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SUB-COMMITTEE ON HUMAN ELEMENT, TRAINING AND WATCHKEEPING
2nd session
Agenda item 3

HTW 2/3/1
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VALIDATION OF MODEL TRAINING COURSES

Model course – Advanced Training for Chemical Tanker Cargo Operations

Note by the Secretariat

SUMMARY

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

1 Attached in the annex is a revised draft model course on Advanced Training for Chemical Tanker Cargo Operations.

2 The preliminary draft of this revised model course was forwarded to members of the validation panel for their comments. Due to time constraints, any comments received on the draft course from the validation panel will be provided directly to the Sub-Committee.

Action requested of the Sub-Committee

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

***

ANNEX

DRAFT IMO MODEL COURSE ON ADVANCED TRAINING FOR CHEMICAL TANKER CARGO OPERATIONS

MODEL COURSE

1.03

ADVANCED TRAINING FOR CHEMICAL TANKER CARGO OPERATIONS

2014 Edition

INTERNATIONAL MARITIME ORGANIZATION

ACKNOWLEDGEMENTS

This course for Advanced Training for Chemical Tanker Cargo operations is based on material developed by Anglo Eastern Maritime Training Centre, Mumbai for IMO.

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

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Introduction

■ Purpose of the model courses

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

It is not the intention of the model course programme to present instructors with a rigid "teaching package" which they are expected to "follow blindly". Nor is it the intention to substitute audio-visual or "programmed" material for the instructor's presence. As in all training endeavors, the knowledge, skills and dedication of the instructors are the key components in the transfer of knowledge and skills to those being trained through IMO model course material.

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

This course is for Masters, officers and others on board chemical tankers who have immediate responsibilities for cargo handling and care in transit. By successfully doing this course, the aforementioned shipboard personnel will fulfill the mandatory minimum requirements of Section A Regulation V/1-1 paragraph 3 of STCW 1978, as amended. The coverage of the model course is wide in scope and includes chemical tanker safety, fire safety measures and systems, prevention and control of pollution, operational practice and obligations under applicable laws and regulations, thereby covering all the training necessary. In addition the course covers the managerial aspects on board including a section on risk assessment and safety management as well as contingency planning in line with the ISM Code.

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

■ Use of the model course

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

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

This course is designed to follow the requirements of the STCW convention including the 2010 Manila amendments and builds upon the knowledge and skills included in the IMO Model course 1.01 – "Basic training for oil and chemical tanker cargo operations" The diagrams and learning objectives included in the Basic course may also be used to assist in the making of presentations for the advanced training in chemical tanker operations course.

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

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

■ Aims

This course provides training to candidates to be duly qualified under Section A – V/1-1para 3 of the STCW code with specific duties for loading, unloading and care in transit of chemical cargoes. It comprises an advanced training programme appropriate to their duties, including chemical tanker safety, fire safety measures, pollution prevention, safe operational practices and obligations under applicable rules and regulations. The course covers the competence requirements as given in the table under Section A-V/1-1-3 of the STCW Code adopted by the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended.

During the course, there will be:

- Advanced level of familiarization with the equipment, instrumentation and controls used for cargo handling on a chemical tanker
- A greater awareness of the need of proper planning, use of various checklist involved in various cargo handling operations

- An enhanced awareness to apply safe procedures at all times when carrying out the various operations on board an chemical tanker
- An acquisition of experience in identifying operational problems and solving them.
- An improvement in the ability to promote safety culture and protect the marine environment
- An increased ability to assist and co-ordinate during emergencies

■ Lesson plans

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

■ Presentation

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

■ Implementation

For the course, to be effective, considerable attention must be paid to the availability of:

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

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

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

■ Guidance to course developers and instructors

This course comprises of advanced level of chemical tanker cargo operations.

The course involves:

1. Knowledge of chemical tanker designs, systems, and equipment
2. Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation
3. Proficiency in tanker safety culture and implementation of safety management system
4. Knowledge and understanding of monitoring and safety systems, including the emergency shutdown system
5. Ability to perform cargo measurements and calculations
6. Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity
7. Knowledge and understanding of chemical cargo-related operations
8. Development and application of cargo-related operation plans, procedures and checklists
9. Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment
10. Ability to manage and supervise personnel with cargo-related responsibilities
11. Knowledge and understanding of the chemical and the physical properties of noxious liquid substances
12. Understanding the information contained in a Material Safety Data Sheet (MSDS)
13. Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations
14. Knowledge and understanding of dangers of non-compliance with relevant rules/regulations
15. Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers
16. Knowledge and understanding of chemical tanker emergency procedures
17. Actions to be taken following collision, grounding or spillage
18. Knowledge of medical first-aid procedures on board chemical tankers, with reference to the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG)
19. Understanding of procedures to prevent pollution of the atmosphere and the environment
20. Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied
21. Proficiency in the use of the IBC Code and related documents

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

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

The idea is to help the trainees develop a proactive attitude on how to develop a safety culture and act accordingly.

■ Training and STCW Convention 1978, as amended

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

Advanced training requirements for masters, chief engineer officers, chief mates, second engineer officers and any person with immediate responsibility for loading, unloading and care in transit or handling of cargo on chemical tankers are detailed in Table A-V/1-1-3 of the STCW Code as amended.

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

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

Part B provides an outline of lectures, demonstrations and exercises for the course, together with a suggested sequence and timetable. From the teaching and learning point of view, it is more important that the trainee achieves the minimum standard of competence defined in the STCW Code than that a strict timetable for each topic is followed. Depending on their experience and ability, some students will naturally take longer to become proficient in some topics than in others. The time table can be rearranged to achieve an adequate flow of the topics to be covered as has been portrayed in Part B of this course keeping a strict view of covering all the minimum required standards of achieving the course objectives.

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

Part D contains an Instructor Manual, against each learning objective requiring a depth in understanding and application especially where the specified learning objective are requiring descriptions and explanations are covered in Part D of this model course along with diagrams and photographs to be displayed when covering the various learning objectives in the detailed teaching syllabus along with simulator exercises and case studies.

It is envisaged that such micro level division of each learning objective in the teaching syllabus will give the instructor, with varied backgrounds around the world, ample guidelines on developing his/her work plan, as well as the flexibility to adapt keeping in mind the level of the trainees.

Part E: The Convention defines the minimum standards to be maintained in Part A of the STCW Code. Mandatory provisions concerning Training and Assessment are given in section A-1/6 of the STCW Code. These provisions cover: qualifications of instructors, supervisors and assessors. Assessment of competence & Training is assessed within an institution. Corresponding Part B of the STCW Code contains non-mandatory guidance on training and assessment.

A Separate IMO model course addresses Examination and Assessment of Competence. This course explain the use of various methods of demonstrating competence and criteria for simulating competence as tabulated in the STCW Code and may be helpful in developing any necessary assessments that can include a form of a written examination. As a further aid to the instructor therefore, suggestions have been made on how to set a very specific objectivetype question paper for this course. In case a simulator is being used for training pertaining to this model course, then it is suggested that this form of assessment be independent of the assessment done on the simulator.

■ Responsibilities of Administrations

Administrations should make sure that training courses delivered by colleges and academies are such as to ensure officers completing training do meet the standards of competence required by STCW regulation V/1-1 paragraph 3

■ Validation

The Sub-Committee on Standards of Training and Watch keeping has validated the information contained in this document for use by technical advisors, consultants and experts for the training and certification of seafarers so that the minimum standards implemented may be as uniform as possible, "Validation", in the context of this document, means that the Sub-Committee has found no grounds to object its content.

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

Part A: Course Framework

■ Scope

This course provides training for Masters, chief engineer officers, chief mates, second engineer officers and any person with immediate responsibility for loading, unloading, care in transit, handling of cargo, tank cleaning or other cargo related operations on chemical tankers. It comprises an advanced training programme appropriate to their duties on chemical tankers for their ability to imbibe a safety culture to perform & monitor all cargo operations, familiarity with properties of chemical cargoes, take precautions to prevent hazards, apply health &safety precautions, respond to emergencies fire safety measures, take precautions to prevent pollution of the environment, and monitor & control compliance with legislative requirements. The course takes full account of Section A-V/1-1 para 3 of the STCW Code adopted by the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended.

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

■ Objective

Provided they hold an appropriate certificate and are otherwise qualified in accordance with Regulation A-V/1-1 para 6.2 of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978, as amended, those successfully completing the Advanced training in chemical tanker cargo operations course should therefore be able to safely perform their duties for loading, unloading and care in transit or handling of cargo on chemical tankers. They will make a safer and more effective contribution to the operation and control of the cargo on chemical tanker, which will improve the ship safety and provide greater protection to the environment in particular.

■ Entry standards

This course is open to any person with immediate responsibility for loading, unloading, care in transit, handling of cargo, tank cleaning or other cargo related operations on chemical tankers. It comprises of seafarers who have qualified in accordance with Regulation V/1-1 para 6 of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended.

■ Course certificate

All who are qualified in "Advanced training for chemical tanker cargo operations" programme in accordance with Regulation V/1-1 paragraphs 6.3 shall be issued with a certificate of proficiency.

■ Course intake limitations

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

■ Staff requirements

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

■ Teaching facilities and equipment

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

The following equipment should be available:

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

■ Use of Simulators

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

- If using simulator-based training, instructors should ensure that the aims and objective of these sessions are defined within the overall training program and that tasks are selected so as to relate as closely as possible to shipboard tasks and practices. Instructors should refer to STCW 1978, as amended, including 2010 Manila amendments, Section A-I/12, Part 1 and 2.

■ Design

The core technical and academic knowledge, understanding and proficiency are set out in Table A-V/1-1-3 of the STCW 1978, as amended, including 2010 Manila amendments, as shown below:

Standard of competence:
1 Every candidate for certification in advanced training for chemical tanker cargo operations shall be required to:

.1 demonstrate the competence to undertake the tasks, duties and responsibilities listed in column 1 of table A-V/1-1-3 ; and

.2 provide evidence of having achieved:

.2.1 the minimum knowledge, understanding and proficiency listed in column 2 of table A-V/1-1-3 , and

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

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

The flow of topics mentioned in the time table in Part B, is thus reflecting, how the trainer should design their course and delivery and is for guidance only.

To show consistency and adherence to STCW 2010, as given in table A-V/1-1-3, a mapping is provided below for easy reference from STCW's competences and training outcomes to the topics covered in this Model course.

The STCW 1978, as amended,
Table A-V/1-1-3 mapping of IMO Model Course 1.03 topics

STCW 2010 Table A-V/1-1-3 Mapping of IMO Model course 1.03 topics

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
1	**Ability to safely perform and monitor all cargo operations**	1.0 Knowledge of chemical tanker designs, systems and equipment, including: 1.1 General arrangement and Construction 1.2 Pumping arrangement and equipment 1.3 tank Construction and arrangement 1.4 pipeline and drainage systems 1.5 tank and cargo pipeline pressure and temperature control systems and alarms 1.6 gauging control systems and alarms 1.7 gas-detecting systems 1.8 cargo heating and cooling systems 1.9 tank cleaning systems 1.10 cargo tank environmental control systems	1	**Topic 1 Design and Characteristics of a chemical tanker**	1.0 Knowledge of chemical tanker designs, systems and equipment, including: 1.1 General arrangement and Construction 1.2 Pumping arrangement and equipment 1.3 tank Construction and arrangement 1.4 pipeline and drainage systems 1.5 tank and cargo pipeline pressure and temperature control systems and alarms 1.6 gauging control systems and alarms 1.7 gas-detecting systems 1.8 cargo heating and cooling systems 1.9 tank cleaning systems 1.10 cargo tank environmental

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
		1.11 ballast systems 1.12 cargo area venting and accommodation ventilation 1.13 vapour return/recovery systems 1.14 firefighting systems 1.15 tank, pipeline and fittings' material and coatings 1.16 slop management			control systems 1.11 ballast systems 1.12 cargo area venting and accommodation ventilation 1.13 vapour return/recovery systems 1.14 firefighting systems 1.15 tank, pipeline and fittings' material and coatings 1.16 slop management
		2.0 Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation	2		2.0 Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation
		3.0 Proficiency in tanker safety culture and implementation of safety management system	3		3.0 Proficiency in tanker safety culture and implementation of safety management system
		4.0 Knowledge and understanding of monitoring and safety systems, including the emergency shutdown system	4		4.0 Knowledge and understanding of monitoring and safety systems, including the emergency shutdown system
		5.0 Ability to perform cargo measurements and calculations	5	**Topic 2 Loading, Unloading care and handling of cargo**	5.0 Ability to perform cargo measurements and calculations

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	Competence	Knowledge, Understanding and Proficiency	S. No	Topic	Knowledge, Understanding and Proficiency
		6.0 Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity	6		6.0 Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity
		7.0 Knowledge and understanding of chemical cargo-related operations, including: 1. loading and unloading plans 2. ballasting and deballasting 3. tank cleaning operations 4. tank atmosphere control 5. inerting 6. gas-freeing 7. ship-to-ship transfers 8. inhibition and stabilization requirements 9. heating and cooling requirements and consequences to adjacent cargoes 10. cargo compatibility and segregation 11. high-viscosity cargoes 12. cargo residue operations 13. operational tank entry	7		7.0 Knowledge and understanding of chemical cargo-related operations, including: 1. loading and unloading plans 2. ballasting and deballasting 3. tank cleaning operations 4. tank atmosphere control 5. inerting 6. gas-freeing 7. ship-to-ship transfers 8. inhibition and stabilization requirements 9. heating and cooling requirements and consequences to adjacent cargoes 10. cargo compatibility and segregation 11. high-viscosity cargoes 12. cargo residue operations 13. operational tank entry

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
2	**Familiarity with physical and chemical properties of chemical cargoes**	8.0 Development and application of cargo-related operation plans, procedures and checklists	8		8.0 Development and application of cargo-related operation plans, procedures and checklists
		9.0 Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment	9		9.0 Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment
3	**Take precautions to prevent hazards**	10.0 Ability to manage and supervise personnel with cargo-related responsibilities	10		10.0 Ability to manage and supervise personnel with cargo-related responsibilities
		11.0 Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including: 1. chemical cargoes categories (corrosive, toxic, flammable, explosive) 2. chemical groups and industrial usage 3. reactivity of cargoes	11	**Topic 3 Physical and Chemical Properties of Noxious Liquid Substances**	11.0 Knowledge and understanding of the chemical and the physical properties of noxious liquid substances including: 1. chemical cargoes categories (corrosive, toxic, flammable, explosive) 2. chemical groups and industrial usage 3. reactivity of cargoes

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
		12.0 Understanding the information contained in a Material Safety Data Sheet (MSDS)	12		12.0 Understanding the information contained in a Material Safety data Sheet (MSDS)
4	**Apply occupational health and safety precautions**	13.0 Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations. 1. flammability and explosion 2. toxicity 3. health hazards 4. inert gas composition 5. electrostatic hazards 6. reactivity 7. corrosivity 8. low boiling point cargoes 9. high density cargoes 10. solidifying cargoes 11. polymerizing cargoes	13	**Topic 4 Hazards and Their Control measures**	13.0 Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations. 1 flammability and explosion 2 toxicity 3 health hazards 4 inert gas composition 5 electrostatic hazards 6 reactivity 7 corrosivity 8 low boiling point cargoes 9 high density cargoes 10 solidifying cargoes 11 polymerizing cargoes
		14.0 Knowledge and understanding of dangers of non-compliance with relevant rules/regulations	14		14.0 Knowledge and understanding of dangers of non-compliance with relevant rules/regulations

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
		15.0 Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers: 1. precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus 2. precautions to be taken before and during repair and maintenance work 3. precautions for hot and cold work 4. precautions for electrical safety 5. use of appropriate personal protective equipment (PPE)	15	**Topic 5 Safe Working Practices including Risk assessment.**	15.0 Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers: 1. precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus 2. precautions to be taken before and during repair and maintenance work 3. precautions for hot and cold work 4. precautions for electrical safety 5. use of appropriate personal protective equipment (PPE)
5	**Respond to emergencies**	16.0 Knowledge and understanding of chemical tanker emergency procedures, including: 1. ship emergency response plans 2. cargo operations emergency shutdown 3. actions to be taken in the event of failure of systems or services essential to cargo	16	**Topic 6 Chemical Tanker Emergencies and First Aid procedures**	16.0 Knowledge and understanding of chemical tanker emergency procedures including 1. ship emergency response plans 2. cargo operations emergency shutdown 3. actions to be taken in the event of failure of systems or services essential to cargo

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
		4. firefighting on chemical tankers 5. enclosed space rescue 6. cargo reactivity 7. jettisoning cargo 8. use of a material safety data sheet (MSDS)			4. firefighting on chemical tankers 5. enclosed space rescue 6. cargo reactivity 7. jettisoning cargo 8. use of a material safety data sheet (MSDS)
6	**Take precautions to prevent pollution of the environment**	17.0 Actions to be taken following collision, grounding or spillage	17		17.0 Actions to be taken following collision, grounding or spillage
		18.0 Knowledge of medical first-aid procedures on board chemical tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)	18		18.0 Knowledge of medical first-aid procedures on board chemical tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)
7	**Monitor and control compliance with legislative requirements**	19.0 Understanding of procedures to prevent pollution of the atmosphere and the environment	19	**Topic 7 Pollution Prevention Procedures**	19.0 Understanding of procedures to prevent pollution of the atmosphere and the environment
		20.0 Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied	20	**Topic 8 IMO Instruments, MARPOL and Industry Guidelines**	20.0 Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied

STCW 2010 Table A-V/1-1-3			IMO Model course 1.03		
S. No	**Competence**	**Knowledge, Understanding and Proficiency**	**S. No**	**Topic**	**Knowledge, Understanding and Proficiency**
		21.0 Proficiency in the use of the IBC Code and related documents	21		21.0 Proficiency in the use of the IBC Code and related documents

■ Teaching Aids (A)

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

A1 Instructor's Manual (Part D of this course)
A2 Resuscitator
A3 Breathing apparatus
A4 Portable oxygen meter
A5 Portable combustible-gas detector
A6 Portable tankscope / Multi point flammable gas (infra-red gas analyzer)
A7 Portable toxic-gas detector & chemical absorption tubes
A8 Portable multigas – detector
A9 Personal multigas – detector
A10 Tank evacuation equipment
A11 Overhead projector for power point presentations
A12 Chemical Tanker Cargo & Ballast Water Handling Simulator
A13 White board
A14 Videos

■ IMO references (R)

R1 SOLAS 1974, International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974) Consolidated Edition 2009, (IMO-IIOE)
R2 STCW 78 as amended, including 2010 Manila amendments, International Convention on Standards of Training, Certification and Watch keeping for Seafarers,
R3 MARPOL as amended, International Convention for the Prevention of Pollution from Ships, 1973/1978(MARPOL as amended) Consolidated Edition 2011
R4 IG Systems, Inert Gas Systems (IMO-860E)
R5 Medical First aid guide for use in accidents involving dangerous good (MFAG)
R6 ISM Code, International Safety Management Code (ISM Code) (IMO-117E
R7 International Code for Fire Safety Systems, 2007 Edition, including Supplement 2012
R8 IBC code, edition 2007, ISBN 978-92-801-4226-IMO sales code IC100E

■ Textbooks (T)

Note: – Other textbooks may be used as deemed fit by the instructor.

T1 Safety in Chemical Tankers, International Chamber of Shipping, Safety in Chemical Tankers. (International Chamber of Shipping, Carthusian Court, 12 Carthusian Street, London, ECIM 6EZ, U.K.)

■ Bibliography (B)

B1 International Safety Guide for Chemical Tankers and Terminals. 5th ed. [London, Witherby and Co. Ltd. (32/36 Aylesbury Street, London, EC1 R OET, U.K),1996] (ISBN 1-85609-081-7)
B2 Basic Safe Tanker Handbook for Oil, Chemicals, LPG and LNG, Edition 2013 Capt. KSD Mistree, MEHEREX Publication, 21, Royal Accord IV, Lokhandwala, Andheri (W), Mumbai - 400 053. India.
Tel.: 91 9821369865, Email: mkmistree@yahoo.co.in
B3 Ship to Ship Transfer Guide (Chemical), International Chamber of Shipping/Chemical Companies International Marine Forum, Ship to Ship Transfer Guide (Chemical), 4th ed. (London, Witherby & Co. Ltd., 2005) (ISBN 1-85609-097-3)

B4 Drager-Tube Handbook, Drager-Tube Handbook 11th ed. (Drager Sicherheitstechnik GmbH, Revalstrasse 1, D-23560 Lubeck, Germany, 1998) (ISBN 3-926762-06-3)

B5 Measures to Prevent Accidental Pollution, INTERTANKO, Measures to Prevent Accidental Pollution, 1990

B6 Code of Safe Working Practices, PO Box 29, Norwich, NR3 1GN Telephone orders/General enquiries: 0870 600 5522 Fax orders: 0870 600 5533 Email: customer.services@tso.co.uk Text phone 0870 240 3701

B7 Tanker Management Self-Assessment, Witherby Publications, 32/36 Aylesbury Street London. www.witherbys.com ISBN 10: 1905331231 ISBN 13: 9781905331239

■ Videos – DVDs, CD ROMs, CBT's (V)

Note: – Other equivalent videos, CD-ROMs, CBT's may be used as deemed fit by the instructor.

For Chemical Tankers VC(x)

VC1 Portable gas detection equipment calibration procedures
Available from: KARCO Website:http://www.karco.in
Email: karco@karcoservices.com
Contact Person: Capt. Pravesh Diwan
Telephone: + 91-22-67101229

VC2 Tanker safety depends on you
Available from: NATIONAL AUDIO VISUAL CENTER
National Technical Information Service
5301 Shawnee Rd, Alexandria, VA 22312
Email: orders@ntis.gov

VC3 Operation and maintenance of inert gas systems
VC4 The ship/shore interface
VC5 Tanker practices series
- cargo - part 4 Code No: 504

VC6 Permit to work Code No: 621
VC7 Entry into enclosed spaces (edition 2) Code No: 682
VC8 Personal safety on tankers (edition 2), Code No: 970
Available from: Videotel Marine International
84 Newman Street, London W1T 3EU, UK
Tel: +44(0) 20 72991800
Fax: +44(0) 207299 1818
Email: mail@videotelmail.com
URL: www.videotel.co.uk

VC9 Static electricity on board tankers – DVD
Available from: KARCO Website:http://www.karco.in
Email: karco@karcoservices.com
Contact Person: Capt. Pravesh Diwan
Telephone: 91-22-67101229

VC10 Vapour emission control Code No: 1118
VC11 Chemical Fire Hazard Management - Edition 2
Available from: Videotel Marine International
84 Newman Street, London W1T 3EU, UK
Tel: +44(0) 20 72991800
Fax: +44(0) 207299 1818
Email: mail@videotelmail.com
URL: www.videotel.co.uk

Part B: Course Outline

■ Lectures

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

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

- **Classroom (Lecturing and explaining)**

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

Part C of this course covers all the requirements of STCW code Table A-V/1-1-3 where the knowledge based specified learning objectives may be used directly for the presentations and Part D of this course includes all the requirements of understanding and application based proficiencies with all the detailed explanations which may be required to cover under STCW code Table A-V/1-1-3. Part D also has the diagrams listed with figure numbers which corresponds to the General Learning objectives of this course. e.g. figure 2 (A-G) covers General learning Objective 2.0 Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operations. Part D also covers suggested case studies and simulator based exercises.

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

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

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

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

The 2010 Manila Amendments to the STCW Convention have also embraced the use of simulators for training and evaluation and assessment of competence. It is therefore important that the potential for utilizing this valuable training tool is realized to the maximum.

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

If the simulators are not available screen shots of the simulators are provided wherein the same may be used to initiate table top exercises along with explanations to elucidate understanding and thus assist effective teaching and learning to take place within the time frame suggested for simulator based training.

When simulators are used for training and assessing competence, the Instructors are guided to the STCW 2010 requirements with relation to simulators and to the training and assessment. The Simulator should conform to the requirements of STCW 2010 Regulation I/12 (use of simulators), section A-I/12, parts 1 and 2, Performance Standards for the simulator and simulator training objectives and sections B I/12, (guidance regarding the use of simulators). The training and assessment should conform to the requirements of STCW 2010 Regulation I/6 (training and assessment), section A-I/6, training and assessment (mandatory) 4.3.3.1, 4.3.3.2 and 6.5 and section B-I/6 (guidance regarding training and assessment) para 1 to 5.

- **Classroom (Case-studies)**

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

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

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

•Course Outline

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

COURSE OUTLINE

	Knowledge, understanding and proficiency	**Total hours for lectures**	**Total hours for practicals**
	Topic: Design and characteristics of a chemical tanker		
1	**Knowledge of chemical tanker designs, systems, and equipment, including:**		
1.1*	general arrangement and construction		0.5
1.2*	pumping arrangement and equipment		0.5
1.3*	tank construction and arrangement		0.5
1.4*	pipeline and drainage systems		0.5
1.5*	tank and cargo pipeline pressure and temperature control systems and alarms		0.5
1.6*	gauging control systems and alarms		0.5
1.7*	gas-detecting systems		0.5
1.8*	cargo heating and cooling systems		0.5
1.9*	tank cleaning systems		0.5
1.10*	cargo tank environmental control systems		0.5
1.11*	ballast systems		0.5
1.12*	cargo area venting and accommodation ventilation		0.5
1.13*	vapour return/recovery systems	0.5	
1.14#	firefighting systems	0.5	
1.15	Tank, pipeline and fittings material and coatings	0.25	
1.16	slop management	0.25	
2	**Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation**	1.5	
3	**Proficiency in tanker safety culture and implementation of safety management system**	1.5	

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for practicals
4	**Knowledge and understanding of monitoring and safety systems, including the emergency shutdown system**	1.5	
	Topic: Loading, unloading, care and handling of cargo		
5	**Ability to perform cargo measurements and calculations: Exercise**	1.5	1.5
6*	**Knowledge of the effect of bulk liquid Cargoes on trim and stability and structural integrity. Exercise on Simulators**		1.5
7	**Knowledge and understanding of chemical cargo-related operations, including:**		
7.1*	loading and unloading plans		3
7.2*	ballasting and deballasting		1.5
7.3*	tank cleaning operations		1.5
7.4*	tank atmosphere control		0.5
7.5*	inerting		0.5
7.6*	gas-freeing		0.5
7.7	ship-to-ship transfers	0.5	
7.8	inhibition and stabilization requirements	0.5	
7.9	heating and cooling requirements and consequences to adjacent cargoes	0.5	
7.10	cargo compatibility and segregation	0.5	
7.11	high-viscosity cargoes	0.5	
7.12	cargo residue operations	0.5	
7.13	operational tank entry	0.5	
8	**Development and application of cargo-related operation plans, procedures and checklists**		1.5
9	**Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment**	0.5	1
10	**Ability to manage and supervise personnel with cargo-related responsibilities**	1.5	
	Topic: Physical and Chemical Properties of Noxious Liquid Substances		
11	**Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including:**		
11.1	chemical cargoes categories (corrosive, toxic, flammable, explosive)	0.5	
11.2	chemical groups and industrial usage	0.5	
11.3	reactivity of cargoes	0.5	
12	**Understanding the information contained in a Material Safety Data Sheet (MSDS)**		1.5

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for practicals
	Topic Hazards and Their Control measures		
13	**Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations, including:**		
13.1	flammability and explosion	1	
13.2	toxicity	0.5	
13.3	health hazards	0.25	
13.4	inert gas composition	0.25	
13.5	electrostatic hazards	0.25	
13.6	reactivity	0.25	
13.7	corrosivity	0.25	
13.8	low-boiling-point cargoes	0.25	
13.9	high-density cargoes	0.25	
13.10	solidifying cargoes	0.5	
13.11	polymerizing cargoes	0.5	
14	**Knowledge and understanding of dangers of non-compliance with relevant rules/regulations:**	1	
	Topic Safe Working Practices including Risk assessment		
15	**Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers:**		
15.1	precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus	1	
15.2	precautions to be taken before and during repair and maintenance work	0.5	
15.3	precautions for hot and cold work	0.5	
15.4	precautions for electrical safety	0.5	
15.5	use of appropriate Personal Protective Equipment (PPE)	0.5	
	Topic Chemical Tanker Emergencies and First Aid procedures		
16	**Knowledge and understanding of chemical tanker emergency procedures, including:**		
16.1	ship emergency response plans	0.25	
16.2	cargo operations emergency shutdown	0.25	
16.3	actions to be taken in the event of failure of systems or services essential to cargo	0.25	
16.4	firefighting on chemical tankers	0.25	
16.5	enclosed space rescue	0.25	
16.6	cargo reactivity	0.25	
16.7	jettisoning cargo	0.5	
16.8	use of a Material Safety Data Sheet (MSDS)	0.5	

Knowledge, understanding and proficiency		Total hours for lectures	Total hours for practicals
17	**Actions to be taken following collision, grounding, or spillage**	0.5	
18	**Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Guide for Use in Accidents Involving Dangerous Goods (MFAG)**	3	
	Topic Pollution Prevention Procedures		
19	**Understanding of procedures to prevent pollution of the atmosphere and the environment**	1.5	
	Topic IMO Instruments, MARPOL and Industry Guidelines		
20	**Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied**	1.5	
21	**Proficiency in the use of the IBC Code and related documents**	3	
22	**Case Studies**	3	
23	**Test and Discussion**	1.5	
	Subtotals	38.5	21.5
	Total for the course	60	

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

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

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

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

Part B: Course Timetable

Teaching staff should note that timetables are suggestions only as regards to sequence and length of time allocated to each objective. Lecturers to adapt these factors to suit the needs of individual group of trainees depending upon their experience, ability and on the equipment and staff available for training: Below is a suggested time table so arranged to let the topics flow in the correct sequence of learning

	1st Period (1.5 Hours)	**2nd Period** (1.5 Hours)		**3rd Period** (1.5 Hours)	**4th Period** (1.5 Hours)
Day 1	1.0 Knowledge of chemical tanker designs, systems, and equipment, including: 1.1*general arrangement and construction 1.2*pumping arrangement and equipment 1.3* tank construction and arrangement	1.4* pipeline and drainage systems 1.5* tank and cargo pipeline pressure and temperature control systems and alarms 1.6* gauging control systems and alarms	**Lunch Break**	1.7* gas-detecting systems 1.8* cargo heating and cooling systems 1.9* tank cleaning systems	1.10* cargo tank environmental control systems 1.11* ballast systems 1.12* cargo area venting and accommodation ventilation
Day 2	1.13* vapour return/recovery systems 1.14# firefighting systems 1.15 tanks pipelines and fittings material and coatings 1.16 slop management	13.0 Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations, including: 13.1 flammability and explosion 13.2 toxicity		13.3 health hazards 13.4 inert gas composition 13.5 electrostatic hazards 13.6 reactivity 13.7 corrosivity low-boiling-point cargoes	13.8 high-density cargoes 13.9 solidifying cargoes 13.10 polymerizing cargoes
Day 3	11.0 Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including:	12.0 Understanding the information contained in a Material Safety Data Sheet (MSDS)		2.0 Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation	3.0 Proficiency in tanker safety culture and implementation of safety management system

	1st Period (1.5 Hours)	**2nd Period** (1.5 Hours)		**3rd Period** (1.5 Hours)	**4th Period** (1.5 Hours)
	11.1 chemical cargoes categories (corrosive, toxic, flammable, explosive) 11.2 chemical groups and industrial usage 11.3 reactivity of cargoes				
Day 4	4.0 Knowledge and understanding of monitoring and safety systems including the emergency shutdown system,	7.0 Knowledge and understanding of chemical cargo-related operations, including: 7.1* loading and unloading plans		7.1 * loading and unloading plans	7.2 * ballasting and deballasting
Day 5	7.3 * tank cleaning operations	7.4* tank atmosphere control 7.5* Inerting 7.6* gas-freeing		7.7 ship-to-ship transfers 7.8 inhibition and stabilization requirements 7.9 heating and cooling requirements and consequences to adjacent cargoes	7.10 cargo compatibility and segregation 7.11 high-viscosity cargoes 7.12 cargo residue operations
Day 6	14.0 Knowledge and understanding of dangers of non-compliance with relevant rules/regulations 7.13 operational tank entry	8.0 Development and application of cargo-related operation plans, procedures and checklists		9.0 Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment.	10.0 Ability to manage and supervise personnel with cargo-related responsibilities
Day 7	5.0 Ability to perform cargo measurements and calculations : Exercise	5.0 Ability to perform cargo measurements and calculations : Exercise		6.0* Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity. Exercise on Simulators	15.0 Knowledge and understanding of safe working practices, including risk assessment and personal shipboard

	1st Period (1.5 Hours)	**2nd Period** (1.5 Hours)		**3rd Period** (1.5 Hours)	**4th Period** (1.5 Hours)
					safety relevant to chemical tankers: 15.1 precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus 15.2 precautions to be taken before and during repair and maintenance work
Day 8	15.3 precautions for hot and cold work 15.4 precautions for electrical safety 15.5 use of appropriate Personal Protective Equipment (PPE)	16.0 Knowledge and understanding of chemical tanker emergency procedures, including: 16.1 ship emergency response plans 16.2 cargo operations emergency shutdown 16.3 actions to be taken in the event of failure of systems or services essential to cargo 16.4 firefighting on chemical tankers 16.5 enclosed space rescue 16.6 cargo reactivity	**Lunch Break**	16.7 jettisoning cargo 16.8 use of a Material Safety Data Sheet (MSDS) 17.0 Actions to be taken following collision, grounding, or spillage	18.0 Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Guide for Use in Accidents Involving Dangerous Goods (MFAG).

