of valve control should be explained and discussed. Pumps for cargo and ballast should be explained with regard to pump type, capacity and the start/stop procedures. System Boil off control system should be explained; start/stop of L/D compressors and L/D heaters, etc. , start/stop of H/D compressors and H/D heaters etc., and it procedures should be explained and discussed. Finally, the instructor should go through the system for inert gas distribution, tank ventilation systems and methods of cargo tank atmosphere evaluation using gas detection system (sequential, portable).

Student Action: After the explanations (discussion) the trainees are to

- Call upon display pictures showing the cargo system and identify the different equipment and items
- Identify a certain cargo, i.e., liquid, and follow the line through the submersible cargo pump to a certain cargo tank
- Identify the cargo pump on the line and valves from manifold to tank
- Start cargo pumps and Spray pumps.
- Open valves on discharge side of the pumps
- Open manifold valves
- Identify a certain ballast line and follow the line through the pump (p) or (s) to a certain tank
- Identify the ballast pumps on the line and valves from sea inlet and overboard line to tank
- Open suction valves in the ballast tank
- Open suction valves of the ballast pumps
- Start ballast pumps
- Start L/D compressors and L/D heaters etc.
- Start/stop of H/D compressors and H/D heaters etc. Close all valves

Instructor Action: Explain the simulated ship type, its equipments, pipelines etc., system mimics and symbols used in mimics, Load master etc.

Debriefing: After the exercise has been carried out, time must be allocated to discussion of the exercise. Any deviation from reality should be focused upon and discussed.

Evaluation: The instructor must set aside sufficient time to discuss thoroughly the systems before the trainees start to use the simulator. Starting up should only be carried out after observing and checking that everything has been correctly prepared. After the trainees have made their observations, taken notes and completed the operations, sufficient time should be set aside for discussion.

Part E: Evaluation

E.1 Introduction

The effectiveness of any evaluation depends on the accuracy of the description of what is to be measured.

The learning objectives that are used in the detailed teaching syllabus will provide a sound base for the construction of suitable tests for evaluating trainee progress.

E.2 Method of evaluation

The methods chosen to carry out an evaluation will depend upon what the trainee is expected to achieve in terms of knowing, comprehending and applying the course content.

The methods used can range from a simple question-and-answer discussion with the trainees (either individually or as a group) to prepared tests requiring the selection of correct or best responses from given alternatives, the correct matching of given Items, the supply of short answers or the supply of more extensive written responses to prepared questions.

Where the course content is aimed at the acquisition of practical skills, the test would involve a practical demonstration by the trainee making use of appropriate equipment, tools, etc.

The responses demanded may therefore consist of:

- the recall of facts or information, by viva-voce or objective tests
- the practical demonstration of an attained skill
- the oral or written description of procedures or activities
- the identification and use of data from sketches, drawings, maps, charts, etc.
- carrying out calculations to solve numerical problems
- the writing of an essay or report

E.3 Validity

The evaluation must be based on clearly defined objectives, and it must truly represent what is to be measured. There must be a reasonable balance between the subject topics involved and also in the testing of trainees' KNOWLEDGE, COMPREHENSION and APPLICATION of concepts.

The time allocated for the trainee to provide a response is very important. Each question or task must be properly tested and validated before It is used to ensure that the test will provide a fair and valid evaluation.

E.4 Reliability

To be reliable, an evaluation procedure should produce reasonably consistent results no matter which set of papers or version of the test is used.

E.5 Subjective testing

Traditional methods of evaluation require the trainee to demonstrate what has been learned by stating or writing formal answers to questions.

Such evaluation is subjective In that It invariably depends upon the judgement of the evaluator. Different evaluators can produce quite different scores when marking the same paper or evaluating oral answers.

E.6 Objective testing

The incorrect alternatives in multiple-choice questions are called ‘distracters’, because their purpose is to distract the uninformed trainee from the correct response. The distracter must be realistic and should be based on misconceptions commonly held, or on mistakes commonly made.