	1st Period (1.5 Hours)	**2nd Period** (1.5 Hours)		**3rd Period** (1.5 Hours)	**4th Period** (1.5 Hours)
Day 9	18.0 Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Guide for Use in Accidents Involving Dangerous Goods (MFAG)	19.0 Understanding of procedures to prevent pollution of the atmosphere and the environment		20.0 Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied	21.0 Proficiency in the use of the IBC Code and related documents
Day 10	21.0 Proficiency in the use of the IBC Code and related documents	10 Case Studies		10 Case Studies	Assessment and discussions

Tea Breaks and Lunch break as found suitable may be given in between periods by the instructor.

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

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

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

Part C: Detailed Teaching Syllabus

TOPIC 1	**DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER**
COMPETENCE 1	**Ability to safely perform and monitor all cargo operations**

TRAINING OUTCOMES:

1. Communications are clear, understood and successful.
   Cargo operations are carried out in a safe manner, taking into account chemical tanker designs, systems and equipment.
   Cargo operations are planned, risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and avoid pollution of the marine environment.
   Procedures for monitoring and safety systems ensure that all alarms are detected promptly and acted upon in accordance with established procedures.

2. Proper loading, stowage and unloading of cargoes ensures that stability and stress conditions remain within safe limits at all times. Potential non-compliance with cargo-related procedures is promptly identified and rectified. Actions taken and procedures followed are correctly identified and appropriate shipboard cargo-related equipment is properly used.

3. Calibration and use of monitoring and gas-detection equipment are consistent with safe operational practices and procedures.

4. Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices.

TOPIC 1 DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
1.0	**Knowledge of chemical tanker designs, systems, and equipment, including:**	**R1,R2,R3,R6, R7**	**T1,B1,B2,B7, VC3, VC10**	**A1,A11,A12,A13, A14**
1.1	**General arrangement and construction**			
1.1.1	Sketch and describe the elements of a chemical tanker design			
1.1.1.1	Identify general tank and ship arrangements			
1.1.1.2	Describe the need for different types of chemical tankers			
1.1.1.3	Describe different types of chemical tankers in relation to dangerous and noxious properties of cargoes to be carried			
1.1.1.4	Explain how the ship type governs the survival capability & assumed damage in relation to the ship types			
1.1.1.5	Describe other safety aspects of tanker design taken into consideration in relation to:			
1.1.1.5.1	Accommodation, service and machinery spaces and control rooms			
1.1.1.5.2	Cargo and/or ballast pump-rooms			
1.1.1.5.3	Ventilation of pump-rooms and/or similar spaces			
1.1.1.5.4	Location of cargo tank vents			
1.1.1.5.5	Electrical installations			
1.1.1.6	Describe how tank design assists with:			
1.1.1.6.1	Minimizing residues			
1.1.1.6.2	Increasing cargo outturn			
1.1.1.6.3	Prevention of cargo contamination			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.2	**Pumping arrangement and equipment**			
1.2.1	Describe the construction of following pump types on chemical tankers:			
1.2.1.1	Centrifugal			
1.2.1.2	Screw			
1.2.1.3	Eductors			
1.2.2	Explain basic pumping concepts			
1.2.3	Describe deepwell pumps, benefits & discuss the limitations			
1.3	**Tank construction and arrangement**			
1.3.1	Identify references from the Codes dealing with segregation and containment of cargo area			
1.3.2	Describe:			
1.3.2.1	Independent tank			
1.3.2.2	Integral tank			
1.3.2.3	Gravity tank			
1.3.2.4	Pressure tank			
1.3.3	Explain the importance of segregation of cargo area from:			
1.3.3.1	Accommodation, service and machinery spaces			
1.3.3.2	Drinking water and stores for human consumption			
1.3.4	Sketch required means of segregation for loading incompatible grades and explain how segregation is achieved:			
1.4	**Pipeline and drainage systems**			
1.4.1	Describe general cargo piping arrangements on chemical tankers			
1.4.2	Identify materials of construction			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.4.3	identify and describe types of valves normally used for chemical tankers:			
1.4.3.1	Ball valves			
1.4.3.2	Membrane valves			
1.4.3.3	Gate valves			
1.4.3.4	Butterfly valves			
1.4.4	Describe cargo segregation in terms of:			
1.4.4.1	Segregation by two valves not acceptable in the chemical trade			
1.4.4.2	Spool-pieces / blind flanges			
1.4.5	Discuss the care, handling and use of cargo hoses:			
1.4.5.1	Compatibility and suitability with chemical cargoes			
1.4.5.2	Cargo temperature limitations			
1.4.5.3	Inspection and testing procedures			
1.4.5.4	Certification of hoses			
1.4.6	Describe the requirements for an annual pressure test of the ship's cargo hose			
1.5	**Tank and cargo pipeline pressure and temperature control systems and alarms**			
1.5.1	Describe requirements of pressure monitoring systems of chemical Tankers			
1.5.2	Explain why temperature sensors may be required on chemical Tanker			
1.5.3	List types of temperature sensors			
1.5.4	Describe precautions to be taken when handling temperature monitoring devices.			

TOPIC 1 DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
1.5.5	Explain Alarms and shut-down circuits used on board chemical tankers			
1.5.6	List precautions to be taken when handling alarms and shutdown circuits.			
1.6	**Gauging control systems and alarms**			
1.6.1	Describe the principles of operation and types of gauging devices for cargo tanks			
1.6.2	Explain the terms:			
1.6.2.1	Open gauging			
1.6.2.2	Restricted gauging			
1.6.2.3	Closed gauging			
1.6.3	Explain the use and purpose of high-level alarm systems for cargoes			
1.6.4	Explain the tank overflow control system			
1.7	**Gas-detecting systems**			
1.7.1	Describe the instruments necessary for detecting toxic and flammable cargoes			
1.7.2	Discuss fixed and portable vapour-detection instruments			
1.8	Cargo heating and cooling systems			
1.8.1	Explain the importance of heating for some cargoes			
1.8.2	Describe different heating mediums			
1.8.3	Sketch and Describe heating systems using:			
1.8.3.1	Heating coils			
1.8.3.2	Deck mounted heat exchanger			
1.8.4	Explain the risks associated with overheating cargo			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.8.5	Explain the risks and dangers associated with poor monitoring of cargo temperatures for some chemical cargoes.			
1.8.6	Identify problems associated with heated cargoes adjacent to polymerizable or inhibited cargoes			
1.8.7	Identify dangers associated with heated cargoes adjacent to highly volatile cargoes			
1.8.8	State that some cargoes with low boiling point may need to be cooled			
1.8.9	Describe different cooling or refrigeration systems for chemical tankers			
1.8.10	Define reference temperatures			
1.9	**Tank cleaning systems**			
1.9.1	Explain why the type of cleaning system on chemical tankers depends on the ship's cargo and its trade			
1.9.2	Lists the main components of a tank cleaning system			
1.9.3	Explain why the tank cleaning heat exchanger and the tank cleaning pump must be of approximately the same capacity			
1.9.4	State that the tank-washing machines are either portable or fixed			
1.9.5	Describe a tank-washing system			
1.9.6	Describe, the design and safety measures with respect to tank-washing machines			

TOPIC 1	**DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.10	**Cargo tank environmental control systems**			
1.10.1	Describe open and controlled ventilation systems			
1.10.2	Discuss loading rates and ventilation capacity			
1.10.3	Explain the design of safe ventilation to minimize cargo vapours exposure to personnel			
1.10.4	Explain the limitations and risks of open-venting			
1.10.5	Explain when controlled venting is required			
1.10.6	Describe the use of the vapour return line			
1.10.7	Describe safety aspects of vent design, including:			
1.10.7.1	Flame arrestors			
1.10.7.2	Flame screens			
1.10.7.3	High-velocity vents			
1.10.8	Explain the operation and precautions of:			
1.10.8.1	High-velocity valve			
1.10.8.2	Flame arrestor			
1.10.9	Explain the requirements of a pressure/vacuum valve (P/V valves)			
1.10.10	Discuss general precautions and maintenance of P/V valves			
1.10.11	Explain how the inert gas system maybe a part of a vessel's venting system.			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.10.12	List the sources of inert gas available to a chemical tanker as a. Stored compressed nitrogen b. Stored liquid nitrogen; c. Nitrogen generators using pressure swing adsorption (PSA); d. Nitrogen generators using membrane separation; e. Oil fired inert gas generators; f. Nitrogen supplied from shore.			
1.11	**Ballast systems**			
1.11.1	Explain why ballast pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks require to be independent of cargo tanks.			
1.11.2	Explain why discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks are outside machinery spaces and accommodation spaces			
1.11.3	Explain the sequence of setting up of appropriate lines & valves during ballasting / de ballasting operations			
1.11.4	Describe the use of ballast pumps and eductors.			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.11.5	Explain that ballast operations are carried out to maintain safe trim and stability during cargo operations.			
1.11.6	Explain ballast water treatment system			
1.12	**Cargo area venting and accommodation ventilation Systems.**			
1.12.1	Explain why all cargo tanks should be provided with a venting system appropriate to the cargo being carried			
1.12.2	State that as per the IBC code, chemical tankers to be fitted with secondary means of venting			
1.12.3	Describe secondary means of venting			
1.12.4	Explain with respect to the safety the design considerations for a chemical tanker venting system.			
1.13	**Vapour return/recovery systems**			
1.13.1	Define Maximum allowable transfer rate: as The maximum volumetric rate at which a tanker may receive cargo or ballast			
1.13.2	Define Tanker vapour connection as the point in a tanker's fixed vapour collection system where it connects to a vapour collection hose or arm.			
1.13.3	Define Terminal vapour connection: as The point in a terminal's vapour collection system where it connects to a vapour collection hose or a vapour collection arm.			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.13.4	Define Vapour balancing: as The transfer of vapour displaced by incoming cargo from the tank of a tanker receiving cargo into a tank of a facility delivering cargo via a vapour collection system.			
1.13.5	Define Vapour collection system as an arrangement of piping and hoses used to collect vapour emitted from a tanker's cargo tanks and transport the vapour to a vapour processing unit.			
1.13.6	Describe Vapour emission control Systems and Vapour recovery systems.			
1.13.7	Describe operating procedures and requirements for a vapour emission control system.			
1.13.8	State that regulations require at least four vapour connections to be provided, two on each side of the ship, with presentation flanges at the same height above the deck as the cargo manifold. One vapour connection is to be located forward of the manifold and one located aft of the manifold on each side of the ship.			
1.13.9	State that regulations require the first 1 meter inboard of each manifold to be painted on its exterior surfaces, excluding flange faces.			
1.13.10	State that the capacity of the vapour collection system is to be documented through pressure drop/flow rate curves.			

TOPIC 1	**DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.13.11	Explain pressure drop with respect to vapour collection system.			
1.13.12	Calculates pressure drop			
1.13.13	Explain the use of vapour recovery instructions and documentation between the ship and the shore.			
1.14	**Firefighting systems**			
1.14.1	Explain requirements of firefighting on a chemical tanker for cargo area			
1.14.2	Explain fixed fire -extinguishing system for cargo pump rooms of a chemical tanker.			
1.14.3	State that the fire-extinguishing media that are considered to be suitable for specific cargoes are listed in Chapter 17 of IBC code			
1.14.4	Explain why water and foam are suitable as firefighting agents			
1.14.5	Explain advantages of dry chemical powder as a firefighting agent.			
1.14.6	Explain advantages of carbon dioxide as a firefighting agent			
1.14.7	Describe fireman's outfit requirements.			
1.14.8	State that as a safety measure prior to commencing cargo operations the ship's firefighting equipment should be made ready and the international shore connection should be standby			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.15	**Tanks pipelines and fittings material and coatings**			
1.15.1	Explain why coatings, fixtures and fittings must be compatible with cargoes to be carried			
1.15.2	Explain the reasons for the use of stainless steel cargo tank and coatings in cargo tanks			
1.15.3	Explain the use of stainless steel for cargo piping, valves and pumps			
1.15.4	Differentiate different grades and surface finishes of stainless steel			
1.15.5	Describe the properties of specialized tank coatings			
1.15.5.1	Zinc silicate			
1.15.5.2	Epoxy			
1.15.5.3	Phenolic			
1.15.5.4	Polyurethane			
1.15.6	Differentiate organic and inorganic coatings			
1.15.7	Explain the use of rubber linings for highly corrosive cargoes			
1.15.8	Explain the resistance of coatings to groups of chemicals			
1.15.9	Identify the manufacturer's coating resistance list			
1.15.10	Describe in general terms maintenance of tank coatings			
1.15.11	Explain physical and chemical absorption of coatings and subsequent cargo contamination			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
1.16	**Slop management**			
1.16.1	State that compatibility of various cargoes and cleaning chemicals should be checked prior transferring them to a slop tank.			
1.16.2	Explain why following should be avoided: • Mixing of slops from Annex I (oil) cargoes with slops from Annex II (chemical) cargoes; and • Mixing of slops from incompatible cargoes.			
1.16.3	Describe a slops-retaining system			
2.0	**Knowledge of pump theory and characteristics.**	**R2**	**B2,B7,**	**A1, A11,A12,A13**
2.1	Explain the advantages of using centrifugal pump as a cargo pump			
2.2	Explain the disadvantages of a centrifugal cargo pump and how the same can be overcome.			
2.3	State that centrifugal deep well pumps are often hydraulically driven			
2.3.1	Describe, by aid of a drawing, an open hydraulic system			
2.3.2	Describe, by aid of a drawing, a closed hydraulic system			
2.4	Explain why many deep-well pumps do not have non-return valves			
2.5	Describe safe handling of a deep well pump			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Proficiency	**Understanding and**	**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
2.6	State that normally every cargo pump is supplied with performance curves, based on trials, describing the pump's			
2.6.1	Performance curve			
2.6.2	Efficiency curve			
2.6.3	Power consumption curve			
2.6.4	NPSH curve			
2.7	Explain total head			
2.8	Explain the benefits of showing the pump's capacity as a function of total head which is independent of the liquid density			
2.9	Explain design point, NPSH, cavitation and its effects			
2.10	Explain the Pump curves and their relationship			
2.11	Explain how a Q-H curve can be drawn for two pumps running in parallel			
2.12	Explain how actual discharge rate depends on:			
2.12.1	Static back pressure			
2.12.2	Dynamic pressure			
2.13	Explain the danger of running two or more pumps in parallel if their characteristics are not exactly the same or if the pumps are running at different speeds.			
2.14	Describe, with an aid of a drawing, a stripping arrangement using an eductor			
2.15	Describe, the stripping operation with an aid of a drawing, with a stripping arrangement using a deep well pump designed for stripping			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
3.0	**Proficiency in tanker safety culture and implementation of safety-management system**	**R1,R2,R6,R7**	**T1,B1,B2,B3, B5,B6, B7, VC2,VC8**	**A1,A11,A13,A14**
3.1	Describes the importance of ISM Code for chemical tankers.			
3.2	Describes how OCIMF's Tanker Management and Self-Assessment (TMSA) programme can help vessel operators assess, measure and improve their management systems.			
3.3	States that TMSA is designed to create opportunities and optimize performance in crucial areas such as safety and environmental excellence.			
3.4	Demonstrate knowledge of the elements of ISM Code, SMS procedures and Code of Safe Working Practices (COSWP) in relation to cargo operations..			
4.0	**Knowledge and understanding of monitoring and safety systems,**	**R1,R2,R6,R7**	**T1,B1,B2,B3, B5,B6,B7, VC6,VC7**	**A1,A3,A4,A5,A6, A7, A8, A9,A11,A13, A14**
4.1	State that safety alarms of a chemical tanker must be checked and calibrated as per safety management system requirements.			
4.2	Explain why monitoring of atmosphere in gas dangerous and gas safe zones must be carried out regularly			
4.3	Explain closed monitoring of tank contents.			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Proficiency	**Understanding and**	**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
4.4	Explain how exposure levels in all work locations should be monitored.			
4.5	Explain why Bridge, control room, accommodation and engine spaces atmosphere should be monitored regularly.			
4.6	Explain why chemical tanker personnel should always have personal monitors for toxic cargoes when gauging, sampling, entering a pump-room, connecting and disconnecting loading lines, cleaning filters, draining to open containments and mopping up spills etc.			
4.7	Explain why some flammable gas monitors (Explosimeters) should not be used for measuring gas in inert atmospheres.			
4.8	Describe Fixed Gas Detection Installations			
4.9	State that multi gas instruments are commonly used nowadays			
4. 10	State that detector tubes should be used if it becomes necessary to monitor a known high concentration.			
4.11	State that Individual Tank Pressure Monitoring and Alarm Systems must be checked regularly.			
4.12	State that gas detection equipment should, on initial supply, have a calibration certificate, traceable where possible to internationally recognized standards.			
4.13	Explain the importance of continuous gas monitoring			

TOPIC 1	DESIGN AND CHARACTERISTICS OF A CHEMICAL TANKER			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
4.14	Explain the use of the emergency shutdown system			
4.15	State that the Emergency shutdown of cargo pumps, alarms and trips, level alarms, etc., where fitted, should be tested regularly			

TOPIC 2	LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE :
COMPETENCE 1	**Ability to safely perform and monitor all cargo operations**

TRAINING OUTCOMES:

Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
5.0	**Ability to perform cargo measurements and calculations : {Please use Exercise from Part D}**	**R2,R6**	**B1,B2**	**A1,A11,A12,A13**
5.1	Explain 98% filling limit of Cargo tanks as required by IBC codes			
5.2	Identify documents and information requirements to be used in cargo calculations			
5.2.1	State that ullage tables are used to calculate tank volumetric quantities after allowing for corrections			
5.2.2	Explain Specific Gravity, Volume and Density Correction factors			
5.2.3	Calculate cargo quantities using Density correction factors for unsaturated hydrocarbons			
5.2.4	Determines Cargo quantities for Petro chemicals using ASTM Tables			
6.0	**Knowledge of the effect of bulk liquid Cargoes on trim and stability and structural integrity. Exercise on Simulators**	**R1,R2,R6,**	**T1,B1,B2,**	**A1,A11,A12,A13**
6.1	Performs stability calculations			
6.2	Explain the use of trim and stability approved manuals and the requirements to maintain a sea-going condition throughout Loading and unloading operations with respect to structural integrity.			
7.0	**Knowledge and understanding of chemical cargo-related operations, including:**	**R1,R2,R4,R6**	**T1, B1, B2, B3,B5,B6,B7**	**A1,A11,A12,A13**

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.1	**Loading and unloading plans**			
7.1.1	State that the responsible cargo officer has to ensure availability of all cargo information including the requirements of adequate PPE, antidotes and shipping documents required for safe loading of cargoes			
7.1.2	Explain important operational requirements from the Code with respect to the cargo to be handled.			
7.1.3	Describe a stowage plan and its role in preplanning			
7.1.4	Explain the importance of "Correct technical Name" and other relevant information necessary prior to the making of a loading plan.			
7.1.5	Identify requirements for inhibitors and where this information is obtained			
7.1.6	State that cargoes which are flammable or produce harmful vapours should not be loaded over the top			
7.1.7	Describe the precautions prior to loading over the top			
7.1.8	Explain the procedures for cargo sampling and the need for taking various cargo samples at different locations at the load port.			
7.1.9	Explain how cargo samples should be drawn, handled and stowed			
7.1.10	Describe procedures to disconnect hoses/hard arms			
7.1.11	Explain the term 'cargo conditioning' with respect to the chemical trade:			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
7.1.12	Explain, in general terms, the transport requirements for vegetable and animal oils and fats			
7.1.13	State that unloading operations should be pre-planned and the different cargo parcels unloaded sequentially according to the plan			
7.1.14	Explain how inerting requirements for the tank atmosphere control are maintained during unloading			
7.1.15	Explain the need for taking cargo samples at the unloading port.			
7.1.16	Describe generally the requirements for care and transportation of chemical cargoes			
7.1.17	Describe the requirements for care and transportation of bio diesels.			
7.1.18	List general precautions during unloading			
7.1.19	Explain requirements of Chemical cargo unloading with respect to draining and stripping			
7.1.20	Describe precautions to take on completion of unloading			
7.2	**Ballasting and deballasting**			
7.2.1	Explain requirements of Ballasting and Deballasting on a chemical tanker			
7.2.2	Explain, briefly the free surface effect in cargo tanks and ballast tanks			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.2.3	State that ballast operations in port should be in compliance with local regulations			
7.3	**Tank cleaning operations**			
7.3.1	Explain why proper planning is required prior conducting tank cleaning operations			
7.3.2	Describe the contents and coverage of a written tank cleaning plan of a chemical tanker			
7.3.3	State that before starting tank cleaning operations, the responsible officer should conduct a meeting to review the tank cleaning plan with all crew members involved, especially those who will supervise operations.			
7.3.4	State that Tank cleaning or gas freeing alongside should not take place without the express permission of the terminal and port authorities. If allowed, all appropriate safety measures should be in place and shore personnel notified before commencing operations.			
7.3.5	Describe the pre cleaning checks which should be made prior commencing tank cleaning operations			
7.3.6	Describe the stages of chemical tank cleaning			
7.3.7	Explain permitted maximum allowed stripping quantity remaining on board after discharge for Categories X, Y and Z substances			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.3.8	Describe measures of control for Category X substances			
7.3.9	Explain exemptions from mandatory pre- washing requirements in accordance with MARPOL Annex II			
7.3.10	**Explain requirements for discharge to reception facilities and concentration of substance in the effluent discharge to shore**			
7.3.11	Describe action to take when unable to measure concentration of residues in the effluent of cargo required to be regulated under mandatory prewash.			
7.3.12	Explain Limitations on subsequent discharge of wash water or ballast into the sea			
7.3.13	Explain cleaning and discharging of effluent procedures for solidifying and non-solidifying substances			
7.3.14	Explain washing procedures for high-viscosity and low-viscosity substances			
7.3.15	State that there are no special areas for Chemical discharges into the sea except Antarctica area where there is a prohibition of discharges			
7.3.16	Explain slop tank discharge restrictions and requirements			
7.3.17	Explain wall wash test requirements and procedures			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.3.18	Explains Passivation and Pickling of stainless steel tanks.			
7.4	**Tank atmosphere control**			
7.4.1	Explain tank blanketing and padding requirements for transporting Chemicals in bulk.			
7.4.2	State that tank cleaning in chemical tankers may be carried out in the following atmosphere: - undefined or uncontrolled - too lean - inerted			
7.4.3	Explain methods of maintaining control of atmosphere by inerting, padding, and drying during cargo operations			
7.4.4	Describe requirements for testing of tank atmosphere with regard to: · oxygen content · flammable vapours · toxic vapours			
7.5	**Inerting**			
7.5.1	Explain Inerting on Chemical tankers			
7.5.2	State that Chemical tankers transporting low flash point cargoes may be required by The IBC Code to maintain tank atmospheres in an inerted condition. Additional requirements exist for particular cargoes to be kept inerted for cargo quality.			
7.6	**Gas-freeing**			
7.6.1	Explain gas freeing on a chemical tanker			
7.6.2	Describe both displacement and dilution methods in general terms			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.6.3	Explain Safe procedures for gas freeing after tank cleaning and cleaning by ventilation			
7.7	**Ship-to-ship transfers**			
7.7.1	Explain Ship to ship transfer operations of a chemical tanker.			
7.7.2	Explain with reference to Ship to ship transfer operations:			
7.7.2.1	Responsibilities between the 2 ship masters			
7.7.2.2	Communications			
7.7.2.3	Navigational warnings			
7.7.2.4	Weather conditions and limitations			
7.7.2.5	Pre-transfer preparations on each ship			
7.7.2.6	Information exchange			
7.7.2.7	Cargo transfer operations			
7.7.2.8	Completion of cargo transfer			
7.8	**Inhibition and stabilization requirements**			
7.8.1	State that care must be taken to ensure that reactive cargoes that require inhibition are sufficiently inhibited to prevent polymerization during the entire voyage.			
7.8.2	Describe the inhibitor certificate			
7.8.3	State that inhibited cargoes having an inhibitor that needs oxygen should not be carried in an inerted tank.			
7.8.4	Explain why close monitoring of the associated cargo systems of inhibited cargo is necessary.			
7.9	**Heating and cooling requirements and consequences to adjacent cargoes**			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
7.9.1	Describe the consequences to adjacent tank cargoes when heating or cooling some cargoes.			
7.10	**Cargo compatibility and segregation**			
7. 10.1	Explain compatibility of chemical cargoes, reactive and non-reactive groups and the use of compatibility chart			
7. 10.2	Explain cargo segregation with respect to reactive, toxic, polymerizable, volatile, and odour sensitive cargoes.			
7.11	**High-viscosity cargoes**			
7.11.1	Explain viscosity with respect to temperatures			
7.11.2	Explain why monitoring of unloading temperature of the cargo must be carried out			
7.12	**Cargo residue operations**			
7.12.1	Describe requirements to comply with cargo residues prior tank cleaning.			
7.13	**Operational tank entry**			
7.13.1	Describe precautions to take prior making an entry into cargo tanks for operational requirements.			
7.13.2	Appreciate that prior to commencing sweeping operations the crew should be briefed of the dangers involved.			
7.13.3	Demonstrate making an operational entry into cargo tanks for residue sweeping			
8.0	**Development and application of cargo-related operation plans, procedures and checklist**	**R1,R2,R3, R4, R6,R8**	**B1,B2,B3,VC4**	**A1,A11,A12,A13, A14**

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
8.1	**State that thorough planning is essential to safe and correct cargo handling**			
8.2	**List main points in cargo planning as:**			
8.2.1	· Cargo requirements			
8.2.2	· Cargo compatibility			
8.2.3	· Resistance list of tank material/coating			
8.2.4	· Tank cleanliness			
8.2.5	· Tank capacity			
8.2.6	· Cargo handling			
8.2.7	· Load port rotation			
8.2.8	· Unloading port rotation			
8.3	Identify the minimum requirements set out in Chapter 17 of the IBC Code: given the names of some common chemicals to be loaded,			
8.4	Identify the physical and chemical properties of the cargoes by using Cargo Data Sheets			
8.5	Demonstrates with the aid of cargo compatibility chart, whether or not a cargo can be loaded adjacent to another cargo			
8.6	Determine tank coating compatibility			
8.7	Explain generally the requirements for tank cleanliness prior to loading cargo.			
8.8	List the reference publications that provide useful information while planning cargo			
9.0	**Ability to calibrate and use monitoring and gas-detection systems, Portable gas measuring instruments and equipment.**	**R1,R2,R6, R8**	**T1,B1,B2,B4,B6,B7**	**A1,A4,A5,A6,A7, A8,A9,11,A12, A13,A14,VC1**

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
9.1	Explain the requirements of gas detection and monitoring systems for chemical tankers.			
9.2	Explain the use of vapour detection equipment as required by the IBC Code			
9.3	Describe Thermal conductivity meters			
9.4	Describe : a. Combustible gas detectors b. Thermal conductivity meters.			
9.5	Describe the use of Chemical detector tubes			
9.6	Performs Measurement of Oxygen Concentrations			
9.7	Explain Calibration procedures of a typical gas measuring instrument			
10.0	**Ability to manage and supervise personnel with cargo-related responsibilities**	**R1,R2,R6, R8**	**T1,B1,B2,B3,B5,B6, B7, VC5**	**A1,A11,A13,A14**
10.1	Explains the responsible cargo officer on watch supervises and directs the cargo operations ensuring that the stresses and stability of the vessel are always within limits, and that sufficient qualified personnel are on duty			

TOPIC 2 LOADING, UNLOADING, CARE AND HANDLING OF CARGO DURING THE CHEMICAL TANKERS VOYAGE CYCLE

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
10.2	Explains how the responsible officer ensures and maintains: - Suitability of cargo containment prior loading. - Cargo is loaded, as per stowage plan - Cargo is cared for during passage with respect to monitoring its parameters, ventilation, cooling, heating etc., as required. - Cargo is unloaded safely as per plan. Issuing relevant standing/night orders. - Records for cargo and ballast operations are maintained as per company procedures. - Records of cargo parameters, soundings of ballast tank and other spaces are maintained as per company procedures. - Standard language is employed - Seafarers on cargo watches shall carry out the work as assigned to them by the responsible officer of the watch			

TOPIC 3	**PHYSICAL AND CHEMICAL PROPERTIES OF NOXIOUS LIQUID SUBSTANCES**
COMPETENCE 2	**Familiarity with physical and chemical properties of chemical cargo**

TRAINING OUTCOMES:

Effective use is made of information resources for identification of properties and characteristics of noxious liquid substances and related gases, and their impact on safety, environmental protection and vessel operation.

TOPIC 3 PHYSICAL AND CHEMICAL PROPERTIES OF NOXIOUS LIQUID SUBSTANCES

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
11.0	**Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including:**	**R1,R2,R5, R6,R7, R8**	**T1,B1,B2,B6**	**A1,A11,A13**
11.1	**Chemical cargoes categories (corrosive, toxic, flammable, explosive)**			
11.1.1	Explain the properties of Corrosive, toxic & flammable cargoes			
11.1.2	State that care should be taken to ensure that unsuitable materials are not included in the cargo system.			
11.2	**Chemical groups and industrial usage**			
11.2.1	Explain Organic and Inorganic chemical groups.			
11.3	**Reactivity of cargoes**			
11.3.1	State that a chemical cargo may react in a number of ways, such as: • with itself • with air • with water • with another cargo • with other materials			
11.3.2	State that some cargoes may react with other materials, such as: • tank materials and coatings • gaskets • cargo hoses			

TOPIC 3	PHYSICAL AND CHEMICAL PROPERTIES OF NOXIOUS LIQUID SUBSTANCES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
	• cargo sample containers			
12.0	**Understanding the information contained in a Material Safety Data Sheet (MSDS)**	**R2,R3,R6, R7,R8**	**T1,B1,B5,B6**	**A1,A11,A13**
12.1	Explain and demonstrate the information contained in a MSDS			
12.2	State that It is extremely important that the MSDS is specific to the actual cargo product being loaded, and not a generic one, in order to establish all the cargo's components.			
12.3	Use the MSDS appended in Part D and find out the flammable range, TLV, heating requirement, chemical groups, CHRIS code, emergency action, firefighting medium.			

TOPIC 4	**HAZARDS AND THEIR CONTROL MEASURES**
COMPETENCE 3	**Take Precautions to prevent Hazards**

TRAINING OUTCOMES:

Relevant cargo-related hazards to the vessel and to personnel associated with chemical tanker cargo operations are correctly identified, and proper control measures are taken

TOPIC 4	HAZARDS AND THEIR CONTROL MEASURES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
13.0	**Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations, including:**	**R2,R6,R7, R8**	**T1,B1,B2,B4,B6, VC9,VC3**	**A1,A2,A10,A11, A13,A14**
13.1	**Flammability and explosion**			
13.1.1	State that the fire hazard of cargo covered by the IBC / BCH Codes is defined by its flashpoint, boiling point, flammability limits and auto-ignition temperature			
13.1.2	Explain the terms flashpoint, boiling point, flammability limits and auto-ignition temperature			
13.1.3	State that many chemical cargoes are flammable and that it is the vapour that burns			
13.1.5	State that flammable range will be different for different chemical cargoes			
13.1.6	Explain Flammability of chemical cargoes and their control measures			
13.2	**Toxicity**			
13.2.1	Explain degree of Toxicity of chemicals.			
13.2.2	State that correct medical first aid treatment following exposure can mitigate the consequences.			
13.2.3	Explain the three defined types of toxicity which relate to the nature of the substance			
13.2.4	Explain how toxic poisons can enter the body:			
13.2.5	State that Safe operating procedures requires a full understanding of the			

TOPIC 4 HAZARDS AND THEIR CONTROL MEASURES

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
	dangers involved and the use of the correct Personal Protective Equipment (PPE).			
13.3	**Health hazards**			
13.3.1	Explain the health hazards to personnel exposed to toxic chemicals			
13.3.2	Explain the 3 categories of TLV's • TLV – TWA (Time Weighted Average) • TLV – STEL (Short Term Exposure Limit) • TLV – C (Ceiling)			
13.3.3	State that most chemicals may present more than one hazard to health, it may be either one or more of the following: • corrosive • poisonous • toxic • asphyxiation • Result in long term damage to eyes or the nervous system • Have long term carcinogenic effects.			
13.3.4	State that chemical burns due to corrosivity of chemicals is a common health hazard where care needs to be exercised when handling cargoes like acids and alkalis.			
13.4	**Inert gas composition**			
13.4.1	Explain inert gas composition of a membrane separator nitrogen generator			
13.4.2	Explain inert gas composition of an oil fired IG generator			

TOPIC 4 HAZARDS AND THEIR CONTROL MEASURES

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
13.4.3	State that Crew members should be aware of potential hazards of an oxygen depleted atmosphere in the vicinity of tank vents and outlets during inerting, especially if nitrogen is the inert gas being used.			
13.4.4	Explain the dangers of Nitrogen exposure.			
13.4.5	Describe precautions to be taken when handling Nitrogen			
13.5	**Electrostatic hazards**			
13.5.1	Describe the operations where the risk of generating static sparking may occur on board a chemical carrier			
13.5.2	Explain the precautions to be taken for static hazards when loading chemical cargoes.			
13.5.3	Explain hazards of static generation and its controls during tank cleaning in a non inerted after unloading flammable cargo			
13.5.4	State that portable tank cleaning machines should also be continually electrically bonded' through the tank cleaning hoses to the ships structure.			
13.5.5	State that due to the possibility of static electricity generation, carbon dioxide should not be injected into any space containing a flammable atmosphere which is not already on fire.			
13.6	**Reactivity**			
13.6.1	State those Reactive chemicals may be inherently unstable or, when in contact with air, water or			

TOPIC 4 HAZARDS AND THEIR CONTROL MEASURES

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
	other materials may react in a dangerous and violent manner.			
13.6.2	State that Dangerous reactions are those emitting heat, and those that generate hazardous vapours and gases			
13.6.3	State that the reaction rate accelerates as heat is generated. A very fast reaction may cause an explosion.			
13.6.4	Explain how reactive chemicals are categorized.			
13.7	**Corrosivity**			
13.7.1	Explain the hazards and their control measures of corrosive chemical cargoes.			
13.8	**Low-boiling-point cargoes**			
13.8.1	Explain why a cargo to be heated is not stowed adjacent to cargoes which have a low boiling point			
13.8.2	State that as a safe margin, the maximum temperature of the heated cargo must be below the boiling point of the low boiling point cargo.			
13.8.3	State that Typically chemical tanker cooling systems are only designed to prevent the cargo from heating in warmer ambient conditions.			
13.9	**High-density cargoes**			
13.9.1	Explain the dangers of loading high density cargoes and list their control measures.			
13.10	**Solidifying cargoes**			
13.10.1	Explain the hazards and their control measures of carrying solidifying chemical cargoes			

TOPIC 4	HAZARDS AND THEIR CONTROL MEASURES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
13.10.2	Explain solidifying / non solidifying substances			
13.10.3	Explain pour point			
13.10.4	Explain viscosity			
13.11	**Polymerizing cargoes**			
13.11.1	Explain the dangers of polymerization			
13.11.2	State that cargo that polymerize will usually contain an inhibitor that stops the initiation of the polymerisation reaction.			
13.11.3	State that the IBC Code specifies the precautions to be taken against spontaneous decomposition and polymerisation by the use of additives (stabilizers and inhibitors) uniformly distributed within the mass of the product, and by the control of carriage temperature.			
14.0	**Knowledge and understanding of dangers of non-compliance with relevant rules / regulations**	**R1,R2,R3, R6,R7,R8**	**T1,B1,B2,B5, B6,B7**	**A1,A11,A13**
14.1	State that Failure to follow rules, regulations, best practice, guidelines and company procedures has been the cause of many chemical tanker accidents particularly during tank cleaning and gas freeing operations			
14.2	Explain the responsibility of a chemical tanker operator to achieve the objective of safe and pollution free operations			

TOPIC 4 HAZARDS AND THEIR CONTROL MEASURES

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
14.3	Explain repercussions of contravention to the IMO's body of environmental regulations			
14.4	State that most ships and ship-owner / operators actively seek to comply with environmental regulations.			
14.5	State that compliance with international environmental rules still leaves something to be desired.			

TOPIC 5	**SAFE WORKING PRACTICES INCLUDING RISK ASSESSMENT**
COMPETENCE 4	**Apply occupational health and safety precautions**

TRAINING OUTCOMES:

1. Procedures designed to safeguard personnel and the ship are observed at all times

2. Safe working practices are observed and appropriate safety and protective equipment is correctly used

3. Working practices are in accordance with legislative requirements, codes of practice, permits to work and environmental concerns

4. Correct use of breathing apparatus

5. Procedures for entry into enclosed spaces are observed

TOPIC 5 SAFE WORKING PRACTICES INCLUDING RISK ASSESSMENT

Knowledge, Understanding and Proficiency		IMO Reference	Text books, Bibliography, Videos	Teaching aid
15	**Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers:**	**R1,R2,3,R4, R5, R6,R7,R8**	**T1,B1,B2 B3,B6,B7**	**A1,A2,A3,A4, A5,A6, A7,A8,A9,A10, A11,A13**
15.1	**Precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus**			
15.1.1	Explain the ship's SMS requirement of special procedures to be followed if entering an enclosed space			
15.1.2	Demonstrate the procedures required to conduct a risk assessment prior to entry into an enclosed space			
15.1.3	Explain the measures to minimize pump-room hazards			
15.1.4	Explain the importance of training personnel in the use of a breathing apparatus and Demonstrate the use of the SCBA and positive pressure breathing apparatus and resuscitation equipment			
15.1.5	Demonstrate the safeguards for entry procedures in spaces known or suspected to be unsafe.			
15.1.6	Demonstrate the safeguards for entry procedures into cargo tanks to carry out "squeezing" operation in order to maximize cargo outturn			

TOPIC 5	SAFE WORKING PRACTICES INCLUDING RISK ASSESSMENT			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
15.2	**Precautions to be taken before and during repairs and maintenance work**.			
15.2.1	Describe the benefits and limitations of the permit to work system i.e. : - enclosed space entry - Cold work - Hot Work - Electrical isolation - Working aloft - Working on pressurized vessel - Working over the side - Other hazardous tasks			
15.2.2	Explain the practical benefits of appropriate drills prior to commencing repair work with shore facility.			
15.3	**Precaution for hot and cold work**			
15..3.1	Explain how hot work is to be strictly controlled and governed strictly by vessel's SMS procedure			
15..3.2	State that designated space in ER for carrying out hot work are stated and that it should be assessed for risks and the conditions under which hot work could be carried out in such space and that first preference should be given for carrying out hot work in the designated space in ER			
15.4	Precautions for electrical safety on chemical tankers			
15.5	Use of appropriate Personal Protective Equipment (PPE) on chemical tankers			
15.5.1	Demonstrate the use of adequate PPE on chemical tankers (Use the Hazard Level matrix appended in Part D)			

TOPIC 6 CHEMICAL TANKER EMERGENCIES AND FIRST AID PROCEDURES

COMPETENCE 5 Respond to emergencies

TRAINING OUTCOMES:

The type and impact of the emergency is promptly identified and the response actions conform with established emergency procedures and contingency plans
The order of priority, and the levels and time-scales of making reports and informing personnel on board, are relevant to the nature of the emergency and reflect the urgency of the problem

Evacuation, emergency shutdown and isolation procedures are appropriate to the nature of the emergency and are implemented promptly

The identification of and actions taken in a medical emergency conform to current recognized first aid practice and international guidelines

TOPIC 6	**CHEMICAL TANKER EMERGENCIES AND FIRST AID PROCEDURES**			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
16.0	**Knowledge and understanding of chemical tanker emergency procedures, including:**	**A1,A11,A13**	**T1,B1,B2,B5,B6, VC11**	**A1,A11,A13,A14**
16.1	**Ship emergency response plans**			
16.1.1	Explain chemical tanker emergency organization and response plan			
16.2	**Cargo operations emergency shutdown**			
16.2.1	Explain the Emergency shutdown procedure			
16.3	**Actions to be taken in the event of failure of systems or services essential to cargo**			
16.3.1	Describe the Action to be taken in the case of Deck valve \deck pipeline leakage			
16.4	**Firefighting on chemical tankers**			
16.4.1	Explain how a fire caused due to chemicals is different than that caused by other substances			
16.4.2	List the properties of some chemicals that need specific firefighting requirements			
16.4.3	List the action to take in the event of a fire			
16.5	**Enclosed space rescue**			
16.5.1	state that It is essential that regular drills and exercises to practice rescue from an enclosed spaces are carried out, and that all members of a rescue team know what is expected of them.			

TOPIC 6	CHEMICAL TANKER EMERGENCIES AND FIRST AID PROCEDURES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
16.5.2	State that speed is often vital in the interest of saving life, rescue operations should not be attempted until assistance has arrived and a planned approach can be made			
16.5.3	Describe enclosed space rescue procedures			
16.6	**Cargo reactivity**			
16.6.1	Explain early indicators of reactivity and precautions to prevent reactivity in chemical cargoes.			
16.7	**Jettisoning cargo**			
16.7.1	State that the jettisoning of cargo is an extreme measure, justified only in an emergency as a means of saving life at sea or where the integrity of the ship is at risk.			
16.7.2	Describe the precautions to take when jettisoning of chemical cargo has been taken.			
16.8	Use of a Material Safety Data Sheet (MSDS)			
16.8.1	Describe the information the MSDS contains relevant to chemical emergencies			
17.0	**Actions to be taken following collision, grounding, or spillage**	**R2,R3,R6, R8**	**T1,B1,B2,B5,B7**	**A1,A11,A13**
17.1	State that in case of collision, grounding or spillage following standard procedures are to be followed: - Initial Actions - Follow Up Actions - Evidence Collection - Emergency Reporting			

TOPIC 6	CHEMICAL TANKER EMERGENCIES AND FIRST AID PROCEDURES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
17.2	Explain standard initial and follow up actions to be taken subsequent to a collision/grounding			
17.3	Explain standard initial and follow up actions to be taken subsequent to a spillage and activate SMPEP			
17.4	Explain the importance of evidence collection and emergency reporting requirements			
18.0	**Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Guide.**	**R2,R5,R6, R8**	**T1,B1,B2,B6,**	**A1,A2,A3, A11,A13**
18.1	List the contents of the Medical First Aid Guide			
18.2	Explain the use of the MFAG on board a chemical tanker.			
18.3	Describe procedures to use Oxygen resuscitators			
18.4	Explain methods of resuscitation for conscious and unconscious stages.			
18.5	Describe procedures to transfer patients to hospitals.			

TOPIC 7 POLLUTION PREVENTION PROCEDURES

COMPETENCE 6 Take precautions to prevent pollution of the environment

TRAINING OUTCOMES:

Operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment

TOPIC 7	POLLUTION PREVENTION PROCEDURES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
19.0	**Understanding of procedures to prevent pollution of the atmosphere and the environment**	**R2,R3,R6, R8**	**T1,B1,B2,B3,B5**	**A1,A11,A13**
19.1	State that cargo handling operations on a chemical tanker need to comply with environmental regulations in order to avoid pollution of the sea and air.			
19.2	Describes how operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment.			

TOPIC 8	**IMO INSTRUMENTS, MARPOL AND INDUSTRY GUIDELINES**
COMPETENCE 7	**Monitor and Control compliance with legislative requirements**

TRAINING OUTCOMES:

The handling of cargoes complies with relevant IMO instruments and established industrial standards and codes of safe working practice

TOPIC 8	IMO INSTRUMENTS, MARPOL AND INDUSTRY GUIDELINES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
20	**Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied**	**R1,R2,R3, R6,R7,R8**	**T1,B1,B2,B6,B7**	**A1,A11,A12,A13**
20.1	State that MARPOL regulation applies to all ship types. However Annexes II and VI are particularly applicable to chemical tanker cargo operations.			
20.2	Explain important definitions of regulation 1, Annex II 'en route', 'Noxious liquid substances', solidifying and non-solidifying substances' 'nearest land' and others relevant to the requirements of Prevention of Pollution			
20.3	Interpret exceptions, exemptions and equivalents as per the requirements of Annex II MARPOL			
20.4	Describe pollution categories of chemical cargoes in accordance with MARPOL 73/78 Annex II regulations			
20.5	Explain surveys and certification requirements of a Chemical tanker			
20.6	Explain control of operational discharges of residues of NLS			

TOPIC 8	IMO INSTRUMENTS, MARPOL AND INDUSTRY GUIDELINES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
20.7	Explain bio-fuels and blending of bio-fuels, what regulations are applicable for their transportation, tank cleaning and disposal procedures			
20.8	State that SOLAS Chapter VI, Regulation 5-2, prohibits the physical blending of bulk liquid cargoes during a sea voyage			
20.9	States that the format of Cargo Record Book is uniform and that all operations involving NLS and NLS mixtures should be recorded, where possible in applicable coded entries			
20.10	Explain briefly the contents of a shipboard marine pollution emergency plan for NLS			
20.11	Explain requirements of reception facilities and cargo unloading terminal arrangements.			
20.12	State that MARPOL Annex VI regulates exhaust emissions from machinery, and vapour Emissions from cargo operations			
20.13	State that some national and port administrations require that cargo vapours are returned to terminal or retained on board while loading so as to reduce the negative effects of venting cargo vapours to atmosphere.			

TOPIC 8	IMO INSTRUMENTS, MARPOL AND INDUSTRY GUIDELINES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
20.14	State that The Code of Safe Working Practices (COSWP) details the framework for health and safety aboard all types of ships.			
20.15	State that the COSWP Section 4 – Specialist ship operation are specially applicable to chemical tankers			
21.0	**Proficiency in the use of the IBC/BCH Code and related documents**	**R1,R2,R3, R8**	**T1,B1,B2,B4,B5,B6,B7**	**A1,A2,A11,A12**
21.1	Explain the purpose and demonstrate the use of the IBC code			
21.2	State that Inert gas requirement for chemical carriers are guided by SOLAS and complemented by IBC code and the FSS codes.			
21.3	States that chapter 17 of the IBC code and IMO MEPC 2 latest circular lists the cargoes to which the code is applicable .			
21.4	States that specific reference is made in *column o* in the table of chapter 17 of the IBC code gives additional requirements			
21.5	States chapter 15 covers special requirements of specific cargoes and Chapter 16 covers operational requirements which must be referred to when cargo stowage planning and tank cleaning plans are made.			
21.6	Display chapter 19 and explain how index names are provided by the code			

TOPIC 8	IMO INSTRUMENTS, MARPOL AND INDUSTRY GUIDELINES			
Knowledge, Understanding and Proficiency		**IMO Reference**	**Text books, Bibliography, Videos**	**Teaching aid**
21.7	Explain the purpose and use of the ICS Tanker Safety Guide for Chemicals			

Part D: Instructor's Manual

■ Introduction

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

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

The instructor's manual provides guidance on the material that is to be presented during the course. The course material reflects the mandatory minimum requirements for the training and qualifications of Masters, Chief Engineer Officers, chief mates , second engineer officers and any person with immediate responsibility for loading, unloading and care during transit and handling, or other cargo related operations on Chemical tankers as specified in Regulation V/1-2 paragraph 3 of the International Convention on Standards of Training, Certification and Watch keeping for Seafarers 1978, as amended.

The competences stipulated in the STCW 2010 table A-V/1-1-3 have been broadly divided into the following topics and are reflecting how the trainers should design and conduct their course. This is for guidance only.

To show consistency and adherence to STCW 2010, as given in STCW Code Chapter V, Table A-V/1-1-3, a mapping is provided for easy reference in Part A of this Model course from STCW's competences and training outcomes to the topics covered in this IMO Model course

1. Knowledge of chemical tanker design, systems, and equipment
2. Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation
3. Proficiency in tanker safety culture and implementation of safety management requirements
4. Knowledge and understanding of monitoring and safety system, including the emergency shutdown system
5. Ability to perform cargo measurements and calculations
6. Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity
7. Knowledge and understanding of chemical cargo-related operations
8. Development and applications of cargo-related operations plans, procedure and checklist
9. Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment
10. Ability to manage and supervise personal with cargo-related responsibilities
11. Knowledge and understanding of the chemical and physical properties of noxious liquid substances
12. Understanding the information contained in a Material Safety Data Sheet (MSDS)
13. Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations.

14. Knowledge and understanding of danger of non-compliance with relevant
15. Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers
16. Knowledge and understanding of chemical tanker emergency procedures,
17. Actions to be taken following collision, grounding or spillage
18. Knowledge of medical first-aid procedures and antidotes onboard chemical tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)
19. Understanding of procedures to prevent pollution of the atmosphere and the environment
20. Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied
21. Proficiency in the use of the IBC Codes and related documents

The texts used as references throughout the course are mentioned in Part A, Course framework are; Teaching Aids (A), IMO Reference Books (R), Text books (T), Bibliography (B) and Videos (V)

The course outline, timetable and lesson plan provide guidance on the time allocations for the course material, but the instructor is free to make adjustments as deemed necessary. The detailed teaching syllabus must be studied carefully. 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 having the same General learning or specific learning objective numbers given in Part C and Part D respectively as is required to be used by the instructor 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 maximize safety and minimize harmful effects to the environment.

Topics marked with an asterisk (*) could be taught better using a simulator as used in the Model Course: Chemical Tanker Cargo & Ballast Handling 2007 Edition T137Ewhich provides detailed training programme for Chemical Tanker operations using specially created cargo handling exercises. Separate exercises have also been included in this model course with a brief on how to conduct table top exercises if simulators are unavailable.

■ Guidance Notes

Competence: Ability to safely perform and monitor all cargo operations
Topic: Design and characteristics of a chemical tanker

Knowledge of chemical tanker designs, systems, and equipment, including:

General arrangement and construction

1.1.1 Sketch and describe the elements of a chemical tanker design.

The instructor should display the appended chemical tanker diagram and describe its various ship construction aspects.

1.1.1.2 Describe the need for different types of chemical tankers.

The IMO Codes list cargoes, identifying the hazards each presents, during carriage by sea. Cargoes which are assessed as presenting a safety or pollution hazard to such an extent as to warrant protection are required to be carried in designated ship types providing the appropriate degree of protection.

1.1.1.3 Describe different types of chemical tankers in relation to dangerous and noxious properties of cargoes to be carried.

Three ship types I, II and III are prescribed, with the most hazardous cargoes requiring the location inboard from the hull maximum protection as Ship type I B/5 or 11.5meters (whichever is less) from shell plating transversely, not less than B/15 or 6m (whichever is less) from bottom shell plating at centre line and nowhere less than 760 mm, with restrictions on the quantity permissible for carriage applied to individual cargo tanks and ship types II not less than B/15 or 6m (whichever is less) from bottom shell plating at centre line and nowhere less than 760 mm (760 mm inboard from the shipside) and III (no restriction) in descending order of protection requirements. The capacities are also regulated to afford protection to the environment in case of hull damage
Ship Type 1 each tank capacity not more than 1250 m^3;
Ship Type 2 each tank capacity not more than 3000 m^3;
Ship Type 3 each tank capacity not regulated

1.1.1.4 Explain how the ship type governs the survival capability & assumed damage in relation to the ship types

A chemical tankers survival capability in case of shell damage is governed by ship type. The extent of assumed maximum extent of shell damage (side and bottom) is prescribed in the code.
Type 1 ship can withstand an assumed maximum extent of side and bottom damage anywhere in its length
Type 2 ship greater than 150 m length can withstand an assumed maximum extent of side and bottom damage anywhere in its length
Type 2 ship of 150 m or less can withstand an assumed maximum extent of side and bottom damage anywhere in its length except involving either of the bounding a machinery space aft.
A type 3 ship of more than 225 m in length can withstand an assumed maximum extent of side and bottom damage anywhere in its length
A type 3 ship of 125 m in length or more but not exceeding 225 m in length can withstand an assumed maximum extent of side and bottom damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft.
A type 3 ship of 125 m in length or more but not exceeding 225 m in length can withstand an assumed maximum extent of side and bottom damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft.
However, the ability to survive the flooding of the machinery space shall be considered by the Administration.

Ships, subject to the Code, are required to survive the normal effects of flooding following assumed hull damage caused by some external force. In addition, to safeguard the ship and the environment, the cargo tanks of certain types of ships are protected from penetration in the case of minor damage to the ship resulting, for example, from contact with a jetty or tug, and given a measure of protection from damage in the case of collision or stranding, by locating them at specified minimum distances inboard from the ship's shell plating. Both the assumed damage and the proximity of the cargo tanks to the ship's shell shall be dependent upon the degree of hazard presented by the products to be carried.
The IBC Code describes the Assumed standard damage as follows:

.1	**Side damage:**		
.1.1	Longitudinal extent:	$1/3L^{2/3}$ or 14.5 m, whichever is less	
.1.2	Transverse extent	B/5 or 11.5 m, whichever is less (measured inboard from the ship's side at right angles to the centreline at the level of the summer load line)	
.1.3	Vertical extent:	upwards without limit (measured from the moulded line of the bottom shell plating at centreline)	
.2	**Bottom damage:**	**For 0.3L from the forward perpendicular of the ship**	**Any other part of the ship**
.2.1	Longitudinal extent:	$1/3L^{2/3}$ or 14.5 m, whichever is less	$1/3L^{2/3}$ or 5 m, whichever is less
.2.2	Transverse extent:	B/6 or 10 m, whichever is less	B/6 or 5 m, whichever is less
.2.3	Vertical extent:	B/15 or 6 m, whichever is less	B/15 or 6 m, whichever is less

Thus, a type 1 ship is a chemical tanker intended for the transportation of products considered to present the greatest overall hazard and type 2 and type 3 for products of progressively lesser hazards. Accordingly, a type 1 ship shall survive the most severe standard of damage and its cargo tanks shall be located at the maximum prescribed distance inboard from the shell plating.
Hence it must be emphasized here by the instructor that it is important to report the extent of damage to the Master if sighted by anyone and ensure compartment integrity by taking soundings of adjacent compartments in case of an accident.

1.1.1.5 Describe other safety aspects of tanker design taken into consideration in relation to:

1.1.1.5.1 Accommodation, service and machinery spaces and control rooms.

No accommodation or service spaces or control stations shall be located within the cargo area except over a cargo pump-room recess or pump-room recess that complies with SOLAS regulations II-2/4.5.1 to 4.5.2.4 and no cargo or slop tank shall be aft of the forward end of any accommodation.
In order to guard against the danger of hazardous vapours, due consideration shall be given to the location of air intakes and openings into accommodation, service and machinery spaces and control stations in relation to cargo piping and cargo vent systems.

Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations shall not face the cargo area. They shall be located on the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deck-house at a distance of at least 4% of the length (L) of the ship but not less than 3 m from the end of the superstructure or deck-house facing the cargo area. This distance, however, need not exceed 5 m. No doors are permitted within the limits mentioned above, except that doors to those spaces not having access to accommodation and service spaces and control stations, such as cargo control stations and store-rooms, may be fitted. Where such doors are fitted, the boundaries of the space shall be insulated to "A-60" standard. Bolted plates for removal of machinery may be fitted within the limits specified above. Wheelhouse doors and wheelhouse windows may be located within the limits specified above so long as they are so designed that a rapid and efficient gas- and vapour-tightening of the wheelhouse can be ensured. Windows and sides scuttles facing the cargo area and on the sides of the superstructures and deck-houses within the limits specified above shall be of the fixed (non-opening) type. Such side scuttles in the first tier on the main deck shall be fitted with inside covers of steel or equivalent material.

1.1.1.5.2 Cargo and/or ballast pump-rooms

Cargo and/or ballast pump-rooms of chemical tankers are so arranged as to ensure:

.1 unrestricted passage at all times from any ladder platform and from the floor; and
.2 unrestricted access to all valves necessary for cargo handling for a person wearing the required personnel protective equipment.
Permanent arrangements made for hoisting an injured person with a rescue line, while avoiding any projecting obstacles.
Guard railings installed on all ladders and platforms.
Normal access ladders are not to be fitted vertical and shall incorporate platforms at suitable intervals.
Means are provided to deal with drainage and any possible leakage from cargo pumps and valves in cargo pump-rooms. The bilge system serving the cargo pump-room is to be operable from outside the cargo pump-room. One or more slop tanks for storage of contaminated bilge water or tank washings shall be provided. A shore connection with a standard coupling or other facilities are provided for transferring contaminated liquids to onshore reception facilities. Where machinery is driven by shafting passing through a bulkhead or deck, gastight seals with efficient lubrication or other means of ensuring the permanence of the gas seal shall be fitted in way of the bulkhead or deck.

Pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks shall be independent of similar equipment serving cargo tanks and of cargo tanks themselves. Discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks shall be outside machinery spaces and accommodation spaces. Filling arrangements may be in the machinery spaces provided that such arrangements ensure filling from tank deck level and non-return valves are fitted.

1.1.1.5.3 Ventilation of pump-rooms and/or similar spaces

Cargo pump-rooms, due to their location, design and operation, constitute a particular hazard and therefore necessitate special precautions. Cargo pump-rooms should be continuously ventilated during all cargo operations. To meet the requirements of the IBC Code, they must be fitted with mechanical ventilation systems controlled from outside. Because of the potential for the presence of cargo vapours, such spaces should be ventilated for at least 15 minutes before entering and then only after the space has been

found safe to enter. Only authorized personnel should enter and operate equipment in cargo pump-rooms.
Mechanical ventilation inlets and outlets shall be arranged to ensure sufficient air movement through the space to avoid the accumulation of toxic or flammable vapours or both (taking into account their vapour densities) and to ensure sufficient oxygen to provide a safe working environment, but in no case shall the ventilation system have a capacity of less than 30 changes of air per hour, based upon the total volume of the space.
Ventilation systems shall be permanent and shall normally be of the extraction type.
Extraction from above and below the floor plates shall be possible.

1.1.1.5.4 Location of cargo tank vents

The tank venting arrangements are assigned according to the following criteria:
Controlled: for toxic substances Toxic to mammals by prolonged exposure; and/or
Respiratory sensitizer; and/or
Special carriage control needed; and/or
Flash point < 60ºC
Corrosive to skin (< 4 h exposure) and
Open: Any of the minimum safety or pollution criteria for bulk liquid cargoes
subject to chapter 17 or the IBC Code not meeting the requirements for controlled tank vents.
The Exhaust openings of tank vent systems for toxic products shall be located:

.1 At a height of B/3 or 6 m, whichever is greater, above the weather deck or, in the case of a deck tank, the access gangway;
.2 not less than 6 m above the fore-and-aft gangway, if fitted within 6 m of the gangway;
.3 15 m from any opening or air intake to any accommodation and service spaces; And
.4 the vent height may be reduced to 3 m above the deck or fore-and-aft gangway, as applicable, provided high-velocity vent valves of an approved type, directing the Vapour/air mixture upwards in an unimpeded jet with an exit velocity of at least 30 m/s, are fitted.

1.1.1.5.5 Electrical installations

The specification of electrical equipment and of electrical installations on board chemical tankers is subject to the requirements of the flag administration, classification societies, IMO and the International Electro technical Commission (IEC). Electrical equipment installed in hazardous areas has to be of special construction, and certified safe for the area and the vapours concerned. Portable equipment taken into the area should also be intrinsically safe. One of the main considerations aboard chemical tankers is to ensure that the surface temperature of any electrical equipment does not exceed the auto ignition temperature of any cargo that the ship may carry. Although there are a number of recognized certification authorities around the world that have slightly different test procedures and ways of grouping the surface temperature categories, the IBC Code specifies the temperature groups, and equipment with which ships must comply.