The options “none of the above” or “all of the above” are used in some tests. These can be helpful, but should be used sparingly.

Distracters should distract the uninformed, but they should not take the form of “trick“ questions that could misled the knowledgeable trainee (for example, do not insert “not” into a correct response to make It a distracter).

E.7 Distracters

The incorrect alternatives in multiple-choice questions are called “distracters”, because their purpose is to distract the uninformed trainee from the correct response. The distracter must be realistic and should be based on misconceptions commonly held, or on mistakes commonly made.

The options “none of the above” or “all of the above” are used in some tests. These can be helpful, but should be used sparingly.

Distracters should distract the uninformed, but they should not take the form of ‘trick’ questions that could misled the knowledgeable trainee (for example, do not insert “not” into a correct response to make It a distracter).

E.8 Guess factor

The “guess factor” with four alternative responses in a multiple-choice test would be 25%. The pass mark chosen for all selective-response questions should take this into account.

E.9 Scoring

In simple scoring of objective tests one mark may be allotted to each correct response and zero for a wrong or nil response.

A more sophisticated scoring technique entails awarding one mark for a correct response, zero for a nil response and minus one for an incorrect response. Where a multiple-choice test Involves four alternatives, this means that a totally uninformed guess involves a 25% chance of gaining one mark and a 75% chance of losing one mark.

Scores can be weighted to reflect the relative Importance of questions, or of sections of an evaluation.

Information Requested of Instructors Who Implement IMO Model Courses

Introduction

1. IMO model courses are periodically revised to take into account the changes which have taken place in relevant Conventions, resolutions and other matters affecting each course. To help lMO to improve the content of courses when they are revised, the assistance of all instructors who implement or participate in implementing courses is requested, whether the implementation Is part of an IMO technical co-operation project or part of a Maritime Training Academy's regular programme.

Information requested and its format

2. To simplify their consolidation by 1MO, the technical comments and suggestions for the Improvement of model courses should follow the format that is outlined below. If no comments or suggestions are to be provided under a topic, please insert "no comment" against the Item.

3. Please identify:

   .1 the course number and title;
   .2 the date and location of its implementation;
   .3 the approximate number of IMO model courses you have implemented to date; and
   .4 the approximate number of times you have Implemented this particular model course.

4. In commenting on Part A - Course Framework, please comment on the Items ('Scope', 'Objectives', etc.) in the order In which they appear In the course; In all cases, please Indicate:

   .1 the number of participants who met the entry standards and the number who did not;
   .2 the course intake and, if the recommendations In 'Course Intake limitations' were exceeded, the reasons for this and your observations on the effect of this on the qualify of the course;
   .3 If the conditions under 'Staff requirements' were met; If not, please Indicate the nature of the deficiency and give your observations of the effect of this on the quality of presentation of the course; and

.4 any lack of equipment or facilities as compared with the recommendations under 'Teaching facilities and equipment' and your observations of the effect of this lack on the quality of presentation of the course.

5. In commenting on Part B - Course Outline, please bear in mind that minor variations in time allocations are Inevitable. Major difficulties with allocations of time and any omissions or redundancies of subject areas should be briefly explained.

6. In commenting on Part C - Detailed Teaching Syllabus, please identify the specific learning objectives concerned by their paragraph numbers.

7. In commenting on Part D - Instructor's Manual, please clearly identify the section concerned. If the bibliography or the practical exercises are found to be unsatisfactory, please identify suitable alternative texts, as far as is possible, or outline alternative exercises, as appropriate.

8. Any further comments or suggestions you may have which fall outside the scope of the items listed above may be added at the end. In particular, your views on the usefulness of the course material to you in implementing the course would be appreciated, as would the contribution to IMO of any additional teaching material you found useful in implementing it.

Please address your comments to:

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International Maritime Organization
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