1.1.1.6 Describes how tank design assists with:

1.1.1.6.1 Minimizing residues

Every chemical carrier is provided with pumping and piping arrangements specially designed to ensure that each tank designated for the carriage of controlled substances can be emptied so well that the quantity of cargo remaining afterwards is less than the minimum quantity specified in MARPOL.

The MARPOL Annex II regulations mandate equipment and operational measures designed to minimise the volume of cargo remaining in the cargo tanks after unloading (discharging). Before a cargo can be loaded the vessel must have the specific cargo listed on its IMO Certificate of Fitness which is issued by the Flag State. This is evidence that the vessel has been constructed, and operated in full compliance with the IBC Code.
The tank shape and construction assists in minimum residue retention

1.1.1.6.2 increased cargo out turn

On modern double hull vessels tank internals are largely obstruction free and therefore relatively easy to clean and maximise cargo outturn.

MARPOL Annex II categorizes substances posing a threat of harm to the marine environment, with chemicals posing the greatest threat having the most severe controls placed upon their shipment and severe limitations on their discharge into the sea. A principal way of meeting the need to limit discharges to the sea is to reduce the residue that remains within a tank after unloading has been completed.

Every chemical carrier is provided with pumping and piping arrangements specially designed to ensure that each tank designated for the carriage of controlled substances can be emptied so well that the quantity of cargo remaining afterwards is less than the minimum quantity specified in MARPOL. For each tank an initial assessment of the residue quantity has to be made, called a stripping test. The results of this test are recorded, and are used as the basis for the procedures described. Only when the residue is shown to be less than the quantity prescribed by MARPOL Annex II may the tank be approved for the carriage of a controlled substance.

1.1.1.6.3 Prevention of cargo contamination

Chemical tankers are normally constructed with either group loading segregation (with one venting and cargo piping serving a group of tanks.) or completely independent cargo systems in the case of Parcel chemical tankers. Each cargo tank will have an independent pumping and venting system.

Segregation and stowage planning is the key to prevent contamination.
In practice, vessels are usually built to transport a combination of cargo types with some tanks built to Ship Type I and the remainder to Ship Type 2 or Ship Type 3 construction requirements. They are also segregated from such other cargoes by means of a cofferdam, void space, cargo pump-room, pump-room, empty tank, or tank containing a mutually compatible cargo

1.2 Pumping arrangement and equipment

1.2.1 Describe the construction of following pump types on chemical tankers:

1.2.1.1 Centrifugal pumps

An impeller, which is inside a casing, physically moves the liquid cargo by means of a throwing movement which is similar to the expelling of water from the bicycle tire when cycling in wet weather. The liquid cargo is sucked into the casing from the suction side the pump provides a continuous flow of liquid cargo and it is powered by a hydraulic/electric drive unit which, for safety reason, is installed outside the tank. Centrifugal pumps move large volumes of liquid and consequently are generally used as main cargo pumps.

1.2.1.2 Screw pumps

A Screw pump is a more complicated type of rotary pump that uses two or three screws with opposing thread – e.g., one screw turns clockwise and the other counterclockwise. The screws are mounted on parallel shafts that have gears that mesh so the shafts turn together and everything stays in place. The screws turn on the shafts and drive fluid through the pump. As with other forms of rotary pumps, the clearance between moving parts and the pump's casing is minimal.

1.2.1.3 Eductors

An eductor is a type of pump that uses the Venturi effect of a converging-diverging nozzle to convert the pressure energy of a motive fluid to velocity energy which creates a low pressure zone that draws in and entrains a suction fluid. After passing through the throat of the injector, the mixed fluid expands and the velocity is reduced which results in recompressing the mixed fluids by converting velocity energy back into pressure energy. The motive fluid may be a liquid, steam or any other gas. The entrained suction fluid may be a gas, a liquid, a slurry, or a dust-laden gas stream.

1.2.2 Explain basic pumping concepts

The function of any pump is to transfer a medium from one point to another and this involves the use of piping. Such a transfer in a tanker can be divided into two parts:-

1. The movement of liquid from the tank to the pump. This is a function of the pump and its installation design. These factors are beyond the control of the ship provided the design ratings of the pump are maintained.
2. The onward movement of the liquid from the pump to its destination. This is an area where the efficient operation of the pumps is essential if optimum results are to be obtained.

Normally the design of the pumping system makes the need for careful balancing and adjustment of the cargo pump controls during bulk discharge essential to avoid problems. This could be with overheated pumps (Pump Casing temperature rise) in the case of high back pressures or overloaded pumps in the case of low back pressures/low suction pressure (Pump bearing temperature rise).

1.2.3 Describe deepwell pumps, benefits & discuss the limitations

A deepwell pump is located in a recess located in a position in the tank to achieve best possible stripping. Power is either provided by a hydraulic system or an electric motor.
Hydraulically powered deepwell pumps have a hydraulic motor, which is located within the tank. The hydraulic supply and return lines are enclosed within a double walled cofferdam so

that in the event of a hydraulic leak the cargo will not be contaminated. The cofferdam also prevents contamination of the hydraulic oil by the cargo. The pump's cofferdam should be purged regularly in order to allow checking for any signs of leakage past the shaft seals that protect the cofferdam.

Electrically powered deepwell pumps have the motor mounted on deck. It is connected to the pump by either a drive shaft enclosed in an oil filled tube surrounding the shaft, or else the drive shaft is located within the discharge line and is cooled and lubricated by the cargo.

A submersible pump is a pump which has a hermetically sealed motor close-coupled to the pump body. The whole assembly including the motor is submerged in the fluid to be pumped.

A deepwell and a submerged pump may be situated in a recess located in a position in the tank to achieve best possible stripping. This results in minimum residue remaining on board after completion of cargo unloading.

Both the deepwell pumps and submerged pumps are located within the tank, inside the cargo. In case a pump failure takes place these pumps are not accessible and are to be replaced by alternative emergency pumping arrangements.

1.3 Tank construction and arrangement

1.3.1 Identify references from the Codes dealing with segregation and containment

The instructor should use the IBC code and highlight the references made therein for cargo segregation chapter 3.1 and containment chapter 4. The detailed explanation should be covered when doing the use of IBC/BCH codes in Sr.no:/KUP 21 of this model course.

1.3.2 Describe:

1.3.2.1 Independent tank

Independent tank means a cargo-containment envelope, which is not contiguous with, or part of, the hull structure. An independent tank is built and installed so as to eliminate whenever possible (or in any event to minimize) its stressing as a result of stressing or motion of the adjacent hull structure. An independent tank is not essential to the structural completeness of the ship's hull.

1.3.2.2 Integral tank

Integral tank means a cargo-containment envelope which forms part of the ship's hull and which may be stressed in the same manner and by the same loads which stress the contiguous hull structure. The Integral tank cargo-containment is normally essential to the structural completeness of the ship's hull.

1.3.2.3 Gravity tank

Gravity tank means a tank having a design pressure not greater than 0.07 MPa gauge at the top of the tank. A gravity tank may be independent or integral. A gravity tank shall be constructed and tested according to recognized standards, taking account of the temperature of carriage and relative density of the cargo.

1.3.2.4 Pressure tank

Pressure tank means a tank having a design pressure greater than 0.07 MPa gauge.
A pressure tank shall be an independent tank and shall be of a configuration permitting the application of pressure-vessel design criteria according to recognized standards.

1.3.3 Describe the importance of segregation of cargo area from:

1.3.3.1 Accommodation, service and machinery spaces

The IBC / BCH code requires tanks containing cargo or residues of cargo subject to the Code to be segregated from accommodation, service and machinery spaces by means of a cofferdam, void space, cargo pump-room, pump-room, empty tank, oil fuel tank or other similar space to prevent contamination and safety.

1.3.3.2 Drinking water and stores for human consumption

The IBC / BCH code requires a double metal segregation from drinking water and stores for human consumption by means of a cofferdam, void space, cargo pump-room, pump-room, empty tank, oil fuel tank or other similar space to prevent contamination and safety.

1.3.4 Sketch required means of segregation for loading incompatible grades and explain how segregation is achieved:

Ways and means of segregation for reactive and incompatible cargo are:
Cofferdams
Void spaces
Cargo pump-rooms
Pump-rooms
Empty tanks
Oil fuel tanks
Other similar spaces

The IBC code states that tanks containing cargo or residues of cargo subject to the Code shall be segregated from accommodation, service and machinery spaces and from drinking water and stores for human consumption by means of a cofferdam, void space, pump-rooms, empty tank, oil fuel tank or other similar space.
Cargo piping shall not pass through any accommodation, service or machinery space other than cargo pump-rooms or pump-rooms. Cargoes, residues of cargoes or mixtures containing cargoes, which react in a hazardous manner with other cargoes, residues or mixtures, shall:

.1 be segregated from such other cargoes by means of a cofferdam, void space, cargo pump-room, pump-room, empty tank, or tank containing a mutually compatible cargo;
.2 have separate pumping and piping systems which shall not pass through other cargo tanks containing such cargoes, unless encased in a tunnel; and
.3 have separate tank venting systems.

If cargo piping systems or cargo ventilation systems are to be separated. This separation may be achieved by the use of design or operational methods. Operational methods shall not be used within a cargo tank and shall consist of one of the following types:

.1 removing spool-pieces or valves and blanking the pipe ends;

.2 arrangements of two spectacle flanges in series, with provisions for detecting leakage into the pipe between the two spectacle flanges.

1.4 pipeline and drainage systems

1.4.1 Describe general cargo piping arrangements on chemical tankers

The piping system of a chemical carrier is designed to ensure positive segregation between different grades of cargo and to provide for operational flexibility. Pipelines are usually made of stainless steel.

The IBC Code specifies that cargoes, residues of cargoes or mixtures containing cargoes, which react in a hazardous manner with other cargoes, residues or mixtures, must have separate pumping and piping systems which must not pass through other cargo tanks containing such cargoes, unless encased in a tunnel.

Piping systems for toxic products have to be segregated from other tanks and line systems. This is achieved on many chemical tankers by having separate pumps, pipelines and vents so that complete segregation is achieved by the design. On ships with common pipeline systems, toxic products must be separated by at least two physical barriers by the use of removable spool pieces, blank flanges or other appropriate means.
A positive means of confirming that the cargo systems are isolated and drained should be in place and used to confirm that it is safe to remove blank flanges prior to connection. The means should provide protection against pollution due to unexpected and uncontrolled release of product from the cargo system and injury to personnel due to pressure in the system suddenly being released in an uncontrolled manner.

1.4.2 Identify material of construction.

Identification of the material used for tank construction and associated piping is determined by the classification society in consultation with the requirements of the administration and shall be suitable at temperature and pressure for cargoes to be carried. Steel is assumed to be the normal material of construction in accordance with the IBC code.

1.4.3 Identify and describe types of valves normally used for chemical tankers:

1.4.3.1 Ball valves

These are particularly suitable in small and medium dimensions. Above ~ 250 mm diameter, the operating torque becomes high. Most designs have a 'lock-in' cargo volume around the 'ball'. To clean this volume when line-cleaning, the valve must be operated a couple of times.

1.4.3.2 Membrane valves

There are two main categories of membrane valves: one type seals over a "weir" (saddle) and the other (sometimes called a "full bore or straight-way" valve) seals over a seat. The weir or saddle type is the most common in process applications and the seat-type is more commonly used in slurry applications to reduce blocking issues but exists also as a process valve. While diaphragm valves usually come in two-port forms (2/2-way diaphragm valve), they can also come with three ports (3/2-way diaphragm valves also called T-valves) and more (so called block-valves). When more than three ports are included, they generally require more than one diaphragm seat; however, special dual actuators can handle more ports with one membrane.

Membrane valves can be manual or automated. Their application is generally as shut-off valves in process systems within the chemical industry. The older generation of these valves is not suited for regulating and controlling process flows, however newer developments in this area have successfully tackled this problem.

1.4.3.3 Gate valves

A gate or sluice valve slides up and down guides set in a housing that is fitted on a pipeline. The valve is operated by manually turning a threaded spindle. Sizes as large as the housing required for the particular pipeline size are available. It is very dependable and almost fail-proof; however it is not easily automated. When the gate retracts in the 'open' position, it offers no resistance to the flow of oil. It offers an accurate adjustment to the rate of flow desired. It offers positive sealing under high pressures but if the valve seat is damaged it leaks at low pressures.

1.4.3.4 Butterfly valves

The butterfly valve is very easily adaptable to automation. It is easily operated - one-fourth turn opens or closes the valve. It is also light, compact and less expensive. However the disadvantages are that pipeline flow is not easily controllable and the valve being in the middle of oil flow, it offers resistance to flow. It also needs more attention and maintenance as it develops leaks readily.

1.4.4 Describe cargo segregation in terms of:

1.4.4.1 Segregation by two valves

Two-valve segregation is acceptable only in the oil tanker trade. Modern chemical tankers will have spool pieces or blind flange valves fitted. Such a blind flange valve must have a double separation between the products with a drain in the inter-space. A single blind flange is not acceptable. It is also required to separate drain lines or slop connections to avoid the possibility of cargo mixing.

1.4.4.2 Spool-pieces

Spool pieces are short length of straight or bent pipelines.
The engineering principle of using two stops at spool ends, with a provision for detecting if one of the stops does not hold tight (block and bleed principle) should also ensure that a leak can be detected

In the case of vessels equipped with the independent cargo line system, contamination with other cargo can occur through the common manifold, which require proper setting of the spool pieces.

Positive segregation is achieved by physical removal of the short lengths.
After spool pieces have been disconnected, the relevant flanges should be covered with blank flanges using proper flange packing.

1.4.5 Discuss the care, handling and use of cargo hoses:

Although cargo hoses are robustly constructed for a marine environment, they can be damaged from improper handling. In general, while handling hoses, adequate support is the key to the prevention of over-bending (kinking), which can lead to premature hose retirement.
When transferring the one end of the hose, lifting straps should be used that are preferably flat nylon or equivalent reinforced cloth bands, and at least 150 mm wide to prevent any chafing of the hose cover. If nylon or equivalent straps are not available, the best substitute is a sling of large circumference nylon or polypropylene rope. Wire rope should not be used.

All Cargo hoses must be inspected visually before use.

Before connecting up, hose strings should be examined for any possible defect which may be visible in the bore or outer covers such as blistering, abrasion, or evidence of leakage. When the cargo hoses of the shore installation are used and any defects are found in the cargo hoses, the captain should refuse the use of the defective cargo hoses.
Cargo hoses should always be handled with care and should not be dragged over a surface, bended excessively or rolled in a manner which would twist the body of the hose. Hose should not be allowed to come in contact with a hot surface such as a steam pipe.
When in use, a cargo hose should be properly supported along its length to avoid excessive bending of the hose or its weight hanging from the manifold connection. This is especially important when significant tidal or draft variations can cause the relative heights of the ship and shore manifolds to alter a great deal, requiring frequent adjustment at the hose support.
Fendering, stools or chocks can be used to provide support under the hose, particularly at the manifold and at the shipside rail. When a hose is supported from above, bridles and saddles should be used to spread the load, and may require more than one supporting point.

Hoses should have blank flange fitted immediately after they are disconnected from the ship's manifold.

1.4.5.1 Compatibility and suitability with chemical cargoes

Check that the hoses are compatible with products to load and are clean. Liquid and vapour hoses used for cargo transfer shall be compatible with the cargo. Any limitations of the cargo properties listed by the hose manufacturer should always be observed.

1.4.5.2 Cargo temperature limitations

Liquid and vapour hoses used for cargo transfer shall be suitable for the minimum and maximum expected cargo temperature.

1.4.5.3 Inspection and testing procedures

Hoses subject to tank pressure or the discharge pressure of pumps shall be designed for a bursting pressure not less than 5 times the maximum pressure the hose will be subjected to during cargo transfer.
Each cargo hose before being placed in service and each new length of cargo hose produced shall be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not more than two-fifths of its bursting pressure. The hose shall be stenciled or otherwise marked with the date of testing, its specified maximum working pressure and, if used in services other than the ambient temperature services, its maximum and minimum service temperature, as applicable. The specified maximum working pressure shall not be less than 1 MPa gauge.

Cargo hoses shall be tested to 1.5 times the designed working pressure annually and record of tests and inspections shall be maintained.

1.4.5.4 Certification of hoses

A manufacturer's test certificate will provide information about the hose's construction method, its performance range and its nominal sizes.

1.4.6 Describe the requirements for an annual pressure test of the ship's cargo hose

While in service, hoses should regularly be visually inspected, and they should be hydraulically pressure tested to a pressure not less than 1.5 times its specified maximum working pressure but not more than two-fifths of its bursting pressure. at least annually. Test results should be recorded in a cargo hose condition log book.

1.5 Tank and cargo pipeline pressure and temperature control systems and alarms

1.5.1 Describe requirements of pressure monitoring systems of chemical Tankers

Pressure monitoring systems for the cargo tanks must comply with the following:
Pressure gauges are fitted at various points in the cargo system, on pumps, in pipelines and in tanks. They may be used to indicate pressure in a liquid being pumped into or out of a tank, or static pressure such as that of inert gas.
They can indicate negative as well as positive pressure, and can be linked to shutdown or alarm systems.
It is important that procedures exist for ensuring that pressure gauges and sensors are checked and calibrated in accordance with manufacturers' instructions.

Most chemical tankers have pressure sensors fitted as a secondary protective measure against tank over or under pressurization and these can also be used to check that the tank venting system is functioning correctly and where provided that the alarms are correctly set.

High-pressure alarms and low-pressure alarms must be set to:
- Activate additional safety or other alarm systems;
- Support maintenance of correct positive I.G. pressure in tanks;
- Prevent air intake to tanks; and
- Comply with regulations.

In the case of inerted vessels, if pressure sensors are provided as the means of secondary protection, the alarm settings for the pressure sensors must be set to actuate when the tank pressure reaches 10% greater than the normal actuation settings of the pressure valves themselves. In the case of the low-pressure settings, the pressure in a tank should never be permitted to fall below zero and the pressure sensors should be set to alarm above zero.
In the case of non-inerted vessels if pressure sensors are provided, the over-pressure setting should be set to alarm at 10% greater than the normal actuation settings of the pressure valves, and at a vacuum 10% greater than the normal actuation settings of the vacuum valves.
Pressure sensors should be so arranged and constructed as to avoid the clinging of cargo and should be easy to calibrate and maintain.
When a change of alarm-setting pressure is needed depending on cargo or loading, procedures for the change should be prescribed in the operating manual of the system.

1.5.2 Explain why temperature sensors may be required on chemical Tanker

Temperature sensors are fitted so that the temperature of the cargo can be monitored, especially where required by the IBC Code. It is important to know the cargo temperature in order to be able to calculate the weight of cargo on board, and because tanks or their coatings often have a maximum temperature limit. Many cargoes are temperature sensitive, and can be damaged by overheating or will polymerize and solidify. Sensors may also be fitted to monitor the temperatures of the structure around the cargo system.

1.5.3 List types of temperature sensors

Types of thermometers

Liquid /vapour thermometers rely on the expansion or contraction of liquid in a very fine-bore calibrated tube or capillary. The liquids most commonly used are mercury, ethanol or xylene. It is important to ensure that the liquid column in the instrument is continuous; otherwise the reading will be inaccurate.

Liquid filled thermometers have a metal bulb containing a fluid which changes volume with temperature change. The changes are transmitted via capillary tubing to an indicator or recorder. The system is sealed under considerable pressure to overcome the effects of vapour pressure from the liquid. Mercury filled thermometers should not be used with aluminum and certain other materials.
Bi-metallic thermometers consist of two metals with different coefficients of expansion which are welded together to form a bi-metallic strip. When heated, the strip will bend because of the unequal expansion, and the flexing movement can be used to drive a pointer in a similar manner to the Bourdon tube. Bi-metallic thermometers are susceptible to vibration and should only be installed in positions free from this effect.

Thermocouples rely on heat applied to the junction of two dissimilar metals generating a very small voltage which can be measured. A change will indicate a change in temperature. Normally the voltage is sensed electronically and the read-out is remote.

Resistance thermometers use the fact that the electrical resistance of certain materials changes with temperature, and that if it is measured it will indicate temperature. The material normally used in resistance thermometers is fine platinum wire. Its resistance is measured by means of an electrical resistance bridge connected to an indicator or recorder, normally by electronic means, and the read-out is remote.

1.5.4 Describe precautions to be taken when handling temperature monitoring devices.

The following precautions should be observed with all temperature monitoring devices: the thermometers used should be suitable for the complete range of temperatures expected; the sensor should make good thermal contact with the material whose temperature is to be measured; if readings do not change when expected, the instrument should be checked; thermometers are easily damaged, especially those with capillary tubes.

They should be handled with care and protected from mechanical damage and extremes of temperature beyond their scales, otherwise they may become inaccurate; when a fixed thermometer is removed from its working location, care should be taken to avoid loosening or removing its pocket, especially if the system is pressurized; when a thermometer is replaced in a working location, care should be taken that it does not bottom in its pocket when screwed in as this could cause damage.

If the thermometer is slack in the pocket a material with high thermal conductivity (such as suitable lubricating oil) can be used to ensure accurate readings; electrical connections should be clean, tight and correct. Care should be taken to see that intrinsically safe leads are not cross-connected with ordinary power sources.

Fixed cargo temperature indicating devices:
Such equipment must be maintained in working order at all times and a calibration check utilizing the UTI (Portable Gauging / Temperature Equipment) should be carried out at frequent intervals as per vessel's planned maintenance system. Records and results of the checks are to be maintained. Calibration of the fixed equipment by Third Parties is carried out as required after replacement of or repairs to any of the existing units

1.5.5 Explain Alarms and shutdown circuits used on board chemical tankers
Alarms and shutdown circuits

An important feature of many modern measurement and control instruments is the ability to signal a particular situation. This can be a main operational alarm that gives an indication of a pre-set situation such as liquid level in a tank, or a malfunction alarm indicating a failure within a sensor's own operating mechanism. The designs and purposes of alarm and shutdown circuits vary widely, and their operating system may be pneumatic, hydraulic, electrical or electronic. Safe operation of plant and systems depends on the correct operation of these circuits and a knowledgeable reaction to them.
1.5.6 List precautions to be taken when handling alarms and shutdown circuits.

The following precautions should be observed:

Where provided, test facilities should be used before cargo operations commence, to check that the circuits and their alarms are operating, any instrument fault should be rectified; wiring inside and outside cabinets should be checked for chafing, condensation, insulation deterioration, bad connections etc; watch keepers should be instructed how to distinguish between each audible alarm and what action is necessary the accuracy of all inputs to alarm circuits should be checked If an alarm is activated, the cause must be investigated and necessary remedial action taken.
If an alarm circuit becomes defective during cargo operations, it should be repaired as soon as possible. Defective circuits may be by-passed temporarily in case of an emergency, but this action should only be taken with the full agreement of the responsible officer after a proper risk assessment is done and the decision should be recorded. Completion of the repair work should also be recorded.
It should be borne in mind that individual ship has got own characteristics and limitations. The master and all personnel in all cases must be aware of cargo/ship information that has been given and comply with relevant safety procedures.

1.6 Gauging control systems and alarms
1.6.1 Describe the principles of operation and types of gauging devices for cargo tanks

Cargo tanks can be provided with a Gauging equipment which measures the level of product in the tank and provides the information to a remote display. To limit the crew's exposure to harmful chemicals, Chapter 13 of the IBC Code specifies three methods of gauging the level of a liquid in a tank, namely closed, restricted or open. The particular requirements for gauging specific cargoes can be found in Chapter 17 of the IBC Code. Most closed gauging systems are also provided with alarms which warn the crew when the tank is nearing its maximum capacity.

As required by the IBC Code, many chemical cargoes should only be gauged using completely closed gauging systems. This is in order to avoid exposing the crew to cargo vapours. Examples of closed gauging systems are float gauges and gauges that utilise radar or differential pressure systems. Chemicals considered less hazardous do not require quite such rigorous controls, and the specified restricted gauging accepts that a very small amount of vapour may escape during gauging. Where permitted, open gauging allows non hazardous cargoes to be gauged through tank openings using manual measuring equipment.

Float gauges

These are closed gauges, and consist of a float which is attached by a self tensioning tape to a device with a local read out, and frequently has provision for a remote read out. As the liquid in the tank rises or falls the tape measures the distance between the float and the datum set at the top of the tank (ullage).

Float gauges, especially the tape, are easily damaged and the following precautions should be observed:

- Floats should be secured when at sea, except briefly during measurement of tank contents. If the float remains unsecured at sea it will almost certainly be damaged due to sloshing of the cargo;
- Remote and local readings should be compared frequently to determine any discrepancies;
- Readings may need to be corrected to allow for tape and tank expansion or contraction, cargo density and ship trim and heel;
- Tapes should be checked regularly for free vertical movement of the float, and if damaged, they should be replaced;
- When tapes are renewed, or a gauge reassembled after maintenance, they should be recalibrated to ensure correct measurement between the cargo and the required tank datum. Manufacturer's instructions should be consulted; and
- During tank cleaning the float should be locked in the raised position to avoid damage to the tape by high pressure washing water.

Radar, ultrasonic or microwave gauges

These are also closed gauges, and work on the principle used in radar or echo sounders. Pulses are transmitted from the top of the tank and the time taken for them to be reflected back is measured and displayed as an ullage or sounding. Special arrangements may be made during construction to reduce interference by internal tank structure. Radar gauges are generally reliable, and most maintenance can be performed from outside the tank, with the tank in the closed condition

Pressure differential gauges

Pressure gauges utilise the difference between atmospheric pressure and the pressure the liquid exerts near the tank bottom. This sensor therefore provides the weight of the cargo in the tank. In order to obtain the volume, further calculations are required using knowledge of the cargo density and its temperature. In some systems, additional sensors are provided to enable the density to be automatically measured and applied.

Manual closed gauging systems

These systems use a probe at the end of a tape to check the level of cargo in a tank. The measuring probe is lowered into the tank via a small diameter pipe fitted with a ball valve at deck level. On contact with the surface of the liquid an audible signal is generated and the ullage in the tank is displayed. Most probes of this type can also measure the temperature of the product as well as the oil/water interface, when the probe is lowed further into the liquid.

The body of the unit is gas-tight when secured by the valve on the pipe on deck thereby providing an effective vapour lock. The operator is not exposed to cargo vapours when using this equipment. Vessels are frequently provided with a number of these units as a backup to the primary gauging system.

1.6.2 Explain the terms:

1.6.2.1 Open gauging

A device which makes use of an opening in the tanks and may expose the person gauging the cargo to its vapour. An example of this is the Ullage port opening.

1.6.2.2 Restricted gauging

Using a Restricted device which penetrates the tank and which, when in use, permits a small quantity of cargo vapour or liquid to be exposed to the atmosphere. When not in use, the device is completely closed. The design shall ensure that no dangerous escape of tank contents (liquid or spray) can take place in opening the device.

1.6.2.3 Closed gauging

Using a Closed device which penetrates the tank, but which is part of a closed system and keeps tank contents from being released. Examples are the float-type systems, electronic probe, magnetic probe and protected sight-glass. Alternatively, an indirect device which does not penetrate the tank shell and which is independent of the tank may be used. Examples are weighing of cargo, pipe flow meter.

1.6.3 Explain the use and purpose of high-level alarm systems for cargoes

High level alarm systems may be fitted to warn the operator of liquid level rising beyond a preset level.
Some cargoes require specifically high level alarm that is independent of any alarms fitted to the closed gauging system. The alarm may be activated by either a float operated switch, a capacitive pressure transmitter, or an ultrasonic device. The activation point should be set to when the cargo is approaching the normal full condition. Typically this limit will be set at 95%.

1.6.4 Explain the tank overflow control system

Besides an independent high level alarm some cargoes require a tank overflow control system
A tank overflow-control system shall:
.1 come into operation when the normal tank loading procedures fail to stop the tank liquid level exceeding the normal full condition;
.2 give a visual and audible tank-overflow alarm (high level) to the ship's operator; and
.3 provide an agreed signal for sequential shutdown of onshore pumps or valves or both and of the ship's valves. The signal, as well as the pump and valve shutdown, may be dependent on operator's intervention. The use of shipboard automatic closing valves shall be permitted only when specific approval has been obtained from the Administration and the port State authority concerned.

Tank overflow control systems (high level alarms) is typically set to alarm and operate when the level in the tank reaches 98% of capacity.

1.7 Gas-detecting systems

1.7.1 Describe the instruments necessary for detecting toxic and flammable cargoes.

Ships carrying toxic or flammable products or both shall be equipped with at least two instruments designed and calibrated for testing for the specific vapours in question. If such instruments are not capable of testing for both toxic concentrations and flammable concentrations, then two separate sets of instruments shall be provided.
Vapour-detection instruments may be portable or fixed. If a fixed system is installed, at least one portable instrument shall be provided.

1.7.2 Discuss fixed and portable vapour-detection instruments

In order to monitor the atmosphere within enclosed spaces, especially prior to tank entry, several different gas measuring instruments are required.
In addition to any fixed gas detection system, at least two of the following portable instruments should be available on board:
Oxygen analyzers capable of measuring the percentage volume of oxygen;
Flammable gas indicators (also called explosimeters) capable of measuring the Lower Flammable Limit (LFL) of the atmosphere; and
Toxic gas indicators which are capable of measuring the presence of a specific toxic gas are used to establish the risk to personnel.

1.8 Cargo heating and cooling systems

1.8.1 Explain the importance of heating for some cargoes

Highly viscous products might need to be heated in order to reduce their viscosity and enable the cargo tanks to be stripped effectively at the discharge port. Detailed heating instructions should be obtained from the shipper. Products that have a melting point which is close to or higher than the expected ambient conditions require heating to prevent freezing of the cargo.

1.8.2 Describe different heating medium

The following media can be used for heating:
Steam is efficient but is difficult to control and has a high contact temperature;
Water is less efficient than steam but provides a more accurate temperature control; and
Thermal oil is utilized where the cargo may react with water.

1.8.3 Sketch and Describe heating systems using:

1.8.3.1 Heating coils

These consist of a continuous rack of small bore pipe, made of stainless steel,
which are laid to cover the bottom of the tank. The coils are mounted about 10 cms. above the deck and are secured by brackets.
The heating medium is circulated through the coils, under pressure when
steam is used, or by a pump when an alternative heating medium is used.

1.8.3.2 Deck mounted heat exchanger

This system utilizes the deepwell cargo pump to circulate the cargo via a heat exchanger mounted on deck and returned to the tank via a drop line mounted at the opposite end of the tank from the cargo pump.

1.8.4 Explain the risks associated with overheating cargo

Careful monitoring of temperature to ensure cargoes are not degraded or damaged due to over heating or lack of heating and to comply with MARPOL Annex II requirements must be understood. For example a high amount of heat can cause changing colour of product like phenol because of which the product quality can be spoiled.

1.8.5 Explain the risks and dangers associated with poor monitoring of cargo temperatures for some chemical cargoes.

Maintenance of heating or cooling systems prevents its failures, which protect and prevent some of the chemical cargo from adverse reactions or downgrading. The temperature of cargoes that may self-react should be monitored closely. Unexpected changes of temperature are an early indicator of a possible self-reaction.
Should the temperature rise be in excess of what is expected, taking into account the ambient conditions and the temperature of adjacent cargoes, then this should be treated as an emergency and handled accordingly.

Some cargoes are water reactive if the heating or cooling system leaks then reactivity may trigger off an emergency situation. Maintenance of the heating arrangements reduces risks for emergency situations resulting in major losses to personnel, property and environment.

1.8.6 Identify problems associated with heated cargoes adjacent to polymerizable or inhibited cargoes

Although spontaneous polymerisation can occur at ambient temperatures, it is very often initiated by elevated temperatures, either due to environmental conditions or adjacent heat sources.
Solidification can occur when inhibited cargoes or their condensates are exposed to excessive heat from adjacent tanks. This solidification can cause increase in volume. If excessive heat is caused by the sun, spraying the deck area with seawater may prevent this type of solidification due to polymerisation of the cargo.

1.8.7 Identify dangers associated with heated cargoes adjacent to highly volatile cargoes

Stowing volatile cargo next to heated cargo may give rise to evaporation losses and excessive rise in tank vapour pressure. Available documentation and Charterers instructions should specify maximum permissible temperatures. Adjacent heat is an important specification for stowage planning on chemical tankers.

1.8.9 Describe different cooling or refrigeration systems for chemical tankers

Cooling systems
Some chemical tankers are equipped with a system that can circulate a cooling medium in order to keep the cargoes below a specified temperature. The coolant is usually circulated via the same coils that are used when heating a cargo. Typically chemical tanker cooling systems are only designed to prevent the cargo from heating in warmer ambient conditions and cannot maintain or cool a cargo below 15^{o} C. The IBC code requires cooling capacity for

a number of cargoes that have a high vapour pressure and thus might start to boil if ambient conditions would allow the cargo to heat.

1.8.10 Define reference temperatures

Reference temperature: is the temperature at which the vapour pressure of the cargo corresponds to the set pressure of the pressure-relief valve.
Special carriage requirements for some cargoes require that no cargo tanks shall be more than 98% liquid-full at the reference temperature.

1.9 Tank cleaning systems

1.9.1 Explain why the type of cleaning system on chemical tankers depends on the ship's cargo and its trade

Tank cleaning method and the cleanliness involved have different standards depending upon the previous cargo and the cargo to be loaded. Summarized below practical tank cleaning methods for various chemical cargo.

Cleaning agent added directly to the washing water

The cleaning chemical is injected into the washing water by means of a dosage pump, usually air-driven, through a fitting attached to the washing pipe on deck. Sometimes the cleaning chemical is added to the suction side of the washing water pump, thus eliminating the need for a dosage pump. But the dosage becomes less accurate and the method is more cumbersome in the latter case.

A direct addition of cleaning chemical to the washing water is quite common, but chemical consumption tends to be high and its full cleaning effect is not always utilized. 1-2 hours of washing is usually to be recommended. The final rinsing being sea or fresh water, depending on the product to be loaded.

Recirculation of the washing water

Gives a better utilization of the cleaning chemical. A mixture of 5 - 50 tons of hot water with the recommended amount of cleaning chemical is made in a cargo tank, a slop tank, a cofferdam or a special tank for the purpose.

The water may be further heated by means of heating coils. A cargo pump may serve as a washing pump with delivery to the washing line on deck, and then to the washing machines. Another cargo pump or stripping pump drains the water back to the containment tank where the cargo residues can be removed by carefully drawing out the washing water from the bottom.

The requirements for a Fixed tank washing machines

The installation of fixed tank washing machines within a cargo tank allows an inert atmosphere to be maintained during the washing operation, and thus permits cleaning in a closed mode in compliance with port regulations prohibiting release of toxic vapours. Their installation and use also reduces crew exposure to cargo vapours and inert gas.
The design of fixed tank washing machines will have met all statutory requirements for safety as regards materials of construction, water flow rates and generation of static electricity. Any routine servicing should be performed in accordance with the manufacturer's instructions, but no on board modifications should be contemplated.

The requirements for a Portable tank washing machines and hoses

The outer casing of portable machines should be of a material which will not generate an incendive spark on contact with the internal structure of a cargo tank.

Hoses should be indelibly marked to allow identification. Bonding wires should be incorporated within all water hoses. Couplings should be secured to the hose in such a way that effective electrical bonding is assured from end to end of the hose. Hoses should be tested for electrical continuity in a dry condition prior to use and in no case should the resistance exceed 6 ohms per metre length. Such testing should not involve high voltages. A record should be kept showing the date and result of electrical continuity testing.

The hose coupling arrangement should be such that effective bonding can be established between the tank washing machine, the hoses and the fixed tank cleaning water supply line. Washing machines should be electrically bonded to the water hose by means of a suitable connection or external bonding wire.

When suspended within a cargo tank, machines should be supported by means of a natural fibre rope and not left to hang from the water hose.

1.9.2 Lists the main components of a tank cleaning system
The main components of the tank cleaning system are:

- Tank cleaning pump with water distribution pipeline
- Tank cleaning heat exchanger
- Tank-washing machines
- Tank stripping system
- Slop retention and decanting system

1.9.3 Explain why the tank cleaning heat exchanger and the tank cleaning pump must be of approximately the same capacity

To obtain the best possible cargo stripping specially for viscous cargoes and in order to maintain the cargo flow to the pump cargo temperatures and flow rates must be monitored and maintained so that the heaters are not required to be frequently started and switched off to maintain required temperatures. Tank cleaning heat exchanger and the tank cleaning pump must thus be of approximately the same capacity.

1.9.5 Describe a tank-washing system

There are many variations of tank cleaning equipment but they all work on the same basic principle whereby a tank cleaning machine directs jets of water, under pressure, against the tank's internal surfaces. The nozzles of the tank cleaning machine slowly rotate, both vertically and horizontally, so that all surface areas of the tank are covered.
The installation of fixed tank washing machines within a cargo tank allows cleaning in a closed mode minimizing the release of toxic or flammable vapours. Fixed tank washing systems often have an option to modify the washing cycle. Fixed tank cleaning systems are permanently bonded to the ship's structure.
Portable machines are made of non spark inducing materials. Portable machines are connected to the ship's tank cleaning system by means of hoses. The advantage of portable machines is that they can be placed at various levels throughout the wash cycle. When cleaning after unloading particularly difficult cargoes such as vegetable oils, the machines can be positioned where they can work more effectively to cover shadow areas where permanently fixed machines cannot reach.

The MARPOL Annex II regulations mandate equipment and operational measures designed to minimise the volume of cargo remaining in the cargo tanks after unloading (discharging).Final disposal of slops or wash water should be in accordance with the ship's P&A Manual and MARPOL requirements. Tank washings and slops may be retained on board in a slop tank for later disposal at sea if permitted or ashore to an approved shore reception facility.

1.9.6 Describe, the design and safety measures with respect to tank-washing machines

The design of fixed tank washing machines will have met all statutory requirements for safety as regards materials of construction, water flow rates and generation of static electricity. Any routine servicing should be performed in accordance with the manufacturer's instructions, but no on board modifications should be contemplated.

Before any operations begin, the responsible officer should confirm that adequate checks are made to establish that all equipment to be used during tank cleaning operations is in good working order.

1.10.0 Cargo tank environmental control systems

1.10.1 Describe open and controlled ventilation systems

The IBC code chapter on "Cargo tank venting and gas-freeing arrangements" defines an open tank venting system as a system which offers no restriction except for friction losses to the free flow of cargo vapours to and from the cargo tanks during normal operations. An open venting system may consist of individual vents from each tank, or such individual vents may be combined into a common header or headers, with due regard to cargo segregation. In no case shall shutoff valves be fitted either to the individual vents or to the header.
A controlled tank venting system is a system in which pressure- and vacuum-relief valves or pressure/vacuum valves are fitted to each tank to limit the pressure or vacuum in the tank. A controlled venting system may consist of individual vents from each tank or such individual vents on the pressure side only as may be combined into a common header or headers, with due regard to cargo segregation.
Tank vent system outlets are required by the IBC Code to be located at a safe distance from areas where personnel may be present.

A pressure/vacuum (P/V) valve is designed to protect a tank from over or under pressure during loading and discharging. The P/V valve also protects the tank from changes in pressure during the sea voyage and protects the cargo from direct contact with the atmosphere.
Should an under pressure develop in the tank, for example when discharging, the vacuum side of the P/V valve opens and allows air to enter the tank.
When loading, pressure will build up in the vapour space above the cargo and, once the predetermined limit is reached, the P/V valve's pressure side opens relieving the pressure.
The valves are designed so that when they lift under pressure the vapour isejected vertically and well clear of the working deck.
Chemical carriers are provided with an independent P/V valve for each tank.
The P/V valves are designed to handle vapour flow based on the maximum loading or discharge rate of the tank.
The vent line should be self draining where possible. IMO regulations require that a secondary venting system be provided should the primary means of venting fail. This can either be complied with by fitting an extra P/V valve and vent line or by fitting a pressure sensor in the tank,

Tanks containing toxic products have to be provided with separate venting systems which have to be sited a safe distance away from the working deck and from the accommodation spaces.
The inlet and outlet of ventilation systems for working spaces such as pump rooms are required to be sited a specified distance from the accommodation spaces.
The position of accommodation ventilation system intakes is also specified and the ventilation system has to be able to re-circulate air within the accommodation should an accidental release of toxic vapour occur.
A controlled cargo-ventilation system should be used for cargoes other than those for which open ventilation is permitted.

1.10.2 Discuss loading rates and ventilation capacity

The master shall be provided with the maximum permissible loading and unloading rates for each tank or group of tanks consistent with the design of the venting systems. When handling high vapour pressure cargoes, particularly in high ambient temperatures, high rates of vapour generation may occur during either loading or discharging. As a high vapour pressure cargo enters an empty tank there is a rapid evolution of gas, as a result it may be necessary to reduce the loading rates. During the loading of high vapour pressure cargoes a very high concentration of gas, approaching 100% by volume, may be returned to the shore. Controlled venting must be established if closed cargo operations are required.
Secondary venting system where required, must also be operational. Information on maximum loading rates and venting capacities is to be readily available and displayed in the cargo control room.

1.10.3 Explain the design of safe ventilation to minimize cargo vapours exposure to personnel

Controlled tank venting systems are fitted to tanks to be used for cargoes having a flashpoint not exceeding 60°C (closed-cup test). They are provided with devices to prevent the passage of flame into the cargo tanks. The design, testing and locating of the systems shall comply with the requirements of the Administration, which shall contain at least the standards adopted by the Organization. Very toxic and volatile cargoes should, if the shore is equipped with a vapour return, be loaded with vapour return in order to avoid vapour release into the atmosphere. VECS manual must be complied with.

1.10.4 Explain the limitations and risks of open-venting

An open system should only be used for cargoes that are not toxic and designated in the IBC Code as suitable for open venting. Attention should be given to the adequacy of open vents on a tank in order to avoid the possibility of over-pressurization.

1.10.5 Explain when controlled venting is required

Venting requirements for individual products are shown in column g, and additional requirements in column o in the table of chapter 17.
A controlled tank venting system is a system in which pressure- and vacuum-relief valves or pressure/vacuum valves are fitted to each tank to limit the pressure or vacuum in the tank.

1.10.6 Describe the reasons for use of the vapour return line

The purpose of vapour return line is to ensure that cargo vapours are not released to the atmosphere. Vapour return lines on chemical tankers are either connected to the vessel's P/V line or, if the vessel is fitted with an inert gas system, to an extension of that system.
The vapour return lines are led to the manifold where a connection is provided to connect to the shore vapour collecting line.
As the tank is loaded the shore recovers the displaced gas from the tank being loaded where it is stored, treated or disposed of under controlled conditions. The vapour return system is intended to maintain a slight over pressure in the cargo tank(s) which is below the pressure setting of the tank's P/V valve.
In certain circumstances, the vessel is required to accept cargo vapours from shore while the ship is discharging, although the operating principle remains the same.
In order to ensure that the balance of gas between ship and shore is maintained within safe limits, over and under pressure sensors are provided on the ship's vapour return line to provide a warning should the operational limits be exceeded. The tank's P/V valve remains the essential safety device should the pressure or vacuum in the tank exceed the designed set levels.
Regulations require the ship to be able to return vapours of most toxic chemicals to shore.

1.10.7 Describe safety aspects of vent design, including
In this context, it should be noted that flame arresters and flame screens are more susceptible to blockage.
Provisions should be made such that the system and fittings may be inspected, operationally checked, cleaned or renewed as applicable.

1.10.7.1 Flame arrestors

A device used in gas vent lines to arrest the passage of flame into enclosed spaces. They prevent flame propagation by absorbing and dissipating heat. The arrestors are designed to stop an ignited flammable vapour mixture travelling at subsonic or supersonic velocities. They are also designed to protect against continuous burning.

1.10.7.2 Flame screens

A portable or fitted device incorporating one or more corrosion resistant wire woven fabrics of very small mesh used for preventing sparks from entering a tank or vent opening, or for a short period of time preventing the passage of flame, yet permitting the passage of gas

1.10.7.3 High-velocity vents

A device to prevent the passage of flame in the reverse direction, consisting of a mechanical valve which adjusts the opening available for flow in accordance with the pressure at the inlet of the valve in such a way that the efflux (exiting) velocity cannot be less than 30 m/s.

1.10.8 Explain the operation and precautions of:

1.10.8.1 High Velocity Valve:
The operation of the high velocity vents and/or P/V valves should be checked using the testing facility provided by the manufacturer. Furthermore, it is imperative that whilst doing so, an adequate visual or other check is made to ensure that the check-lift is actually operating the valve. On occasion a seized or stiff vent has caused the check-lift drive pin to shear and the ship's personnel to assume, with disastrous consequences, that the vent was operational.

Hi-Jet type high velocity pressure/vacuum valves are designed to provide protection to individual tanks and are capable of allowing high volumes of tank atmosphere to pass, as would be the case during loading/discharging. They are also designed to throw the vented gases clear of the deck area. They are not designed to be operated in the "jacked-open" position. The maximum PV valve flow capacity is to be readily available in the cargo control room. This flow capacity is 125% maximum loading rate.

1.10.8.2 Flame arrestor:

The gases which are vented to atmosphere or controlled via vapor control systems are typically flammable. If the conditions are such that ignition occurs, a flame inside or outside of the system could result, with the potential to do catastrophic damage. The flame arrester protects the tank from flames in the atmosphere such as from lightning strikes.

1.10.9 Explain the requirements of a pressure/vacuum valve. (P/V valve)

The requirements of a pressure/vacuum valve in a cargo tank are as follows:
The tank's P/V valve remains the essential safety device should the pressure or vacuum in the tank exceed the designed set pressure levels. The cargo tank venting system should have previously been set for the type of operation to be performed. Cargo vapour displaced from tanks during loading or ballasting should only be exhausted to atmospheres through the tanks' venting system, unless vapours are being returned to shore. The loading rate should not exceed the maximum flow rate of the tanks' venting system.
P/V valves are fitted with a flame screen on the vacuum side. Particular attention should be given to checking that flame screens do not become blocked by ice, condensed cargo vapour or other contaminants. Some older vessel's tanks are protected by a common venting system where vent lines are grouped together and served by a single P/V valve. Such arrangements can lead to cross contamination of cargo vapours from one tank to another. In the event of overfilling a tank, liquid contamination can also occur. Such arrangements are seldom found on modern vessels where it is now common practice to provide a separate vent line and P/V valve for each tank.
In order to ensure the correct functioning of P/V valves the following should always be complied with:

- P/V valves should be serviced and calibrated according to class requirements;
- Prior to loading and discharging, P/V valves should be checked to ensure they function as designed;
- During cargo operations the correct functioning of P/V valves should be monitored; and tested.
- Pressure sensors fitted as the secondary system as a back up to the primary vent system should be checked to ensure that they function as designed and where provided that the alarms are correctly set.

1.10.10 Discuss general precautions and maintenance of P/V valves.

Where a P/V valve's operating parameters can be adjusted, the correct pressure setting for the product to be handled should be confirmed. Vent lines and P/V valves must be checked for correct operation prior to arrival.
Malfunction or blockage due to cargo vapour freezing, polymer build-up, atmospheric dust, or icing in adverse weather conditions can easily result in structural damage to a tank. Heat tracing lines, if fitted should be tested and used if required for the cargo. Flame screens are particularly susceptible to blockage and should be checked to ensure that they are clear.

1.10.11 Explain how the inert gas system may be a part of a vessels venting system.

In the context of chemical tanker operations and chemical cargoes, an inert gas system may have three distinct uses: preventing a fire, preventing a chemical reaction or maintaining cargo quality. Inerting, Gas-freeing and Venting operations are intrinsic on a chemical tanker and the Vapour Emission control systems may be a part of the venting system.

Where required, VEC is to be used and operated in accordance with IBC Code, local regulations, and instructions contained in the vessel's VEC System Operation Manual and in conjunction with the requirements and provisions of the shore installation.

Masters and Officers must be aware that significant operational and safety implications are present, as the shore and the ship are effectively joined together as one unit.
The primary hazards include:

The ship loses effective control of the tank atmosphere pressure, and is directly influenced by any changes which may occur within the terminals system. It is therefore most important that associated pressure sensing devices on the vessel are well maintained. It is also essential that individual cargo tank P.V. valves are properly maintained and operate correctly. Check that the VECS alarms are correctly set and tested. Secondary PV alarms are set 10% above PV valves setting as per Oil Major requirements for normal operations

1.11 Ballast systems

1.11.1 Explain why ballast pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks require to be independent of cargo tanks.

Ballast pumps, ballast lines, vent lines and other similar equipment serving permanent ballast tanks shall be independent of similar equipment serving cargo tanks and of cargo tanks themselves to prevent flammable, toxic, corrosive and hazardous vapours entering such places

1.11.2 Explain why discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks shall be outside machinery spaces and accommodation spaces.

The discharge arrangements for permanent ballast tanks sited immediately adjacent to cargo tanks shall be outside machinery spaces and accommodation spaces to prevent flammable, toxic, corrosive and hazardous vapours entering such places. However filling arrangements may be in the machinery spaces provided that such arrangements ensure filling from tank deck level and non-return valves are fitted.

1.11.3 Explain the sequence of setting up of appropriate lines & valves during ballasting / de ballasting operations

Display an example of a typical chemical tanker line and valve set up. It may be executed on a simulator or recommended to be used by the trainer to make the students understand the line setting up and parameters required to be monitored by a table top exercise to be done in the class using the figure provided in Appendix 1with a screenshot of the chemical tanker ballast water system and make the trainee operate the system on as a table top exercise as follows:

1.11.4 Describes the use of ballast pumps and eductors.

The ballast pump is used to take as much as possible out of the tanks, leaving the final draining to be completed via the eductor.
Ballast pumps are usually of the centrifugal type.
The instructor, with the CCR BALLAST PUMP SYSTEM display diagram appended in Appendix 1, traces the lines to set up the eductor system and change over the ballast pump(s) to pump sea to sea and remain running whilst completing the deballasting operations.

1.11.5 Explains that ballast operations are carried out to maintain safe trim and stability during cargo operations.

At all times during unloading and loading operations the ship should have adequate stability, stresses within limits and suitable trim to allow for departure at short notice in the event of an emergency. To achieve this vessel may have to ballast or deballast while loading/ unloading.

1.11.6 Explain ballast water treatment system.

Ballast water management (or treatment) systems (BWMS) that treat ballast water to a specified biological standard are now increasingly being fitted to vessels and Various designs and operating principles are employed. Once the IMO BWM Convention has entered into force, most chemical tankers that remain in Service will probably be required to be retrofitted with type approved treatment equipment.
All crew should be familiar with the operation and maintenance of the equipment fitted on board their vessel, so far as this may be relevant to their duties, and records should be maintained of all ballasting and de-ballasting Operations as required under the ships' ballast water management plan.
Ballast Water Treatment Equipment use mechanical, Physical, chemical, or biological processes, either singularly or in combination, to remove, render harmless, or avoid the uptake or discharge of harmful aquatic organisms and pathogens within ballast water and sediments. Ballast water treatment equipment may operate at the uptake or discharge of ballast water, during the voyage, or at a combination of these events. In case of any failure compromising the proper operation of the BWMS, audible and Visual alarm signals should be given in all stations from which ballast water operations are controlled.

1.12 Cargo area venting and accommodation ventilation Systems.

1.12.1 Explain why all cargo tanks should be provided with a venting system appropriate to the cargo being carried.

The IBC code specifies cargoes which react in a hazardous manner must:- be segregated by means of cofferdam / wide spaces / empty tank / common bulkhead only to mutually compatible cargo. – have separate pumps, piping, and venting system to prevent hazardous reactivity with tank material, other cargo vapour, or other incompatible material.
To prevent dangerous reactions from occurring, all cargo tanks should be provided with a venting system appropriate to the cargo being carried. This could be:

An open venting system which may consist of individual vents from each tank, or such individual vents may be combined into a common header or headers, with due regard to cargo segregation. OR

A controlled venting system which may consist of individual vents from each tank or such individual vents on the pressure side only as may be combined into a common header or headers, with due regard to cargo segregation.
Venting requirements for individual products are shown in column g, and additional requirements in column o in the table of chapter 17 of the IBC code.

1.12.3 Describe secondary means of venting

IMO regulations require that a secondary venting system be provided should the primary means of venting fail. This can either be complied with by fitting an extra P/V valve and vent line or by fitting a pressure sensor in the tank; a venting system that fails to function can lead to an excessive buildup of pressure or vacuum in a tank, resulting in major structural damage

1.12.4 Explain with respect to the safety the design considerations for a chemical tanker venting system.

The ventilation system of each tank is dimensioned to deal with all vapours that are released by loading at normal rates so as to minimize the risk of accumulation of cargo vapour in areas open to access by personnel.
The cargo venting system must be provided with readily renewable and approved devices to prevent the passing of flame
In order to guard against the danger of hazardous vapours, due consideration shall be given to the location of air intakes and openings into the accommodation, service and machinery spaces and control stations in relation to cargo piping and cargo vent systems and its location.

1.13 Vapors return/recovery systems

1.13.6 Describe Vapour emission control Systems and Vapour recovery systems.

Vapour return lines on chemical tankers are either connected to the vessel's P/V line or, if the vessel is fitted with an inert gas system, to an extension of that system.
The vapour return lines are led to the manifold where a connection is provided to connect to the shore vapour collecting line.
As the tank is loaded the shore recovers the displaced gas from the tank being loaded where it is stored, treated or disposed of under controlled conditions. The vapour return system is intended to maintain a slight over pressure in the cargo tank(s) which is below the pressure setting of the tank's P/V valve.
In certain circumstances, the vessel is required to accept cargo vapours from shore while the ship is discharging, although the operating principle remains the same.
In order to ensure that the balance of gas between ship and shore is maintained within safe limits, over and under pressure sensors are provided on the ship's vapour return line to provide a warning should the operational limits be exceeded. The tank's P/V valve remains the essential safety device should the pressure or vacuum in the tank exceed the designed set levels.
Regulations require the ship to be able to return vapours of most toxic chemicals to shore.

1.13.7 Describe operating procedures and requirements for a vapour emission control system.

VEC is to be used and operated in accordance with IBC Code, local regulations, and instructions contained in the vessel's VEC System Operation Manual and in conjunction with the requirements and provisions of the shore installation.

Masters and Officers must be aware that significant operational and safety implications are present, as the shore and the ship are effectively joined together as one unit.

The ship is directly influenced by any changes which may occur within the terminal system and may lose effective control of the tank atmosphere pressure. It is therefore most important that associated pressure sensing devices on the vessel are well maintained. It is also essential that individual cargo tank P.V. valves are properly maintained and operate correctly. Check that the VECS alarms are correctly set and tested. (Secondary PV alarms are set within 5-10% range of the PV valves setting as per Oil Major's requirements for normal operations).

1) For VECS as per USCG requirements the VECS alarms should be activated at 80% of PV valve setting.
2) Where IG pressure sensors are used to satisfy secondary venting requirements, PV alarm setting for secondary venting of cargo tanks are required by Oil majors to be set within 10% range of the pressure setting of the PV valve.
Whenever any of these alarms activates during cargo operations, the cargo operations shall be immediately stopped and cause of alarm activation rectified before resuming cargo operations.

Vessels fitted with a VEC system must have an independent overfill alarm providing audible and visual warning. These are to be tested at the tank to ensure their proper operation prior to commencing loading, unless the system is provided with an electronic self-testing capability. Fixed gauging systems must be maintained in a fully operational condition at all times.
Tanks must not be opened to the atmosphere for gauging or sampling when connected to the shore vapour collecting system, unless the cargo being handled permits, loading to the tank is stopped, the tank is isolated from any other tank being loaded, and precautions are taken to safely reduce any pressure within the cargo tank vapour space.
The ship's system is to be provided with means to collect and drain condensed vapour, which may have accumulated in the pipelines. Drains must be installed at low points within the ship's piping system. These drains must be checked clear before each use of the VEC system and on a regular basis when the system is not in use.

Care must be taken to ensure that no possibility of misconnection of Vapour and Liquid hoses can occur. The ship's vapour connection is to be clearly identified. The outboard 1.0 meter of piping is to be painted with yellow and red bands (0.1m red, 0.8m yellow, 0.1m red) and marked with the word "Vapour" (not less than 50mm high). The vessel's presentation flange is to be fitted with a stud to prevent an incorrect connection.
To prevent electrostatic build up within the vapour return pipe work, all pipe work is electrically bonded to the hull. The integrity of these connections is to be periodically checked.
VECS manual requirements to be complied with respect to loading rate, vapour density, pressure drop etc.

1.13.11 Explain Pressure drop with respect to vapour collection system

As per the IBC code, The main factors to be considered in the sizing of a tank venting system are as follows:
.1 design loading and unloading rate;
.2 gas evolution during loading: this shall be taken account of by multiplying the maximum loading rate by a factor of at least 1.25;
.3 density of the cargo vapour mixture;

.4 pressure loss in vent piping and across valves and fittings; and
.5 pressure/vacuum settings of relief devices.

Pressure drop calculations are made comparing cargo transfer rate to pressure drop from the farthest tank to the vapour connection, including any hoses used. Calculation to be made for each cargo handled at the maximum transfer rate and lower.
The rate based on pressure drop calculations for a given pressure at the facility vapour connection, such that the pressure in any cargo tank connected to the vapour collection system does not exceed 80% of the opening set pressure of any pressure relief valve in the cargo tank venting system

1.13.12 Calculates pressure Drop

The capacity of the vapour collection system is documented through pressure drop flow rate calculations as follows:

The list from classification rules for VCS, covers a range of cargoes normally carried, and gives vapour pressure and specific gravity, as well as density of vapour/air mixture and vapour growth rate at 45°C.

1.13.13 Explain the use of Vapour recovery instructions and documentation between the ship and the shore

The primary hazards in the vapour emission control systems include: The loss of the effective control of the tank atmosphere pressure, and is directly influenced by any changes which may occur within the ship or the terminal's system. It is therefore most important that associated pressure sensing devices on the vessel are well maintained. It is also essential that individual cargo tank P.V. valves are properly maintained and operate correctly. It is important here that the instructor emphasizes to the trainees the requirements to check that the VECS alarms are correctly set and tested.
The full procedures for the use of the VEC system are to be clearly agreed at the pre-transfer meeting between the Terminal Representative and the Chief Officer.
As the ship and the shore Vapour systems are interconnected
Instructions are to contain information on both the shore and the tanker's vapour collection system including:
— A line diagram of the vapour collection piping indicating the locations and purpose of all control and safety devices;
— The maximum allowable transfer rate as limited by the venting capacity of the pressure or vacuum relief valves, or any other factor which would limit the transfer rate;
— the maximum pressure drop in the ship's/shore's vapour collection system for various transfer rates,
— The relief settings of each pressure and vacuum relief valve;
— pre-transfer procedures,
— Procedures to be followed in the event of a fault during vapour collection operations

1.14.1 Explain requirements of firefighting on a chemical tanker for cargo area

IBC Code states that Chemical tankers are fitted with a fixed foam system for firefighting that is capable of delivering foam to the entire cargo area i.e. to the deck area as well as to any cargo tank.

1.14.2 Explain fixed fire - extinguishing system in for cargo pump rooms of a chemical tanker.

The chemical Codes require extinguishing agents for fixed fire - extinguishing system in cargo pump rooms to be carbon dioxide, but water or high-expansion foam may be used in certain vessels.

1.14.4 Explain why water and foam are suitable as firefighting agents.

Water as a firefighting agent is very suitable as it is easily available it is an excellent cooling agent it may be used in a fog/spray form to create a protection it may be used as a screen for firefighters when they are approaching a fire.

Foam suitable for fighting chemical fires have good smothering effect on flames, however it is less effective against fires that have a low flashpoint it has limited heat absorbing effect and it should not come in contact with live electrical equipment.

1.14.5 Explain advantage of dry chemical powder as a firefighting agent

- It has a good smothering effect
- It can be used in electrical plants it is not toxic
- It has a low cooling effect
- It should not be used on electronic instruments, control panels etc.
- It has an inhibiting effect

1.14.6 Explain advantage of carbon dioxide as a firefighting agent

- It is an excellent smothering agent
- It can be used on fires in electrical equipment and instruments
- State that carbon dioxide should not be injected into a space having explosive atmosphere as it may generate static electricity
- State that personnel must vacate the space and head count taken subsequent to which carbon dioxide may be injected

1.14.7 Describe fireman's outfit requirements.

Required 4 sets – stowage in good order as per fire control plans. Protective *clothing*, boots, gloves, helmet, safety lamp, once, all in easily usable condition. B. A. set with smoke helmet proper hose length or SCBA with 200% spare cylinder or 100% spare cylinder and compressor. A fireproof lifeline with belt, resistant to the cargoes carried.

1.15 Tanks pipelines and fittings material and coatings

1.15.1 Explain why coatings, fixtures and fittings must be compatible with cargoes to be carried

The materials used in construction of the cargo systems including coatings, fixtures and fittings must be compatible with the cargo to be carried. In addition, care must be taken to ensure that no incompatible materials are used during maintenance. Incompatible materials may trigger a self-reaction within the cargo that can be dangerous to ship and crew, or may cause cargo contamination.
Besides affecting cargo, conversely tank coating if not compatible could also get damaged.

Although chemical tankers are designed to contain cargoes safely within the cargo system there are occasions when small amounts of a product, such as cargo samples, are required to be stored outside the containment system.
The IBC Code specifies requirements for the safe storage of cargo samples.

1.15.2 Explain the reasons for the use of stainless steel cargo tank and coatings in cargo tanks

Chemical tankers are specialised vessels designed and built to transport a wide range of liquid cargoes in bulk. The ability to load many different grades of corrosive or reactive cargo at the same time requires the vessels to be provided with a large number of tanks of various sizes, and to be fitted with a complex cargo pumping and piping system to ensure complete segregation between incompatible cargoes. Cargo tanks are part of the hull structure and are constructed of either mild or stainless steel. Mild steel tanks are usually coated with an inorganic zinc coating, an epoxy type coating or an advanced polymer coating for cargo compatibility. Stainless steel is mostly compatible for all types of cargo but expensive to construct and maintain.

1.15.3 Explain the use of stainless steel for cargo piping, valves and pumps

The Cargo system including the cargo piping, valves and pumps of a chemical carrier are designed to ensure positive segregation between different grades of cargo.
The cargo tanks may be of different tank coatings suitable to cargo compatibility requirements for cost conservation.
To provide for operational flexibility in cargo operations, pipelines, valves and pumps are independent of each other and provided with means to common/grouped facility and are usually made of stainless steel which is mostly compatible for all types of cargo but expensive to construct and maintain.

1.15.4 Differentiate different grades and surface finishes of stainless steel

Stainless steel does not readily corrode, rust or stain with water as ordinary steel does, but despite the name it is not fully stain-proof, most notably under low oxygen, high salinity, or poor circulation environments. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure. Stainless steel is used where both the properties of steel and resistance to corrosion are required.
Chemical tankers with stainless steel tanks mostly have 316 LN which is the standard grade, and for it to achieve compliance with the AISI (American Iron & Steel Institute) standard, the content of chrome (Ch), nickel (Ni) and molybdenum (Mo) must fall within the following range:

Chrome	16-19%
Nickel	10-14%
Molybdenum	2-3%

As it is the molybdenum that provides the resistance to pitting corrosion and attacks from chlorides, prudent shipowners require the molybdenum content to be higher than the minimum AISI level – specifications of 2.70% and 2.75% minimum have become the norm. Many steelworks now deliver 316 LN grade with an average molybdenum content of 2.70% and nothing below 2.50% mirrors this.

There have been a number of cases recently involving 316 LN vessels where damage has been caused by cargoes which were not overly aggressive. It was found that the 316 LN used in these vessels contained the absolute minimum levels of Ch, Ni and Mo acceptable to the AISI standard. It can be shown from experience that vessels with minimum molybdenum (say 2.02%) may suffer severe pitting corrosion, which would normally be shrugged off by steel with a 2.70% or greater Mo content. Clearly, the Mo content will depend upon the specifications given to the building yard – if owners fail to specify the required percentage of these expensive constituents and merely specify 316 LN, they will be liable to get the minimum that the yard can get away with.

Due to high prices for the very important alloying elements nickel and molybdenum, one alternative to solid austenitic stainless steel could be looking for clad steel. One obvious drawback of clad steel is the compromise in rolling and annealing temperatures for the stainless steel cladding and the mild steel substrate, which can result in surface defects of the stainless steel cladding.

1.15.5 Describe the properties of specialized tank coatings

1.15.5.1 Zinc silicate

Zinc Silicate, particularly those of organic type are very resistant against strong solvents and normally tolerate higher temperatures than epoxies.

Typical products like aromatic hydrocarbons (benzene-xylene etc.), alcohols and ketone. Jet fuels may suffer zinc pick up from the coating to an extent which is considered a contamination. Zinc silicate are not resistant against acids, or alkalis. The PH value of the cargo should be within the range 5.5-10.5. This means that some molasses (slightly fermented-low pH) may attack zinc silicates, as well as high contents of free fatty acids in vegetable oil or animal oils:
Zinc silicate coatings may under above mentioned circumstances cause zinc pick up into the cargo. They are therefore not normally suitable for edible oils for human or animal consumption .Remember that the contents of free fatty acids, and correspondingly increase the zinc pick up during transport.
Certain coatings have governmental approval for edible oils, check for pH limitations in such cases during transportation.
Zinc silicate are not suitable for long time exposure to seawater, the life span will be unduly reduced.

After carriage of molasses in zinc silicate coated tanks a thorough cleaning should be carried out as soon as possible. Sour cargo remaining on the tank bottom may damage the coating. Zinc silicate are only partly resistant to chlorinated compounds (e.g. carbon tetrachloride, EDC, TCE). If the water content is high hydrochloric acid may develop, which will attack the coating. In similar way hydrolysable hydrocarbons such as esters, acetates and halogenated compounds may attack the cargo. If however, the product is guaranteed dry and the cargo tanks and piping are completely drained and dried these products can be carried.
Alkaline tank cleaning agents (caustic) should never be used in zinc silicate coated tanks. Considerable damage can be done in one single cleaning operation. Zinc silicate stands well up against other cleaning agents such as "solvent cleaners" and "emulsifiers" unless they have alkaline additives Check first with the maker of the cleaning product:
If a zinc silicate coating has been attacked one can often observe a thin layer of white dust on the surface, or the coating gives a porous appearance, Inform the owners at once: it may be that the last cargo was off specification and caused the damage.

1.15.5.2 Epoxy

Generally possess a good resistance against alkalis, seawater, wine, vegetable oils, crude oils, gas oils, lube oils and also weak acid (e.g. free fatty acids in vegetable oil, but acid value should not exceed 20-40). Epoxy has limited resistance against aromatic hydro carbons (solvent: such as benzene, toluene, certain alcohols (e.g. methanol), ketone (acetone) and some esters. Epoxy is sometimes indicated as resistant also to stronger acids. This may be correct, but as an applied coating one must count on "holidays" in the film, thus making epoxy unsuitable for really corrosive liquids.

Epoxy coating which have been stressed beyond their chemical resistance with strong solvents tend to soften: (test with your nails).
In such a case the coating must be given ample time to weather out "trapped solvents" and recover its hardness before being subjected to cargo or water again. Do not try to speed up the recovery by application of heat, the top skin of the coating may then first harden, leaving trapped solvent underneath, with flaking as a consequence. Ventilate with a good turbulence in all corners of the tank Hardness of epoxy coatings can be established by means of a standardized test procedures.

Epoxy coatings should normally not be heated above 60-80ºC. During tank washing, steaming etc. During the loaded voyage lower temperatures should be kept.

1.15.5.3 Phenolics

Have poor resistance to solvents but are fairly resistant to weak acid and alkalis. They are not used on board in chemical tankers to a great extent.
Maintenance of tank coatings means, above all, not to subject the coatings to non-permissible cargoes. Check with maker's recommendations. Limitations as regard pH-values, max temperatures and max permissible storage time on board must be followed. Aliphatic-polyester polyurethanes are thin film coatings that provide harder, more chemically resistant films (with the exception of alkali resistance). Color and gloss retention, and impact resistance is less than with aliphatic-acrylic types. Elastomeric Polyurethanes Aromatic polyurethanes modified with hydrogenated castor oil are typically used to manufacture elastomeric polyurethane coatings. Most formulations on the market use Toluene Diisocyanate (TDI) reacted with Polyols. These products provide good adhesion to steel and concrete when properly prepared. Moisture curing polyurethanes are most widely used as primers for steel. They use up substrate moisture, adhere well, and are fast to recoat. These primers are more often than not pigmented with aluminum or micaceous iron oxide. These pigments are generally manufactured moisture free and lower the permeability of the coating film.

1.15.6 Differentiate organic and inorganic coatings

Organic Coatings in the majority of cases are solvent based and can be applied by a wide variety of methods. Water based or reducible systems can also be considered, but with these products a little more care is required, especially with regard to paint shop conditions (temperature & humidity), and use of galvanized or stainless equipment.

Inorganic Coatings
By their very nature of being based on non-carbon chemistry, the-majority of inorganic coatings are slurries or dispersions carried in water. In view of this care must be exercised on storage to maintain a store temperature above 5°C minimum and below 25°C. As with water based organic coatings, paint shop temperature and humidity need more control. With the development of the polysiloxanes, inorganic coating systems have been introduced, which entirely consist of inorganic polymeric coating materials.

The polymerisation of monomeric silicon-oxygen building blocks to polysiloxanes in combination with organic substituent's on the side chains have resulted in the formulation of aliphatic polysiloxanes hybrid coatings. Because of their inorganic silicium-oxygen backbone, they have none of the failure characteristics of organic coatings. They are inert and do not continue to oxidize, and therefore do not have a tendency to check, crack or chalk on weathering or lose thickness. They are not affected by rain, dew, condensation, snow or cold. The coating is hard, glossy, and tightly adherent and has, in combination with primers, an outstanding resistance against corrosion at considerably lower total film thicknesses and coats than traditional coating systems.

With the introduction of epoxy polysiloxanes coatings with high solids, improvement in color and gloss retention and corrosion resistance mean that polyurethane topcoats are now redundant in anti-corrosive systems with consequently economic and health and safety benefits, resulting from fewer coats and the elimination of isocyanide toxicity.

1.15.7 Explain the use of rubber linings for highly corrosive cargoes

− Rubber lined tanks are suitable for corrosive cargoes such as Phosphoric Acid; but not suitable for Nitric Acid and sulphuric acids
− It is also used for Hydrochloric Acid and waste acids.
− The rubber lining can be of the Neoprene, Chloroprene, Nitrile and Butyl variety.
− Rubber is not suitable for vegetable oils, animal oils or solvents

As complex as rubber lining is, one of its greatest strengths is simply its thickness. Rubber linings are typically applied at a thickness of 3/16". Thinner linings may have similar chemical resistance, but when they start to degrade the chemical reaches the steel substrate at a much quicker rate. When a rubber lining begins to degrade, only the exposed surface is attacked while the rubber underneath remains intact. This allows additional time for the pinholes to be identified and repaired prior to substrate failure.

1.15.8 Explain the resistance of coatings to groups of chemicals

The general rules are:
Zinc silicate coatings are not resistant to caustic soda or alkaline cleaning chemicals. Epoxy coatings are resistant to petroleum products, caustic soda, vegetable oil, wine, seawater, fatty acids, limited resistance to alcohol and aromatics. Coal Tar epoxy is resistant to seawater, crude oil and petroleum products in general but should not be used for jet fuels or light oil. In certain cases the tank coating manufacturer gives a limited acceptance for a product (time and/or temperature). Avoid then placing heated products on the other side of the bulkhead. Let epoxy weather out properly after solvent cargoes.

For all Coated Tanks
− Do not load any cargo in coated tanks without verifying the manufacturer's Paint Resistance Tables to confirm the compatibility of a particular paint with a particular cargo.
− Even though a particular cargo may be shown in the list of cargoes in the COF, it is essential to verify the paint resistance list to confirm the compatibility and its limitations.

1.15.9 Identify the manufacturers 'coating resistance list

Instructor may display the list appended in Appendix 1 of this manual fig. 1.15.10 and state that:
For most cargoes the compatibility with most common coating systems can be checked automatically. The coating resistance lists of the major coating suppliers are integrated into some chemical ships software programs. For a displayed cargo, the coating in question can be selected. The result of the check is resistant, not resistant, or limited resistance (or not tested). In case of limited resistance the limitations are displayed.
There are tank coating guides available for references on older coated tanks chemical tankers also.

1.15.10 Describe in general terms maintenance of tank coatings

Maintenance and Repair of tank coatings

- Tanks must be cleaned and gas free.
- Any blisters present must be burst and blister caps removed from the surface.
- Heavy scale must be removed from all surfaces.
- Scale, debris and cargo residues must be removed from the tanks.
- All grease and oil must be removed from all surfaces.
- All hot work in way of tanks must be complete.
- Cargo suction strums (if fitted) should be removed in order to give total access.
- All tanks must be fresh water washed.
- Any areas of steel renewal should be prepared in the manner described under Steelwork Preparation.

Apply the coatings as per manufacturers' instructions.

1.15.11 Explain physical and chemical absorption of coatings and subsequent cargo contamination

For coated cargo tanks, the wall wash test is not just a measure of how clean the surfaces of the tanks are, it is also a measure of the amount of absorbed/ adsorbed residues that the wall wash solvent (usually methanol) is able to chemically extract from the outer layers of the coating.
Organic coatings readily absorb and retain low carbon chain molecules, for example lower alcohols, some aromatics, ketone, chlorinated solvents etc. and it is known that these products will stay inside the coating, until they are actively removed, either by tank cleaning methods or by extraction into a subsequent cargo. The degree to which they can be removed is largely influenced by their volatility. Inorganic (zinc silicate) coatings absorb the same types of cargoes, but because of the open/porous nature of the coating surface, these cargoes are generally not retained. However, due to their inherent porosity and their fairly rough surface profile, previous cargo residues may become absorbed and/or adsorbed into the coated surface and as a result some cargo residues may be retained, including non-volatile cargoes. These must be actively removed either by tank cleaning or by extraction into another cargo, otherwise they could pose a contamination threat to subsequently loaded sensitive chemical cargoes. In other words, if a cleaning chemical claims to be able to remove previous cargo residues to a standard where a wall wash inspection will be accepted, (in the case of cleaning coated cargo tanks) this actually means that the cleaning chemical must have the ability to penetrate inside the coating and remove traces of previous cargoes that may be residing there Clearly the challenge is to find surface active cleaning materials that can clean coated cargo tanks to a wall wash standard, before the use of tank cleaning solvents is prohibited, otherwise owner and charterers of chemical and product tankers will be facing serious tank cleaning headaches in the future as a result of contamination. It should be emphasized here by the instructor that whether the cleaning chemicals are for cleaning stainless steel or coated cargo tanks, for general use or for achieving a high purity standard, they should still be effective (particularly in view of the significant volumes that are used on board tankers today). It is known that zinc silicate coatings actively retain hydrocarbon based, non-volatiles'.

1.16 Slop management

1.16.2 Explain why the following should be avoided:

- **Mixing of slops from Annex I (oil) cargoes with slops from Annex II (chemical) cargoes; and**
- **Mixing of slops from incompatible cargoes.**

Discharge of Annex I and Annex II MARPOL cargoes are governed strictly by their corresponding regulations.

- Care should be taken to avoid mixing slops from cargoes which requires to be discharged as per OIL / NLS MARPOL regulations.
- Care should also be taken with cargoes which are incompatible and may react dangerously.

Some cargoes which are compatible with the coating may, when mixed with water or other incompatible cargoes, form acids and thus damage the coating.

1.16.3 Describe a slops-retaining system

Annex II does not require the fitting of dedicated slop tanks but slop tanks may be needed for certain washing procedures. Cargo tanks may be used as slop tanks. Every ship constructed on or after 1 January 2007 shall be provided with a pumping and piping arrangement to ensure that each tank certified for the carriage of substances in Category X, Y or Z does not retain a quantity of residue in excess of 75 litres in the tank and its associated piping. A stripping performance test shall be carried out in accordance Annex II.

2.0 Knowledge of pump theory and characteristics.

2.1 Explain the advantages of using a centrifugal pump as a cargo pump

The advantages of using a centrifugal pump as a cargo pump its simple construction, there being no valve in this construction, its relatively small size, because the pump can operate at high speed and there being no damage to the pump if the discharge valve gets closed during pumping

2.2 Explain the disadvantages of a centrifugal cargo pump and how the same can be overcome.

The disadvantages of a centrifugal cargo pump are:

- its having high efficiency only within a limited field
- its normally not being self-priming
- the backflow through the pump when it stops
- the difficulty of pumping high-viscosity liquids

The drawbacks concerning a low differential pressure per stage, self-priming and handling highly viscous liquids may be solved by submerging the pump in the liquid or by using priming equipment.
The drawbacks concerning backflow may be solved by using non-return valves.

2.3.1 Describe, by aid of a drawing, an open hydraulic system.

An open hydraulic system is one where the hydraulic fluid is returned into a unpressurized tank at the end of a cycle through the system.
Pump-inlet and return (via the directional valve) are connected to the hydraulic tank. Such systems use pumps which supply a continuous flow. The flow is returned to tank through the control valve. that is, when the control valve is centered, it provides an open return path to tank and the fluid is not pumped to a high pressure. Otherwise, if the control valve is actuated it routes fluid to and from an actuator and tank. The fluid's pressure will rise to meet any resistance, since the pump has a constant output. If the pressure rises too high, fluid returns to tank through a pressure relief valve. Multiple control valves may be stacked in series. This type of circuit can use inexpensive, constant displacement pumps.

2.3.2 Describe, by aid of a drawing, a closed hydraulic system.
A closed system is where the hydraulic fluid stays in one closed pressurized loop without returning to a main tank after each cycle.
Hydraulic motor-return is connected directly to the pump-inlet. To keep up pressure on the low pressure side, the circuits have a charge pump (a small gear pump) that supplies cooled and filtered oil to the low pressure side. Cooling can be a problem due to limited exchange of oil flow.

2.4 Explain why many deep-well pumps do not have non-return valves

Many deepwell pumps, available today have a capability to enable to load through the pump, the non-return valve if fitted would not permit loading.

2.5 Describe correct and safe handling of a deep well pump

The uses of deepwell centrifugal pumps are to ensure maximum quantity unloaded or minimum remaining on board. Dangerous chemicals, acids, oils or edibles must be handled in a safe way for people and environment. The chemical tanker must be equipped with cargo pumps that can efficiently empty cargo tanks and associated cargo piping to meet the most stringent requirements and withstand the tough impact during hours of tank cleaning afterwards, switch between cargoes without cargo contamination and carry anything from acids to drinking water.

Stripping

When the cargo tank is empty, the speed of the cargo pump is reduced to perform the final stripping of tank.
Purging and seal monitoring from deck level can be done on some types of Cargo deepwell pumps.
The pump's cofferdam is purged before and after discharge operations of a typical chemical tanker with deepwell pumps.

These pumps are purged, using inert gas (ship's IG or nitrogen) or air, as a means of checking for seal condition and tightness. The pumps must be purged before and after every loading/discharging/tank cleaning operation and the appropriate record form completed.

If the purging records indicate a deviation from the manufacturer's recommended parameters, such as pump cofferdam is blocked or excessive seal leakage being detected, the management office is to be notified and appropriate corrective action is to be taken at the first opportunity.

2.7 Explain total head

Total Head:
The total head of a pump is the difference between the pump suction and discharge pressures - expressed in terms of metres or feet head:
Static Total head is the total head with pump not running.
Dynamic total head is the total head with pump running.
Suction Head:
This is the vertical distance, in feet or metres, from the centerline of the pump to the level of liquid in the vessel from which the liquid is being pumped.
If the liquid level is above the pump centerline, the suction head is positive.
If below the centerline, the suction head is negative.
Static suction head is the suction head with pump not running.
Dynamic suction head is the suction head with pump running.

Discharge Head:
Is the discharge pressure of the pump, expressed in feet or metres of liquid.
Static discharge head is the discharge head with pump not running.
Dynamic discharge head is the discharge head with pump running.

Total Head: = Discharge head -Suction head

2.8 Explain the benefits of showing the pump's capacity as a function of total head which is independent of the liquid density

Total head is independent of the density of the liquid.
Capacity is defined as the quantity of liquid which is discharged from the pump in a given time. Capacity is expressed in 'm^3/hr', 'gal/min', etc. The capacity of a pump is governed by the 'Head', the 'Speed' and the 'Size' of the pump – not the specific gravity.

In the case of a variable speed pump:
- Head varies as the square of the speed.
- Capacity varies directly as the speed.
Power varies as the cube of the speed since it is a function of head and capacity.

2.9 Explain design point, NPSH, cavitation and its effects

The difference between the maximum theoretical suction lift and the pumps permissible suction lift is the pump's net positive suction head above the liquid vapour pressure, abbreviated as NPSH. It is important to state the difference between available NPSH and required NPSH.

Design Point or BEP (best efficiency point)
The efficiency of the pump at the designed point is normally maximum and is called the Best Efficiency Point - BEP
It is possible to operate the pump at other points than BEP, but the efficiency of the pump will always be lower than BEP. BEP is located somewhere between 80% and 85% of the shut off or maximum head. To maximize the life of the pump you should operate the pump as close to the BEP as you can.

Cavitation is one of the disadvantages of the centrifugal pump. It can occur in centrifugal pumps and other devices where a sudden pressure reduction occurs. It is most often associated with handling liquids that are close to their boiling point, when the reduction in pressure causes the boiling point of a liquid to be reduced and hence boiling can occur. This will result in the production of vapour bubbles. In a centrifugal pump this is most likely to happen at the suction [inlet] of the pump where the pressure is at its lowest value. The vapour bubbles formed pass along the impeller to the discharge side of the pump replacing liquid and reducing the output of the pump. Once the bubbles reach the discharge the greater pressure there causes the bubbles to collapse and burst. This collapse produces forces so large that small pieces of metal can be physically knocked out of the impeller or case leaving small holes The bubbles can also cause the impeller to run out of balance creating excessive vibration. Three signs that cavitation is occurring in a pump are a distinctive crackling noise due to the collapse of the bubbles; excessive vibration; reduced output. Cavitation can often be reduced or overcome by partly closing the discharge valve or reducing pump speed, which increases the internal pressure in the pump and thus helps prevent the formation of vapour bubbles.

2.10 Explain the Pump curves and their relationship

Head, (H) in the QH-curve
The QH-curve shows the head, which the pump is able to perform at a given flow. Head is measured in meter liquid column [mLC]; normally the unit meter [m] is applied. The advantage of using the unit [m] as the unit of measurement for a pump's head is that the QH-curve is not affected by the type of liquid the pump has to handle.

The efficiency is the relation between the supplied power and the utilized amount of power. The efficiency is the relation between the power, which the pump delivers to the water (PH) and the power input to the shaft (P2).

As it appears from the efficiency curve, the efficiency depends on the duty point of the pump. Therefore, it is important to select a pump, which fits the flow requirements and ensures that the pump is working in the most efficient flow area.

Power consumption, (the P2-curve) The relation between the power consumption of the pump and the flow is shown in figure 2.0 in Appendix 1, Part D. The P2-curve of most centrifugal pumps is similar to the one in figure 2.0 where the P2 value increases when the flow increases.

NPSH-curve (Net Positive Suction Head). The NPSH-value of a pump is the minimum absolute pressure that has to be present at the suction side of the pump to avoid cavitation.
The NPSH-value is measured in [m] and depends on the flow; when the flow increases, the NPSH-value increases as well; figure 2.0

With reference to the appended Figure 2.0 The typical Q-H curve shows that the maximum head is about 130 metres liquid column (mlc), where the output is of course zero. On the curve is shown the so-called design point, at a head of 100 mlc, giving an output of 115 m^3/h; this point represents the most economical working condition of the pump. The curve of efficiency also shows this, giving a maximum efficiency of 51 %.

At the bottom is a curve for NPSH (Net Positive Suction Head). The curve refers to the suction side of the pump and can best be explained as the absolute pressure on the suction side that is necessary to keep the pump full of liquid if the vapour pressure of the liquid were zero. To keep the pump working correctly, the pressure on the suction side has to be greater than NPSH + VP to keep the pump from cavitating. Note that the greater the discharge rate, the greater the NPSH.

In the case of a variable speed pump:

- Head varies as the square of the speed.
- Capacity varies directly as the speed.

2.11 Explain how a Q-H curve can be drawn for two pumps running in parallel
Two centrifugal pumps connected in parallel

With two pumps running the flow rate curves intersect at a higher head (B) see figure 2.0 Appendix 1 Part D. and a greater capacity than if one pump was running. To determine the flow of an individual pump while both are running, trace back at that combined head to the single pump curve and read the flow for each pump at "G", see figure 2.0Appendix 1 Part D. With two pumps running, the system head is higher causing each pump to reduce its capacity a little.

2.12 Explain how actual discharge rate depends on:
2.12.1 Static back pressure
2.12.2 Dynamic pressure

.1 The **static back pressure** is a function of the pressure due to static head (vertical distance of the discharge pipe) and pressure head (height of liquid in the tank to be filled) and head loss due to friction in piping, valves and fittings.
The static and pressure heads remain constant in most systems.

.2 **Dynamic pressure**

Reference in drawn to figure 2.0 Appendix 1 Part D. Looking at the Q-H curve, the pump must operate at some point of this curve. The actual point is determined by the shore curve representing the pressure, which the pump has to work against. This head is partially due to a static pressure (which is determined by the difference in height between the tank ashore and the connection to the ship at the jetty) plus the pressure in the shore tank. To this is added a dynamic pressure, due to resistance in the line and which grows with increasing output of pumps. It is th friction head that varies with the pump's capacity. The higher the flow, the more the friction (or head) loss in these components. Friction loss varies by approximately the square of the resistance. Twice as much flow produces almost four times the friction losses.
Before the start of pumping it is the static pressure, which is measured at the manifold.

2.13 Explain the danger of running two or more pumps in parallel if their characteristics are not exactly the same or if the pumps are running at different speeds.

Some types of centrifugal pumps are not fitted with a non-return valve. If running two or more pumps in parallel if their characteristics are not exactly the same or if the pumps are running at different speeds, the higher flow rate will create a back pressure on the lower flow rate pump which will result in the back flow of cargo and result in filling up that tank. The pump running at lower speed could be damaged due to this.

2.14 Describe, with an aid of a drawing, a stripping arrangement using an eductor

Eductors are a kind of jet-type pump that do not require any moving parts to be able to pump out a liquid or gas from a certain area. These pumps make use of their structure to transfer energy from one fluid to another via the Venturi effect. The structure of the pump is such that it has an injector chamber with a narrow shaped nozzle or tapered jet that is located inside the chamber and points axially towards the exhaust chamber to increase the pressure of the motive fluid as it enters the eductor. At the bottom of this nozzle is an opening that is used to suck in any form of fluid or other substance that needs to be extracted from a certain environment. The suction happens due to Venturi effect that creates a drop in pressure at the tip of the nozzle due to the fast flowing motive fluid which has gained kinetic energy due to the tapered shape of the nozzle. This difference in pressure causes the desired fluid to be sucked into the eductor and mixed into the flow stream to be guided out of the eductor.

These pumps are able to carry out stripping of cargo tanks in circumstances where other pumps might not be able to function. Liquids that cannot be pumped using other pumps can be extracted through eductors such as liquid that may contain particles of solid or foreign matter. The portability of these pumps allows them to be used in various applications. However, an important thing to note would be that not all of the fluid that an eductor discharges comes from the compartment that is being stripped.

2.15 Describe, the stripping operation with an aid of a drawing, with a stripping arrangement using a deep well pump designed for stripping

A well maintained and properly operated deepwell pump will drain a cargo tank almost as dry as a reciprocating stripping pump. At the end of the discharge there may remain a small amount of cargo in the tank and the pump well will be full, or partially full, of cargo. Reference is drawn to figure 2.0 Appendix 1 Part D. where on a typical vessel the pump is stopped on loosing suction. The liquid from the main discharge line is pushed towards the manifold to clear the line with air/ nitrogen as required after shutting the pump stack valve. The pump has to be restarted at low RPM (typically 80 to 100 bars pressure.) and Air/ nitrogen has to be purged through the stripping line which shall in turn push the cargo through the stripping line/ cargo line to the manifold.

3.0 Proficiency in Tanker safety culture and implementations of safety management systems

All the topics in this General Learning Objective is of the Knowledge category where required specific learning objectives cover the learning pattern. The pointer being that IMO's major function is to make shipping of all types safer. The measures incorporated in the numerous safety conventions and recommendations apply to various types of ships - and the safer a ship is, the less likely it is to be involved in an accident.

Important to state here is the topic should not turn out to be another paper exercise but inculcate the student with how best he requires to know the available safety instruments contents and how he can use it to fulfil his own desires of working safely. Safety does begin at the top. A DPA must be genuinely interested in ensuring safety within the organization this has to percolate down to the Ordinary Seaman within the purview of the available instruments of ISM, COSWP, FSS and TMSA.

3.1 Describes the importance of ISM Code for chemical tankers

The International Safety Management (ISM) Code was adopted in 1994 and became mandatory for tankers in 1998. The ISM Code imposes strict standards on shipping companies.

1 The purpose of this Code is to provide an international standard for the safe management and operation of ships and for pollution prevention.
2 it invited all Governments to take the necessary steps to safeguard the shipmaster in the proper discharge of his responsibilities with regard to maritime safety and the protection of the marine environment.

3 it further recognized the need for appropriate organization of management to enable it to respond to the need of those on board ships to achieve and maintain high standards of safety and environmental protection.

4 Recognizing that no two shipping companies or ship-owners are the same, and that ships operate under a wide range of different conditions, the Code is based on general principles and objectives.

5 The Code is expressed in broad terms so that it can have a widespread application. Clearly, different levels of management, whether shore-based or at sea, will require varying levels of knowledge and awareness of the items outlined.

6 The cornerstone of good safety management is commitment from the top. In matters of safety and pollution prevention it is the commitment, competence, attitudes and motivation of individuals at all levels that determines the end result.

3.2 Describes how OCIMF's Tanker Management and Self-Assessment (TMSA) programme can help vessel operators assess, measure and improve their management systems.

The instructors have to make the trainees appreciate that the (TMSA) programme encourages vessel operators to assess their safety management systems against listed key performance indicators and provides best practice guidance.
TMSA is an effective way to minimise the possibility of problems reoccurring and it creates opportunities and optimizes performance in crucial areas such as safety and environmental excellence.

4.0 Knowledge and understanding of monitoring and safety systems

4.2 Explain why the monitoring of atmosphere in gas dangerous and gas safe zones must be carried out regularly

The regular monitoring of atmosphere in gas dangerous zones is to be carried out to ensure no flammable or toxic gases have leaked.
Gas safe zones must be monitored regularly for ensuring safety to personnel in case of any hazardous, flammable or toxic vapour leakages entering the safe zone.

4.3 Explain closed monitoring of tank contents

Chemical tankers in requirements with the Chemical codes will need the means to enable closed or restricted monitoring of tank contents to prevent the escape of dangerous or hazardous vapour into an environment which may be harmful to the health of personnel.
Some of the closed monitoring equipments used on chemical tankers are:

- Gauging equipment which measures the level of product in the tank and provides the information to a remote display;
- One or two high level alarms, working independently of the gauging equipment, which trigger an alarm when the level of cargo in the tank nears the maximum capacity;
- Pressure sensors which measure the pressure above the cargo and provide a warning should pre-set over pressure or under pressure settings be exceeded;
- Temperature monitoring sensors which measure the temperature of the cargo at different levels in the tank and provide the information to a remote display; and

Some tanks are fitted with gas sensors which automatically measure the oxygen content and the concentrations of selected gases within the space and provide the information to a remote display.

4.4 Explain how exposure levels in all work locations should be monitored

Exposure levels in all work locations should be monitored by using suitable instrumentation for detecting and measuring the concentration of the gases involved.
There are 3 basic types of measurement:

Short term or 'spot' measurements

- These are measurements taken over a short time period (e.g. a few minutes) a single point in the ships workplace. They give a rough indication of the concentration at a particular time and location after an observed leak.

Measurement of average concentration over a given time period

- These measurements, represented by the TWA, are particularly useful for measuring personal exposure by sampling air from the various hazardous and safe locations of a ship. The results can be compared directly with OELs.

Continuous measurement of concentration at fixed locations

- These provide a continuous measure of the concentration of certain gases in various fixed locations by gas detectors in a fixed time cycle in the designated locations of a ship.

4.5 Explain why Bridge, control room, accommodation and engine spaces atmosphere should be monitored regularly

Bridge, control room, accommodation and engine spaces classified as per the BCH / IBC codes as Safe Zones on a chemical tanker still needs the atmosphere to be monitored regularly for the safety of personnel in case hazardous gases which may have leaked from the Gas dangerous area have entered the safe zone.

4.6 Explain why chemical tanker personnel should always have personal monitors for toxic cargoes when gauging, sampling, entering a pump-room, connecting and disconnecting loading lines, cleaning filters, draining to open containments and mopping up spills etc.

Chemical tanker personnel should always carry personal monitors when gauging, sampling, entering a pump-room, connecting and disconnecting loading lines, cleaning filters, draining to open containments and mopping up spills as vapour concentrations may exceed the TLV-TWA with toxic cargoes on board or previously loaded.

4.7 Explain why some flammable gas monitors (Explosimeters) should not be used for measuring gas in inert atmospheres.

Most flammable gas monitors (Explosimeters) should not be used for measuring gas in inert atmospheres as they have a pellistor as the sensing element. For the purpose of combustion pellistors rely on the presence of oxygen (minimum 11% by volume) to operate efficiently.

4.8 Describe Fixed Gas Detection Installations

It is important to state here that fixed gas detectors may not be able to recognize all the chemicals that are transported on chemical tankers but may be restricted to only a few flammable vapours.
Fixed gas detection systems
There are two types of gas detection system commonly used on board Chemical carriers, a sampling system and a gas detection system incorporating remote heads.

The sampling system draws gas samples from each monitored location into a central analyser located in a 'safe' area. Typically, samples will be drawn from cargo areas in a pre-programmed sampling sequence and will be passed through an infrared analyser. The system alarms get activated if pre-set limits are exceeded.
Remote detector heads may also be used to monitor gas concentrations. The signal from flameproof infrared gas detectors will be passed to a central control unit having visual and audible alarm functions.

Some chemical gases over time may have a damaging effect on electronic instruments hence detector tubes may have to be used

4.13 Explain the importance of continuous gas monitoring

Void and ballast spaces located within the cargo tank block should be routinely monitored to check that no leakage has occurred from adjacent tanks.
Tank pressures and pressures within vapour collection piping systems should be continuously monitored by sensors that incorporate high and low pressure alarm functions connected to audible and visual alarms and ensure safety in case of under or over pressures within.

4.14 Explain the use of the emergency shutdown system

Automatic shutdown valves may be fitted on the ship and ashore. The action of these is automatically initiated by, for example, a certain level being reached in the ship or shore tank being filled. Where such systems are used, the cargo handling rate should be established to prevent pressure surges from the automatic closure of valves causing damage to ship or shore line systems. Alternative means, such as a re-circulation system and buffer tanks, may be fitted to relieve the pressure surge created. A written agreement should be made between the Responsible Officer and Terminal Representative indicating whether the cargo handling rate will be adjusted or alternative systems will be used.
An emergency shutdown procedure is required to be agreed between ship and shore, as per the safety check list formally recorded and signed by both the Responsible Officer and Terminal Representative.
The agreement should state the circumstances in which operations have to be stopped immediately. Due regard should be given to the possible introduction of dangers associated with the emergency shutdown procedure.

Topic Loading, unloading, care and handling of cargo during the chemical tankers voyage cycle :

5. Ability to perform cargo measurements and calculations:

5.1 Explain 98% filling limits of a cargo tank

Cargo tanks should be so loaded as to avoid the tank becoming liquid-full during the voyage, having due regards to the highest temperature that the cargo may reach.

As per IBC code reference temperature is defined as the temperature at which the vapour pressure of the cargo corresponds to the set P/V valve pressure.
The filling limit requirements for some cargoes are specified in the IBC code chapter 15.(Instructor to refer to the examples in the IBC code 15.3.23, 15.8.26.2 and 15.14.7.2 respectively) The maximum allowable tank filling limits for each of these cargoes is to be shown from the code.

Liquid full calculations as stated in the IBC codes for typical cargoes where applicable should be worked out.

5.2 Identify documents and information requirements to be used in cargo calculations

The range of chemicals shipped in bulk now has been increased enormously and to maintain product quality, the specific gravity and cargo density need to be often determined at loading and discharging ports.
Specific gravity expresses the weight of a unit volume of a matter compared with the weight of the same volume of water, both at a defined (but sometimes different) temperature. Expressions such as SG 20/20°C are used in the petroleum industry. The first figure denotes the temperature of the product and the latter the temperature of the water used as a comparison. Specific gravity includes the effect of air displacement.
The hydrometer consists of a displacement body with a graduated scale. The accuracy in reading gives a maximum of three correct figures, the fourth figure being doubtful. This means an accuracy of 0.1 to 0.2%. This accuracy is generally insufficient for cargo quantity determination. The hydrometer is, however, well suited as an instrument for a general check of cargo density on board. A set of hydrometers for suitable density ranges should be on board depending on trade.
Specific weight/density is part of all product specifications as a check on concentration, mixture etc. The SG/density falls with the rising temperature. Volume correction factors are used for recalculation (per °C or °F) or tables (for petroleum products) available from, e.g. American Petroleum Industry (API).
A warning: It sometimes happens that cargo density and thus the quantity is determined at both the loading end and the discharge end by means of hydrometers. Obviously therefore there will be discrepancies in the two quantity determinations simply due to the relatively poor accuracy in the density readings. As a result questions regarding cargo claims may arise. The answer is to use the "as loaded density" (whether completely correct or not) and correct it for the change in temperature at the discharge end. This "calculated" density is then used in the quantity determination upon discharge. Thereby it can be established with good accuracy whether cargo has been lost or not.
There are also other specific gravity scales.
Further reference are available at: ASTM standard D 1298-67 (API 2547).

5.2.2 Explain Specific Gravity, Volume and Density Correction factors

Both Volume and density correction factors are based on the same physical phenomenon.
Fluids or solids expand when heated but the mass or weight remains unchanged => the density decreases
Relation between change in temperature and change in volume is expressed by the coefficient of volume expansion
Relation between density and temperature. Coefficient of volumetric expansion is not always linear (does not expand uniformly, acts like anomalous expansion of water).
Knowledge of the coefficient of thermal expansion of a liquid is essential to compute the required size of a cargo tank to accommodate a volume of liquid over the full temperature range to which it will be subjected. Since the coefficient of expansion of petroleum is non-linear (Not in a straight line, ASTM tables are to be used.) For many chemicals this function is linear and hence application of the density correction factor or coefficient may be used for cargo calculations Curve is described by the ASTM-VCF tables.

- For a small temperature range curve can be replaced by tangent line.
- Inclination of this line is better known as the Density correction factor (DCF or Density correction coefficient (DCC)

- Density correction factor (DCF or Density correction coefficient (DCC) = Density correction per degree centigrade.

Examples of DCF:

Caustic Soda (50%)	-	0.00070
Ethanol	-	0.00079
Glycerin	-	0.00063
i-pentane	-	0.00097
Latex	-	0.00100
Acetone	-	0.00114

Specific gravity expresses the weight of a unit volume of a matter compared with the weight of the same volume of water, both at a defined (but sometimes different) temperature.
Expressions such as SG 20/20 are used in the tanker industry. The first figure denotes the temperature of the product and the latter the temperature of the water used as comparison.
Specific gravity includes the effect of air displacement.
The specific gravity of water varies as follows:
04˚C is 1.0000
15˚C is 0. 9982
20˚C is 0.9913

Cargo related exercises

Ex. I. If a specific gravity SG 20/20˚C of a substance is to be converted to SG 20/4˚C (Note SG 20/20 means SG of substance @ 20˚C/SG of water @ 20˚C)
Let SG 20/20 of say, Caustic soda = x,

SG of Caustic Soda @ 20˚C = x X S/G Water @ 20˚C
SG of Caustic Soda @ 20˚C = x X 0.9913

or

$$\frac{\text{SG of Caustic Soda @ 20˚C}}{\text{S/G Water @ 4˚C}} = \frac{x \text{ X } 0.9913}{1}$$

Ex. II. Similarly: Convert specific gravity SG 20/4˚C of caustic soda to SG 20/20˚C
Let SG 20/4˚C of Caustic Soda = y
SG of Caustic Soda @ 20˚C = y X S/G Water @ 4˚C
SG of Caustic Soda @ 20˚C = y X 1

$$\frac{\text{SG of Caustic Soda @ 20˚C}}{\text{S/G Water @ 20˚C}} = \frac{y \text{ X } 1}{0.9913}$$

multiply as follows :
S/G 20/4 = SG 20/20 x 0.9913 /1.0000(S/G Water @ 4˚C)

Ex. III. Other examples: If a specific gravity SG 15/4˚C is to be converted to SG 15/15˚C.

$$\frac{\text{SG of Caustic Soda @ 15˚C}}{\text{1.0000(S/G Water @ 4˚C)}} = z$$

SG of Caustic Soda @ 15˚C = z X 1.0000(S/G Water @ 4˚C)

$$\frac{\text{SG of Caustic Soda @ 15˚C}}{\text{S/G Water @ 15˚C}} = \frac{z \text{ X } 1.0000\text{(S/G Water @ 4˚C)}}{0.9982}$$

The tendency is now to use metric units in cargo calculations. The expression specific gravity is then substituted by density and weight with mass. Density is expressed in absolute figures viz. kg/m^3 at a defined temperature.
A recalculation from specific weight to density involves a correction for the displacement in air by means of a vacuum factor.

$$\text{Density} = \frac{\text{Specific Gravity}}{\text{Vacuum Factor}}$$

The vacuum factor varies slightly with density (specific gravity):

Density	Vacuum Factor
1.0	1.00108
0.9	1.00122
0.8	1.00139
0.7	1.00161

5.2.3 Calculate cargo quantities using Density correction factors for unsaturated hydrocarbons

EXERCISE: Q1. After loading a chemical in an empty tank the following readings are taken: Trim= nil; corrected sounding= 7.125 m; temp of liquid = +27°C, The density of cargo at 15°C is 1.550 KG/M^3
Density correction factor is .00070 / °C. what is the mass of the liquid?

Note: extracts of all graphs, sounding tables etc. have to be shown
Sol1: (vol. Calculation)
Sounding = 7.125 m
Using tables volume@27°C = 1234.26 m^3

(density calculation)
density @ 15°C = 1550 kg/ m^3
therefore density @ 27°C = 1550 - 12(.00070)=15416 kg/ m^3

(mass calculation)
mass = vol@27°C x den@27°C = 1234.26 x 15416 = 19027352 kg = 19027.4 MTS

5.2.4 Determines Cargo quantities for Petro chemicals using ASTM Tables

CARGO CALCULATIONS FOR PETROCHEMICALS (e.g.: Naphtha, Benzene...)
The basis of these calculations is that a volume measured at a certain temperature is corrected to a standard temperature by means of a volume correction factor. This corrected volume is called Standard Volume.
From this standard volume we calculated Mass or Weight by means of a Weight Correction Factor of a Density at this standard temperature.
The procedure is explained below:
- With observed density and temperature find the density from ASTM tables
- With observed temperature and density at 15°C find VRF from ASTM tables
- From density at 15°C subtract 0.0011 to get WRF. (Weight reduction factor)
- Obtain the observed volume from ship's ullage tables and multiply by VRF (Volume Reduction Factor) to obtain volume at 15°C. (Weight in Vacuum or Mass)
- Volume @ 15°C x WRF = Quantity in metric tons. (weight in air)

Qty.in Mts x 1.0161= Qty. in long tons.

6.0 Knowledge of the effect of bulk liquid Cargoes on trim and stability and structural integrity. Exercise on Simulators/PC

6.1 Perform stability calculation

This topic is best covered on a simulator Loadicator where the effects of SF and BM parameters can be promulgated by the instructor. If such a simulator/PC is unavailable then a print screen of such an example is appended which can be made use of to explain the effects of bulk cargoes on the trim and stability and structural integrity. It is also important for the instructor to emphasize when loading high density cargoes, it is necessary to stagger the loading of tanks to reduce the load concentrations at those frames. The instructor has to emphasize here that the ship's master is provided with sufficient number of approved loading conditions to be used for the loading of the ship. In general, for non-approved loading conditions, approved KG/GM limit curve(s) or approved loading instrument software satisfying the stability requirements (intact and damage) for the draught range to be covered should be used to verify compliance on board.
In absence of simulator, loadicator software of a chemical tanker can also be used on a PC. In case such a facility is unavailable then use printouts of the loading plan print out appended in 7.1 Appendix 1 Part D and explain each condition there from.

6.2 Explain the use of trim and stability approved manuals and the requirements to maintain a sea-going condition throughout Loading and unloading operations with respect to structural integrity.

Some trim and stability manuals only deal with arrival and departure conditions and vessels may not be aware that stability problems may exist during intermediate conditions.
Approved stability booklet provided on board should be consulted to determine restrictions with regard to maximum trim, forward draft and slack tanks.
The loading and unloading operations shall be completed in such a manner so as ensure that while at sea the vessel complies with safe trim requirements.
Many ports require that throughout loading and unloading conditions vessel's propeller remains fully immersed at all times and may also have restrictions on maximum trim.
It is required to comply with the approved stability booklet for the vessel and endeavour to have minimum slack tanks to prevent sloshing damages.

7.0 Knowledge and understanding of chemical cargo-related operations, including:

7.1 Loading and unloading plans
7.1.2 Explain important operational requirements from the Codes with respect to the cargo to be handled.

For each cargo the codes set out specific requirements for carriage of cargo (Ch 17).
For some specific cargoes the codes require plans to be approved by the administration. Codes also set detailed requirements for, the separation of cargo, accommodation and machinery spaces; segregation of different types of cargoes; controls and instrumentation for cargo handling equipment; control of conditions within cargo spaces and venting from them; piping and pumping arrangements; electrical installations; firefighting and extinguishing systems; and personal protective equipment.

The IBC Codes also list cargoes, identifying the hazards each presents during carriage by sea. Cargoes which are assessed as presenting a safety or pollution hazard to such an extent as to warrant protection are required to be carried in designated ship types providing the appropriate degree of protection.

7.1.3 Describe the stowage plan and its role in preplanning

The codes require a cargo stowage plan to be kept in an accessible place, indicating all cargo on board, including each dangerous chemical carried:

.1 a full description of the physical and chemical properties, including reactivity, necessary for the safe containment of the cargo;
.2 action to be taken in the event of spills or leaks;
.3 countermeasures against accidental personal contact;
.4 firefighting procedures and firefighting media;
.5 procedures for cargo transfer, tank cleaning, gas-freeing and ballasting; and
.6 for those cargoes required to be stabilized or inhibited, the cargo shall be refused

if the certificate required by these paragraphs is not supplied.

In addition to above for quick reference throughout the cargo operations onboard chemical tanker it is responsibility of ships chief officer to prepare a loading/discharge programme, which is to include, but not be limited to, the following (note additional information can be appended):

- Special requirements as per Flag state, local Authorities, Certificate of Fitness, IBC code, Stability and Class
- Final ullages for all loaded tanks against loading temperature.
- The order of cargo/ballast tanks to be filled/emptied together with the expected time schedule showing which pumps (if applicable) would be in use.
- The number of controlled stages required depending on intended cargo operation and ship's design.
- The required ballast condition for each stage of the operation.
- The expected stress, stability and draught conditions at each stage of the operation and damage stability verification as per IBC code
- The operating envelope of shore loading/discharge arms
- Coating Compatibility
- Density, temperature and other relevant properties (Hazard, Flammability & toxicity)
- Heating requirements
- Toxicity of cargo
- USCG cargo compatibility
- Quantity and grade of each parcel
- Transfer rates and maximum allowable pressure
- Cargo Pollution Category
- Fire protection including fire fighting
- Notice of Rate Changes – Venting requirements, over and under pressurization
- Vapour emission control requirements
- Emergency stop procedures
- Antidotes and Toxic Gas detectors for each cargo as applicable
- Action to be taken in event of exposure, fire and spill
- Protective equipment requirement, antidotes and toxic gas detectors
- Tank environment control as per IBC code (Inerting, Blanketing, Padding requirements)
- Precaution against Static generation.
- UKC Limitations
- Crew familiarity

The Chief Officer, in conjunction with another officer, will ensure that all valves on the cargo and ballast systems, including the pump-room, whether in use or not, are correctly set for the intended operation.
The Cargo Loading/Discharge Plan is to be approved by the Master and signed by each Officer involved in the cargo operations. Junior Officers should, whenever possible, be actively encouraged to assist in cargo planning, line setting and the execution of ballast and cargo activities. This plan is to be discussed and agreed in writing with the terminal personnel as described in these procedures.
All rules, conventions and established industry practices must be complied with when preparing/planning cargo loading operations.

Following deal with some such requirements to be followed:
1. Load Line Convention
2. IBC Code/BCH Code
3. Certificate of Fitness
4. Ship's stability information
5. Resistance list for stainless steel
6. Resistance list for cargo tank coatings where applicable
7. Cargo hose resistance list
8. Annual developments for handling approved chemicals from MEPC 2/Circ.
9. Product information
10. Chemical Hazard Data Sheets / Safety Data Sheets
11. Tank filling Limits
12. P&A Manual
13. U.S. Coastguard Compatibility Chart
14. USCG CHRIS code (Condensed)
15. ICS Chemical Tanker Safety Guide
16. ISGOTT
17. Local Regulations

Reactivity considerations for adjacent tanks must be taken using the compatibility charts available.
Some chemical cargoes are not compatible and may even be reactive with water therefore, due consideration is necessary to avoid stowage of such cargoes adjacent to the water ballast tanks. It is also a requirement that the heating coils are to be blown through, cleaned and blanked off, or thermal oil used as a heating medium.
It is recommended that a cargo to be heated is not stowed adjacent to cargoes which have a low boiling point because the excess evaporation will result in consequent cargo loss and possible vapour hazards. As a safe margin, the maximum temperature of the heated cargo must be 10°C below the boiling point of the unheated cargo.
Heated cargoes must never be stowed adjacent to self-reactive cargoes since excess heating of self-reactive cargoes will shorten the life of the stabilizing inhibitor. For inhibited cargoes a certificate in which the following items are shown must be given by the shipper, or the manufacturer of the cargoes.
• Name and amount of inhibitor added;
• Date inhibitor was added and the length of its effectiveness;
• The action to be taken should the length of the voyage exceed the effective lifetime of the inhibitor;
The Company and Charterers must be informed immediately if a product inhibitor certificate is not made available.

Compatibility with the Coatings of the Cargo Tanks:
The suitability of the coating of tanks for loading various chemicals and products must be checked against the paint manufacturer's data sheets before cargoes are assigned to tanks. Also temperature limits imposed by the relevant coatings are not to be exceeded.
Epoxy coatings are capable of absorption of certain chemicals, which could later be released resulting in contamination of future cargoes and possible safety hazards. Similarly "metal pick-up" form recently applied zinc coatings could contaminate sensitive cargoes.
Important to note here that Toxic chemicals, as defined in the BCH/IBC Code, must not be carried as the last cargo immediately prior to edible oils or stowed in adjacent tanks sharing common bulkheads with tanks containing edible oils. Likewise, lengths of pipeline serving tanks containing such toxic products must never run through tanks containing edible oils and vice versa.
For details, refer to FOSFA International (Federation of Oils, Seeds and Fats Association) published list and procedures.
The Carriage of Oils and Fats (Contract Referred Documents) includes a protocol for preventing contamination during the shipping of oils in bulk by sea. This protocol includes the FOSFA lists of banned and acceptable previous cargoes. This list has to be checked and complied with prior loading the next cargo.

7.1.4 Explain the importance of "Correct technical Name" and other relevant information necessary prior to the making of a loading plan.

Any cargo to be loaded should be indicated in the shipping documents by the correct technical name, chapter 19 of the IBC code refers to the correct technical name of all chemicals and must be referred to when planning stowage.
Identify requirements as stated in the respective chapters of the IBC code for stowage and loading precautions, inhibitor requirements and from where this information is obtained.
Additional cargo information giving the necessary data for its safe carriage should be on board and available to all concerned.
The information required for the safe carriage of chemicals as from the MSDS, COF, Tank Cleaning guide, P and A manual, Charterers Instructions etc. should be available.
The cargo should be refused if sufficient cargo information is not available.

7.1.5 Identify requirements for inhibitors and where this information is obtained

The IBC Code gives the special requirements of each cargo to be carried in column O of chapter 17. If cargo is of such a nature that needs chemical application to remain stable and preserve its characteristics, such as inhibitor application, then, such inhibitor which is to be supplied by the shipper, will be applied as per written instructions of the shipper which includes a certificate of inhibition. The IBC/BCH code requires that the shipper must provide this information.

7.1.7 Describe the precautions to be taken prior to loading over the top

Turbulence increases the generation of static electricity. Therefore splash filling, where the cargo is allowed to freefall into the cargo tank from an open ended hose, should be avoided. Where splash filling is a custom of the trade, for example with certain vegetable oils and wine, then a risk assessment should be carried out to address any potential risks, including damage to the cargo. Below are precautionary considerations for risk assessments prior loading over the top.
Volatile petroleum, or non-volatile petroleum having a temperature higher than its flashpoint minus 10ºC, should never be loaded over the top into a non-gas free tank.
There may be specific port or terminal regulations relating to loading over the top.

Non-volatile petroleum having a temperature lower than its flashpoint minus 10ºC may be loaded over the top in the following circumstances:

- If the tank concerned is gas free, provided no contamination by volatile petroleum can occur.
- If prior agreement is reached between the Master and the Terminal Representative.
- The free end of the hose should be lashed inside the tank coaming to prevent movement.
- Ballast or slops must not be loaded or transferred over the top into a tank that contains a flammable gas mixture.

7.1.8 Explain the procedures for cargo sampling and the need for taking various cargo samples at different locations at the load port.

Sampling is necessary because of quality control and avoiding claims at later date.

The cargo samples should be sealed and marked on board, particularly if no independent surveyor is present.

Requirements for taking samples vary; however it is common for samples to be required as follows:

- Manifold sample at commencement of loading (from each shoreline, if more than one);
- First foot sample from each tank during loading;
- Final running sample from each tank after loading;
- Composite sample of final tank after loading

Most chemical tankers are fitted with closed type gauging and sampling but ship's personnel may sometimes come under pressure from shore personnel to sample and gauge cargo from an open hatch. The ship should refuse such requests unless the cargo poses no risk.

Closed sampling systems:
Must be used for inerted or toxic cargoes and as designated in the IBC Code as requiring closed venting &/or Restricted gauging.
Closed sampling employs the same vapour lock system as the tank gauging equipment can be used to take cargo samples. Exposure to cargo vapours is eliminated when properly used.
Various types of sampling receptacles can be attached to a closed gauging device in order to obtain bottom samples or representative samples drawn from various levels within the cargo.
Another type of closed sampling device is one in which cargo flow is directed from the fixed piping system to an assembly where it is injected into a sealed sample bottle.
Restricted sampling systems:
A restricted sampling system results in minimal exposure from the product.
The most common restricted sampling system is one in which product is drawn from the fixed piping system by means of a sampling nozzle and directed into a open sample bottle. Once again, this does not eliminate the requirement to wear cargo specific PPE when sampling.
Open sampling system
An open system uses a sample catching device lowered into a tank via an open hatch. The device may consist of a sample bottle lowered directly into a tank or it can be some other open container which is then used to transfer samples to bottles at the cargo deck level.
While IBC Chapter 17 does not designate which sampling system should be employed for the various cargoes, it is recommended that ship's staff align their sampling procedures with those required for gauging systems found in column J of Chapter 17 in the IBC Code. An

open system should only to be used for cargoes that are not toxic and designated in the IBC Code as suitable for open venting and/or for open gauging.
The following safety precautions should be considered:

- Appropriate PPE must be worn;
- The characteristics of the chemical should be considered and the MSDS sheet and the IBC code consulted;
- Samples should be kept in either clear or amber glass bottles with secure lids;
- Manufacturer's guidance for maintenance of sampling equipment should be followed;
- Sampling equipment should be kept dry and clean at all times, including between grades to avoid contamination;
- Closed sampling equipment must be tested for electrical continuity and earthed prior to introduction into ship's tank;
- Anti-static precautions must be taken & cargo relaxation periods observed when dealing with static accumulator products;
- MSDS should be kept with stored samples:
- All sampling and gauging lines should be made of non-static generating material.
  Requirements for taking samples vary, however it is common for samples to be required as follows:
- Running sample from each tank before discharge; and
- Composite sample before discharge.

7.1.9 Explain how cargo samples should be drawn, handled and stowed

Chemical tankers are required to store a wide range of cargo samples. The IBC Code requires that the storage of samples is within a purpose built storage locker. The sample locker must be designed and built to ensure that sample bottles are securely stored and protected from damage and that the space is adequately ventilated and fitted with flame arrestors. The sample store should be a dedicated locker, resistant to the different liquids that will be stowed in it and sited within the cargo area. The sample locker should separate chemicals that react dangerously with one another and must only be used for the storage of cargo samples.

7.1.10 describes procedures to disconnect those/hard arms

Proper planning is required for disconnecting hoses and hard arms. Effective procedures should be established to minimise residues remaining in the section of line between the vessel's manifold valve and the shore connection.
Disconnection of the hose or cargo arm at the ship's manifold is an occasion when the cargo containment system is deliberately breached. Although hose disconnection is a routine operation, it should always be regarded as comparable to opening up any other cargo pipeline on deck. Personnel engaged in hose disconnection should wear personnel protective equipment Disconnection should only take place after the draining of cargo residues and the relief of any pressure.
Cargo manifolds and cargo hoses should be securely blanked when not in use.

7.1.10 Explain the term 'cargo conditioning' with respect to the chemical trade:

Cargo conditioning for chemical cargoes covers:

1. The cargo quantity is maintained without undue losses during passage.
2. The cargo temperature is maintained or changed as required according to the shipper's instructions; and
3. Inerting, padding or drying conditions are maintained as required.

7.1.12 Explain, in general terms, the transport requirements for vegetable and animal oils and fats

When transporting vegetable oils, animal oils and fats, consideration must always be given to coating compatibility and for the stowage of Slop of incompatible cargoes. The retention of viscous and vegetable oil Slops in zinc coated tanks must be avoided. Solidification in the cargo tanks can occur when solidifying cargoes are stowed adjacent to "cold cargoes" or cold ballast water in adjacent spaces.
Tank bottoms must therefore always be checked for hard factions especially when carrying vegetable and animal oils, at regular intervals throughout the voyage and always prior to arrival in the discharge port.
To avoid solidification of cargo in adjacent tanks, do not ballast the tanks in contact with the surrounding cargo tanks. Keep the ballast water in these ballast tanks about 30 cm below the tank top, allowing for trim.
Epoxy coatings are resistant to vegetable oils, wine, seawater, fatty acids. After cargoes with a strong odour (fish oil, phenol, octanol, tall oil, turpentine, molasses) the tanks should not be used immediately for odour sensitive cargoes such as vegetable oils.

In case of high viscous cargo it is important to be aware that after line blowing the cargo may contain an air-bubble and therefore the ullage measured immediately after blowing may be less than actual giving higher volume of cargo onboard than actual. Pre-blowing and after-blowing ullage measurements should give a good indication of this. The tank in question has to settle before a correct ullage can be taken.
Vegetable oil tanks may in the last phase of discharge be recirculated and hosed down with vegetable oil taken from the cargo pump delivery side (heated oil).
Decomposition of animal and vegetable oils and fats, a process known as putrefaction (or going off), can seriously deplete the oxygen content and evolve toxic gases, making proper ventilation of the space necessary prior to entry and at all times during entry.

7.1.14 Explain how inerting requirements for the tank atmosphere control are maintained during unloading

A positive pressure of inert gas should be maintained in the ullage space of an inerted cargo tank at all times in order to prevent the possible ingress of air. If the pressure falls below the set level of the low pressure alarm, action should be taken to re-pressurize the tank with inert gas. Pressure loss is normally associated with unloading or at sea with falling air and sea temperatures. For cargoes that need to be kept inerted, inert gas, usually nitrogen, is used to ensure the atmosphere in a cargo tank remains non-flammable as the tank is unloaded. The oxygen content should be kept below 8% and a slight over pressure maintained to prevent air being drawn into the tank.
Oil fired inert gas is generally acceptable for use with petroleum products but it has been found that the quality of the inert gas generated by this type of system is not compatible with many chemical products for quality control reasons
When shore supplied nitrogen is to be used for drying or inerting an empty tank that has been cleaned and gas freed, the volume of nitrogen required can be calculated
During unloading, inert gas is supplied to the tank to ensure that the atmosphere remains inert. It is important that the supply of inert gas exceeds the discharge rate of the cargo pump so that a positive pressure is maintained. Should the oxygen content of the inert gas supply exceed 5% or should it not be possible to maintain positive pressure then the unloading operation should be stopped until the situation can be restored.
Should tanks need to be opened for gauging or sampling purposes then the tanks should be 'topped up' prior to commencing or resuming unloading.

Following unloading, tanks inerted with nitrogen should be kept closed until the tank has been cleaned, ventilated, and tested to ensure it is gas free and the oxygen level restored and that the tank is therefore safe for entry.

7.1.15 Explain the need for taking cargo samples at the unloading port.

Sampling is necessary prior to unloading because of quality control and avoiding in transit claims at later date.

Shore personnel or surveyors should not be allowed to open ship's tanks and to draw samples without a member of the ship's crew being present. Use of same sampler for different grades will contaminate the cargo sample unless the sampler has been thoroughly cleaned.

7.1.16 Describe generally the requirements for care and transportation of chemical cargoes

Tank Sealing: The condition and security of all tank openings should be checked regularly to ensure that the tanks are effectively sealed against contamination by the outside environment and to ensure that, where required, a positive pressure of inert gas can be maintained.
Tank venting: Tank vents can become blocked by condensing cargo vapours, ice and by heated cargoes entering the vent lines and solidifying. The risk of blockage increases during heavy or adverse weather conditions. P/V valves should be checked regularly to ensure they are working correctly, care being taken to protect personnel against exposure to cargo vapours. If heat tracing lines are fitted to prevent icing they should be used.
Temperature monitoring: Cargoes that need cooling or heating must be monitored daily and a temperature log maintained. Temperature monitoring is usually by a remote read out in the cargo control room.
Inhibited cargoes: The temperature of cargoes that may self-react should be monitored daily. Unexpected changes of temperature are an early indicator of a possible self-reaction. A polymerizing cargo will generate a lot of heat with a rapid rise in temperature so the vessel should always have plans ready to jettison the cargo.
A positive pressure of inert gas should be maintained in the ullage space of an inerted cargo tank at all times in order to prevent the possible ingress of air. Sometimes it may be necessary to load ballast water into cargo tanks for stress and stability reasons or to improve a vessel's sea keeping qualities in heavy weather. Cargo tanks to be ballasted should be clean or, if this is not possible, only tanks which have contained a non water reactive cargo should be used.

7.1.17 Describe the requirements for care and transportation of bio diesels.

Biodiesel is considered a non-flammable and non-combustible product.
With a flash point temperature of about 170°C, compared to about 60 to 80°C for petro diesel, neat biodiesel and biodiesel blends are substantially safer to store, handle and use compared to conventional petro diesel, ethanol or gasoline.
Biodiesel soaked rags should be stored in safety containers, or dried individually prior to storage. Otherwise, when combined into a pile, natural biodiesel oxidation can potentially produce enough heat to create spontaneous combustion. Although comparatively safe to handle, skin and/or eye contact should be avoided, and inhalation shall be minimized. It is recommended that during extended biodiesel exposure, face mask, safety goggles and suitable work attire should be worn.

Tanks must be washed, rinsed, drained and dried prior to biodiesel loading in order to avoid any cross-contamination. Teflon, viton or nylon lined hoses have very little reaction to biodiesel, and are normally recommended for use.
As with petro diesel, it is important that biodiesel be transported in a way that does not lead to contamination. The following procedures are recommended and are also used by distributors and transporters of petroleum derived diesel.
Proper inspection and/or tank cleaning to wall wash standards and on board test are specified to be carried out to ascertain the standard of requisite cleaning Check for previous load carried and residual. Generally only diesel fuel is acceptable as a residual. If the vessel has not gone through a recommended tank cleaning programme, some residuals may not be acceptable like:

- Food products,
- raw vegetable oils, and
- lubricants
- Acids or alkaline solutions of any nature
- Glycerin,
- plant oils Products with a flash point < 55°C
- aromatic solvents,
- chemical surfactants
- heavy fuel oils Additionally hoses must be cleaned

Determine need for insulation or method to heat contents if shipping during cold weather.
Pure biodiesel is also known as B100. Regardless of how the biodiesel arrives, it must be stored and handled using procedures that do not allow the temperature of B100 or blend to drop below its cloud point. The cloud point of the biodiesel, the biodiesel temperature, the ambient temperature, and the time the fuel is in transport are all factors that should be taken into consideration when transporting B100 to ensure that the fuel does not freeze in transport.

For cold climate transportation, heating requirements should be followed. Since reheating of gelled biodiesel is not recommended, it is also preferred that the neat or blended biodiesel temperature not drop below the applicable cloud point.

7.1.18 List general precautions during unloading

Compliance with company checklists and procedures is required.
Some general requirements are:

- Comply with cargo unloading plan requirements
- Keep a watchman on deck continuously, properly dressed and equipped with a portable radio who will check care- fully check for any leakage, malfunction of pumps or any abnormal situation and report to the duty officer.
- Obtain and record ullage figures and temperatures hourly. In the event that vessel is fitted With CARGO MONITORING SYSTEM computer, get a printout of same to maintain unloading records.
- Keep back pressure records at a minimum hourly intervals.
- While discharging last tank(s), remember to check other tanks supposed to be empty for a probable leakage that might have occurred due to a valve deficiency or simple forgetting.
- Notify the terminal 1-hour before and 10 minutes before completion. The Chief Officer / Cargo Officer shall attend personally the cargo operation during all critical steps.

7.1.19 Explain the requirements of Chemical cargo unloading with respect to draining and stripping requirements.

The chemical tanker should be unloaded so that its trim (as mentioned in P&A Manual) enables the best possible drainage of cargo tanks.
For those cargoes that have a high vapour pressure it may be necessary to assist the unloading and drainage by pressurizing the cargo tank. When pressurizing is being done the tank pressure must be carefully monitored and must not exceed the design pressure.
The means of pressurization depends on the properties of cargo, such as:

- flammability
- reactivity

7.1.20 Describe precautions to take on completion of unloading

On completion of unloading it is essential to reduce the cargo residue in a tank to the minimum attainable. Tanks should be stripped according to the requirements of the ship's P&A Manual.

When discharge of a product is completed, the relevant manifold valve on the ship and the shore should be closed. This will provide separation of the ship and the shore system from a failure or unexpected action in the other. All openings on cargo tanks used for that product must be finally closed and secured.
Additionally:

- Blow the lines with air to push out the cargo to shore (if agreed and confirmed by the terminal)
- Ensure that the surveyors issue "Dry Tank Certificate or Empty Tank Certificate" to vessel.
- Ensure that cargo unloading hose/arm is liquid free before breaking connection.
- Supervise when hose is disconnected.
- Ensure that times of all events of the discharging operation are recorded in the Cargo logbook and main points are transferred in the Deck logbook.
- Ensure that the Cargo Record Book is entered in accurately.
- Prepare a copy of full cargo documents to deliver/expedite to the Company, retaining a full set in Ship's file

7.2 Ballasting and deballasting

7.2.1 Explain the requirements of Ballasting and Deballasting on a chemical tanker.

The chemical tanker should at all times during loading and unloading operations be stable and in good trim, to allow for an emergency departure if necessary.
The stability of most chemical tankers is good in normal conditions, due to the large number of relatively small cargo tanks.
Chemical tankers may have to undertake ballasting or deballasting during cargo operations to obtain adequate trim and prevent undue list.
The responsible officer should see to it that the distribution of cargo and ballast at no time creates excessive stress on the ship's hull.
Chemical tankers may be equipped with SBT where the line, pumps and equipment serving SBT are independent of similar equipment serving cargo tanks.
Ballasting or deballasting of cargo tanks after they have contained a NLS should be done in accordance with the ship's P & A Manual, thereby ensuring compliance with Annex II of MARPOL.

7.2.2 Explain, in general the free surface effect in cargo tanks and ballast tanks

Normally chemical tankers have large number of tanks and this reduces the dangers of free surface effects.
It is important that the stability aspects of some type 3 vessels converted from old double hull vessels is understood as there have been a number of serious incidents involving loss of stability.
In contrast to conventional tankers which are inherently stable, it is recognised that double hull structures which do not have a centre line bulkhead have potential problems in that large free surface effects may be encountered at various stages of cargo and ballast operations. As a consequence, a loss of GM may result in serious stability problems.
It must be stressed that Masters and Officers must be fully aware of this potential problem, and that all cargo and ballast operations are conducted strictly in accordance with the vessel's approved loading manual. Changes to cargo plans must be fully assessed before the revised plan is undertaken.
All ships are supplied with stability data, and loading, unloading ballasting deballasting and exchange of ballast water instructions to comply with statutory requirements. These instructions are to be carefully studied and followed. Generally, these instructions will specify a maximum number of tanks, which may be slack at any one time.

Slack tanks and sloshing effects:
It is essential that Masters and Officers be aware that the partial loading of a cargo tank with cargo or ballast may present a potential problem. The combination of free surface and the flat bottom can result in the generation of wave energy of sufficient power to severely damage internal structures and pipelines and heating coils.
The movement of liquid within a cargo tank when the vessel is rolling or pitching in a seaway is also called "sloshing". In general the negative effects of sloshing can be summarized as follows:

g. The slamming effect of the liquid inside the tank may result in serious damages to the tank structure and fittings.
h. Even a slight rolling and pitching motion can generate the main source of ignition – an electrostatic charge. An electrically charged mist can also occur in the tank partially filled with a mixture of oil and water, such as dirty ballast, tank washings or slops. During tank cleaning continuously monitor the tank being washed to ensure water is not building up in the tank and sloshing in heavy weather.

7.3 Tank cleaning operations

7.3.1 Explain why proper planning is required prior conducting tank cleaning operations

Chemical tank cleaning is a potential hazardous operation. All tank washing operations should be carefully planned, carried out and documented.
Potential hazards relating to planned tank washing operations should be systematically identified, risk assessment carried out/recorded and appropriate preventive measures put in place to reduce the risk to as low as reasonably practicable prior undertaking such operations.
If Portable Tank Cleaning Machines are required to be used for cleaning, depending on the Hazards of the cargo being washed, additional preventive measures may be
necessary. Most chemical tanker operators require a RISK ASSESSMENT to be conducted onboard and submitted to the office for approval and same must be received prior to commencing such tank cleaning operations.

7.3.2 Describe the contents and coverage of a written tank cleaning plan of a chemical tanker.

The tank cleaning plan must include:

- The type of cargo to be cleaned from each tank and the next cargo for which the tank needs to be prepared, and both cargo characteristics. Procedures and Arrangement manuals for effluent discharge provisions, Software or chemical cleaning guides for commercial cleaning methods from previous to next cargo grades. MSDS should be available so that personnel involved are familiar with the hazards;
- The major risks during cleaning, including toxicity, flammability, corrosiveness, reactivity and temperature and control measures to be applied
- The safety equipment and Personal Protective Equipment (PPE) to be available and ready for use throughout the operation and during connecting and disconnecting of hoses at the cargo manifold;
- The tanks to be cleaned, cleaning method, cleaning sequence and gas freeing arrangements;
- Requirements of monitoring of the transfer of tank washings
- MARPOL requirements for the disposal of cargo residues and cleaning water (slops);
- Segregation of slops to avoid mixing different categories of product
- Necessary actions required to keep the cargo deck area free from cargo vapours during tank washing and gas freeing operations.

7.3.5 Describe the pre cleaning checks which should be made prior commencing tank cleaning operations

Pre tank cleaning checks:

- Tank cleaning plan has been made available to all involved;
- Appropriate PPE is used.
- Decontamination showers and eyewash arrangements are ready for use;
- No other operation is being carried out which could interfere with, or affect the safety of the tank cleaning operation;
- Tanks and lines being cleaned are segregated or effectively isolated from tanks that are clean or that contain cargo;
- Safeguards are in place to avoid contamination through common vent and vapour return lines;
- Arrangements for cleaning vapour return lines are included in the tank cleaning plan;
- All cargo tank openings not in use are kept closed;
- Firefighting equipment is ready for immediate use.

7.3.6 Describe the stages of chemical tank cleaning.

The stages of tank cleaning include:
Mandatory Pre wash – in accordance with MARPOL ANNEX II requirements
Pre cleaning- clearing pools or piles of residue cargo
Main wash- generally water washing with hot or cold water as per commercial cleaning requirements based on previous and next cargoes
Chemical cleaning- as per commercial cleaning and wall wash standards required. Note 1. Use of appropriate chemical cleaning additive must be approved and included in the MEPC circular 2 which is annually updated.
Note 2: Verify the tank coating manufacturer's guide, for the compatible tank cleaning additive, before full-scale application of any chemicals used specially-dye removers.
After wash-removal of traces of chemicals.
Spot wash-removal of remaining discolorations due to residues.
Fresh water washing-only if warranted by the next cargo requirements
Mopping and drying
Steaming and venting if required.

7.3.7 Explain permitted maximum allowed stripping quantity remaining on board after discharge for Categories X, Y and Z substances

- Every ship constructed before 1 July 1986 shall be provided with a pumping and piping arrangement to ensure that each tank certified for the carriage of substances in Category X or Y does not retain a quantity of residue in excess of 300 litres in the tank and its associated piping and that each tank certified for the carriage of substances in Category Z does not retain a quantity of residue in excess of 900 litres in the tank and its associated piping.
- Every ship constructed on or after 1 July 1986 but before 1 January 2007 shall be provided with a pumping and piping arrangement to ensure that each tank certified for the carriage of substances in Category X or Y does not retain a quantity of residue in excess of 100 litres in the tank and its associated piping and that each tank certified for the carriage of substances in Category Z does not retain a quantity of residue in excess of 300 litres in the tank and its associated piping.
- Every ship constructed on or after 1 January 2007 shall be provided with a pumping and piping arrangement to ensure that each tank certified for the carriage of substances in Category X, Y or Z does not retain a quantity of residue in excess of 75 litres in the tank and its associated piping.
  A performance test with water as a medium is required to be carried out in accordance with MARPOL 73/78 Annex II, to evaluate the quantity of residues remaining after unloading.

7.3.8 Describe measures of control for Category X substances

Category X residues cannot be discharged overboard. On completion of discharge, the tank is washed and the tank washings pumped ashore. This procedure is called a prewash. This operation of a mandatory pre wash has to be monitored and approved by the relevant port authority representative and an entry must be made in the Cargo Record Book;

Detail procedure complying with Annex II is provided in the P and A manual.

7.3.9 Explain exemptions from mandatory pre washing requirements in accordance with MARPOL Annex II

Exemption for a prewash
On request of the ship's master an exemption for a prewash may be granted by the Government of the receiving Party, where it is satisfied that:
.1 The unloaded tank is to be reloaded with the same substance or another substance compatible with the previous one and that the tank will not be washed or ballasted prior to loading; or
.2 The unloaded tank is neither washed nor ballasted at sea. The prewash in accordance with the applicable paragraph of this regulation shall be carried out at another port provided that it has been confirmed in writing that a reception facility at that port is available and is adequate for such a purpose; or
.3 The cargo residues will be removed by a ventilation procedure approved by the Administration

7.3.10 Explain requirements for discharge to reception facilities and concentration of substance in the effluent discharge to shore

A tank from which a substance in Category X has been unloaded, shall be prewashed before the ship leaves the port of unloading. The resulting residues shall be discharged to a reception facility until the concentration of the substance in the effluent to such facility, as indicated by analyses of samples of the effluent taken by the surveyor, is at or below 0.1% by weight. When the required concentration level has been achieved, remaining tank washings shall continue to be discharged to the reception facility until the tank is empty.
If due to any reason the unloading of a substance of Category Y or Z is not carried out in accordance with the Procedure and Arrangements Manual and quantities of residues in excess of the requirements as per Annex II of MARPOL remain, a prewash shall be carried out before the ship leaves the port of unloading, unless alternative measures are taken to the satisfaction of the surveyor of the administration or duly appointed by the administration, to remove the cargo residues from the ship to quantities specified in Annex II of MARPOL. The resulting tank washings of the prewash shall be discharged to a reception facility at the port of unloading or another port with a suitable reception facility provided that it has been confirmed in writing that a reception facility at that port is available and is adequate for such a purpose.
This could happen due to break down of pump or heating system.

7.3.11 Describes action to take when unable to measure concentration of residues in the effluent of cargo required to be regulated under mandatory prewash.

Where the Government of the receiving party is satisfied that it is impracticable to measure the concentration of the substance in the effluent without causing undue delay to the ship, that Party may accept an alternative procedure as being equivalent to obtain the required concentration in regulation of Annex II MARPOL provided that:
.1 The tank is prewashed in accordance with a procedure approved by the Administration in compliance with Annex II MARPOL; and
.2 appropriate entries shall be made in the Cargo Record Book and endorsed by the surveyor of the administration.

7.3.12 Explain Limitations on subsequent discharge of wash water or ballast into the sea

Discharge standards
Where the provisions in this regulation allow the discharge into the sea of residues of substances in Category X, Y or Z or of those provisionally assessed as such or ballast water, tank washings or other mixtures containing such substances the following discharge standards shall apply:

.1 The ship is proceeding en route at a speed of at least 7 knots in the case of self-propelled ships or at least 4 knots in the case of ships which are not self-propelled;
.2 The discharge is made below the waterline through the underwater discharge outlet(s) not exceeding the maximum rate for which the underwater discharge outlet(s) is (are) designed; and
.3 the discharge is made at a distance of not less than 12 nautical miles from the nearest land in a depth of water of not less than 25 metres.
For ships constructed before 1 January 2007 the discharge into the sea of residues of substances in Category Z or of those provisionally assessed as such or ballast water, tank washings or other mixtures containing such substances below the waterline is not mandatory.

The Administration may waive the requirements for substances in Category Z, regarding the distance of not less than 12 nautical miles from the nearest land for ships solely engaged in voyages within waters subject to the sovereignty or jurisdiction of the State the flag, of which, the ship is entitled to fly. In addition, the Administration may waive the same requirement regarding the discharge distance of not less than 12 nautical miles from the nearest land for a particular ship entitled to fly the flag of their State, when engaged in voyages within waters subject to the sovereignty or jurisdiction of one adjacent state after the establishment of an agreement, in writing, of a waiver between the two coastal State involved provided that no third party will be affected. Information on such agreement shall be communicated to the Organization within 30 days for further circulation to the Parties to the Convention for their information and appropriate action if any.

7.3.13 Explain cleaning and discharging effluent procedures for solidifying and non-solidifying substances

Prewash procedures for non-Solidifying Substances

1. Tanks shall be washed by means of a rotary water jet, operated at sufficiently high water pressure. In the case of Category X substances cleaning machines shall be operated in such locations that all tank surfaces are washed. In the case of Category Y substances only one location need be used.
2. During washing the amount of water in the tank shall be minimized by continuously pumping out slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met the washing procedure shall be repeated three times, with thorough stripping of the tank between washings.
3. Those substances which have a viscosity equal to or greater than 50 mPa.s at 20°C shall be washed with hot water (temperature at least 60°C), unless the properties of such substances make the washing less effective.
4. The number of cycles of the cleaning machine used shall not be less than that specified in the P and A manual of the ship. A cleaning machine cycle is defined as the period between two consecutive identical orientations of the tank cleaning machine (rotation through 360°).
5. After washing, the tank cleaning machine(s) shall be kept operating long enough to flush the pipeline, pump and filter, and discharge to shore reception facilities shall be continued until the tank is empty.

Prewash procedures for Solidifying Substances:

1 Tanks shall be washed as soon as possible after unloading. If possible tanks shall be heated prior to washing.
2 Residues in hatches and manholes shall preferably be removed prior to the prewash.
3 Tanks shall be washed by means of a rotary water jet operated at sufficiently high water pressure and in locations to ensure that all tank surfaces are washed.
4 During washing the amount of water in the tank shall be minimized by pumping out slops continuously and promoting flow to the suction point (positive list and trim). If this condition cannot be met, the washing procedure shall be repeated three times with thorough stripping of the tank between washings.
5 Tanks shall be washed with hot water (temperature at least 60°C) unless the properties of such substances make the washing less effective.
6 The number of cycles of the cleaning machine used shall not be less than that specified in The vessels P and A manual..
7 After washing, the cleaning machine(s) shall be kept operating long enough to flush the pipeline, pump and filter, and discharge to shore reception facilities shall be continued until the tank is empty.

Subsequent commercial cleaning will follow as required.

7.3.14 Explain washing procedures for high-viscosity and low-viscosity substances

The minimum quantity of water to be used in a prewash is determined by the residual quantity of noxious liquid substance in the tank, the tank size, the cargo properties, the permitted concentration in any subsequent wash water effluent, and the area of operation. The minimum quantity is given by the following formula:
Q=k(15r0.8 + 5r0.7 x V/1000)
The constant k is determined by the type of solidifying/ Non solidifying or Viscosity as follows:
Category X, non-Solidifying, Low-Viscosity Substance, k = 1.2
Category X, Solidifying or High-Viscosity Substance, k = 2.4
Category Y, non-Solidifying, Low-Viscosity Substance, k = 0.5
Category Y, Solidifying or High-Viscosity Substance, k = 1.0

Q = the required minimum quantity in m^3
r = the residual quantity per tank in m^3. The value of r shall be the value
demonstrated in the actual stripping efficiency test, but shall not be taken lower than 0.100 m^3 for a tank volume of 500 m^3 and above and 0.040 m^3 for a tank volume of 100 m^3 and below. For tank sizes between 100 m^3 and 500 m^3 the minimum value of r allowed to be used in the calculations is obtained by linear interpolation.

For Category X substances the value of r shall either be determined based on stripping tests according to the Manual, observing the lower limits as given above, or be taken to be 0.9 m^3
V = tank volume in m^3

Subsequent commercial cleaning will follow as required for the next cargo to load.

7.3.16 Explain slop tank discharge restrictions and requirements

Although MARPOL, Annex II does not require the fitting of dedicated slop tanks, slop tanks may be needed for certain washing procedures. Cargo tanks may be used as slop tanks.
Management of slops
The compatibility of various cargo and cleaning chemicals should be checked prior to being transferred to a common slop tank.
Should slops be required to be retained on board for more than a few days then the contents of the slop tank will need to be monitored for any signs of a chemical reaction or for the build-up of flammable vapours Chemical tankers frequently carry oil products such as lube oils and clean refined petroleum products such as gasoil, gasoline and kerosene. When transporting these products the vessel will have to comply with the MARPOL Annex I regulations. Following the unloading (discharge) of an oil cargo, the tank is cleaned and the tank washings (slop water) are transferred to a slop tank. In this slop tank, the slops separate, aided by heating if necessary, with the oil floating on top of water due to its lower specific gravity. The water is then pumped from the bottom of the tank and discharged overboard. The Overboard Discharge Monitoring Equipment (ODME) constantly samples the water being discharged to ensure that the oil content of the water does not exceed limits specified under MARPOL Annex I.

7.3.17 Explain Wall wash requirements and procedures

WALL WASH TEST
Wall wash tests may be carried on board to ensure that the cleaning standard has been achieved for certain cargoes which are sensitive to various contaminants. The basic principle

is that of cleanliness. At regular intervals and before the tests are carried out, the glassware must be cleaned properly by rinsing with 3% peroxide and 2% hydrochloric acid. When samples are taken ensure the structures are not wet through moisture or otherwise and are not hot.

GENERALLY TESTS ARE CARRIED OUT FOR THE FOLLOWING:
Appearance.
Colour.
Odour.
Presence of Hydrocarbon.
Presence of Chlorides.
Permanganate Fade time test.
Acid Wash colour of Aromatic Hydrocarbons

WALL WASH TEST EQUIPMENT AND CHEMICALS:
Test tubes.
Pipette tubes.
Sample bottles and cut-off funnels.
Thermometer.
Black cloth or black thick paper.
Peroxides.
Hydrochloric acid.
Filter Paper.
Silver Nitrate 10%.
Nitric Acid.
Potassium Permanganate.
Platinum Cobalt standard solution.
De-ionized water / Distilled water.
Methanol.
Shaking cylinder 50ml stoppered with base
Sulphuric acid concentrated – 0.5ltr.

TESTS
HYDROCARBON TEST (TO ENSURE NO HYDROCARBON TRACES ARE PRESENT)

Pour 25 ml of each wall wash sample from the sample jars into a test tube calibrated to at least 100 ml.
Add 75 ml of DI water to the sample.
Create a standard solution which is prepared as a blank for comparison. This is a solution containing 25 ml methanol and 75 ml DI water.
Place the sample test tube and the blank side by side and keep for 20 minutes.
Place a black surface under and behind the tubes.
Turn off the lights and shine a flash light from the side, while looking down into the tubes through the liquid column.
IF:
A transparent bluish tinge is observed, slight hydrocarbon presence is confirmed.
A stronger milky white solution is observed, there is a presence of hydrocarbon in moderate to heavy quantities.
A clear solution is observed the sample is clear of hydrocarbon.

CHLORIDE TEST (FOR CHLORIDE SENSITIVE NEXT CARGO AND TANK PRE CLEANED WITH SEAWATER)

If the hydrocarbon test is cleared, it is preferred to use the same sample. If not then use another sample.
Add 5 drops of 10% Silver Nitrate to the sample.
Add 5 drops of 10% Silver Nitrate to the blank
Put the stopper onto both the tubes and invert the tubes.
Place the tubes over the black surface for about 15 minutes.
Turn off the lights and shine a flash light from the side, while looking down into the tubes through the liquid column.
Compare the two tubes. Observe for turbidity.
If there is turbidity, there is a presence in the chloride.

Incase no hydrocarbon test is required or if the hydrocarbon test has failed, then the sample tube should contain the following:

25 ml sample + 25 ml methanol + 50 ml DI water + 5 drops of 10% Silver Nitrate.

This test however is less accurate. If the ship has carried Vegetable Oil, the non-volatile matter creates turbidity. To identify the origin of turbidity add 2 drops of nitric acid before the silver nitrate. If turbidity is observed it is due to the NVM in the vegetable oil.

PERMANGANATE FADE TIME TEST
It is also known as the Permanganate value test. It detects substances capable of being oxidized by potassium permanganate.

On oxidizing potassium permanganate changes its colour from deep purple to salmon pink.

Use 50 ml test tubes.
A special permanganate solution is made by dissolving 0.1 g of potassium permanganate in 500 ml of DI water. This solution must be kept in a refrigerator for
a long period preferably a week.
Care must be taken during this test as the solution deteriorates quickly especially at high temperatures and if exposed to light. A new solution may be required to be prepared every 3 days under unfavorable conditions.
The entire kit therefore must be stored in a cool, dry and dark place preferably inside a fridge. Amber coloured bottles are preferred for storage.
A sealed Platinum Cobalt Standard colour solution (ASTM colour standard 500) is used for comparison.
The temperature must be maintained at 15°C, + 1°C if methanol is used for the test. If acetone is used the temperature should be maintained at 25°C + 1°C.
A measured amount of Permanganate solution is added with a pipette tube and a disposable plastic pump. Never use the mouth for the purpose of pump.
Fill the tubes to a 50 ml level with sample.
Prepare a standard blank with laboratory methanol. Keep alongside the sample for comparing.
Cool the tubes at a steady and controlled rate to 15°C.
Add 2 ml permanganate to each tube. Place the stopper and invert the tubes to mix.
Note the start time.
Return the tubes to the cooler and maintain the required temperature.
Check the colour at 10 minutes intervals and note the readings. The colour changes from deep purple to pink and fades to pale watery yellow.
Record the time elapsed until the colour matches the Platinum Cobalt colour.

ACID WASH COLOUR OF AROMATIC HYDROCARBONS

This method covers the determination of the acid wash colour of benzene, toluene, xylene, refined solvent naphtha and similar aromatic hydrocarbons.
Apparatus: Acid wash colour standards, numbered 0 to 14; Shaking cylinders, 50 ml.
Procedure:
Fill a dry and clean 30 ml stoppered cylinder up to the 7 ml mark with sulphuric acid of the strength specified in Table 1 for the type of sample to be tested. Add sufficient sample to bring the total volume to the 28 ml mark. Insert the stopper, hold a finger over the stopper and give vigorous shakes with a stroke of 10 to 25 cm, shaking for a total of 150 cycles over a period of 40 to 50 seconds, that is at a rate of 3 to 3,75 cycles per second.
Allow the cylinder to stand, protected from direct sunlight, for the period of time shown in Table 1 herein below without further delay invert the cylinder gently once or twice to obtain a uniform colour in the acid layer and compare the colour of the acid layer with those of the standards. Make the comparison against a white background or at daylight.
Designate the colour of the acid layer by the number of the nearest matching standard and add to the number a plus or minus sign if the sample is respectively darker or lighter than the standard colour.
Note: Concentrated sulphuric acid will cause severe burns on contact with the skin. When spilled, remove with plenty of water.
Remark: It is advisable, when performing the test, to use clean plastic disposable gloves.

TABLE 1
Acid strengths and standing time

Sample	**Acid strengths**	**Standing time**
Group 1, Benzene, all ASTM grades Toluene, all ASTM grades Xylene, nitration grades Xylene 5° Xylene 10°	96%	15 Mins
Group 2. Xylene, industrial grade Refined solvent naphtha	96%	5 Mins
Group 3, Hi-flash solvent Heavy solvent naphtha	78%	5 Mins

APPEARANCE TEST
This is generally the first test done before the samples are distributed into the different tubes for the other tests. The standard blank is of pure methanol. This is compared to the sample. The sample bottle must be swirled to give motion to the liquid. Check the bottle for a different colour or suspended particles such as paint flakes, rust, previous cargo etc.

UV Test
The UV-Test is used to identify certain hydrocarbons and chemicals. Many hydrocarbons and chemicals have the ability to absorb UV-light when they are exposed to such light. Certain molecular electrons will get exited if exposed to light. This excitation results in absorbance of light which can be measured. Absorbance at a specific wavelength is a measure for concentration of specific compounds. In a special apparatus called Spectrometer a sample (containing hydrocarbons) and a reference sample (containing just a solvent such as methanol) are exposed to a UV light source.

NVM Test
Used to determine if there are non-volatile impurities on the tank surface. A defined quantity of the wall wash liquid is evaporated. The weight of the residue, the so-called NVM (Non Volatile Matter), is detected by weighing. This is then divided by the original weight of the sample. The NVM content must not exceed the value specified by the shipper / charterer.
Note: Below diagram is not required as it does not convey anything unusual

COLOUR TEST
This is done along with the Appearance test. The sample must be checked against a white background for different colours or dullness. This is especially important to be done after washing a tank which had loaded a dyed cargo previously.

ODOUR TEST
This test is carried out to establish the presence of persistent foreign odour that may be transferred to the next cargo and possibly contaminate it. A filter paper is dipped into the sample and the standard solution. The papers must be smelt immediately and the odour detected. Some odours will leave the paper if smelt after keeping it for some time in the open. In some cases tubes may be smelt directly, though it is not an encouraged practice, especially when the previous cargo was toxic or harmful.

7.3.18 Explain Passivation and Pickling of stainless steel tanks.

The corrosion resistance of stainless steel is determined by a chromium-rich oxide film. As soon as this film has formed the material is designated as being passive.
The tank after repeatedly loading corrosive cargoes like sulphuric acid, results in local damage to and contamination of the protective oxide film. It is important that the light corrosion products be removed specifically with a view to avoiding deep pits and split corrosion with all their negative consequences and also to prevent contamination of the next cargo to be loaded.
PASSIVATION: The most commonly used chemical method to passivate a stainless steel surface is to apply 65% concentrated nitric acid. Nitric is a strong mineral acid so it can quickly dissolve all iron compounds and other trace metals that are on the surface.
Nitric acid is also a strong oxidizer so it can generate the chromium oxide layer at the same time. Even though nitric acid is a strong chemical, high temperatures and extended times are used to ensure the reaction is effective and complete. The application condition ranges are:
Time: 20 minutes to 2 hours
Temp: up to 70°C (160°F)
Concentration: 20 to 50% by volume nitric acid
Note: Under these conditions nitric acid is very aggressive on gaskets and it may be necessary to replace them after a passivation procedure.
The chemical fluids are sprayed against the walls with considerable force. This is done using an acid-resistant pump unit by means of spray units suspended in the tank or tank washing machines. The chemicals stream down the walls and over the bottom to a deep well from which they are recycled back to the tank of the pump unit by immersion pump. The time occupied by this treatment depends on the type of stainless steel and the temperature. The treatment is followed by rinsing, first with drinking water and then with demineralized water.
The quality of passivation done is checked by measuring the passive layer of chromium-rich oxide using passivity meters.

PICKLING: The pickling treatment removes completely iron particles and other contaminants on the surface resulting from welding heat treatments or otherwise. After the pickling treatment (scrubbing) done with mixed solutions of acids like 65% concentrated Nitric acid 5% to 20 % and a 50% concentrated Hydrofluoric acid 1%-3% in water and subsequently the tank is rinsed acid-free using De-ionized water. The pickling treatment renders the surface chromium-rich, the surface being in fact refined. Although the Austenitic stainless steel is, after pickling and when exposed to sufficient atmospheric oxygen, able to passivate spontaneously, closed systems such as tanks are generally treated chemically in order to passivate their surfaces.

7.4 Tank atmosphere control

7.4.1 Explain tank blanketing and padding requirements for transporting Chemicals in bulk.

For cargoes that react with air or moisture in the air, the IBC Code requires the atmosphere in the vapour space to be controlled by filling the cargo tank and associated piping systems with a liquid gas or vapour which separates the cargo from the air, and maintaining that condition. This is called padding. This process is usually performed after the cargo has been loaded, using nitrogen at low pressure and at a low flow rate. Padding does not replace all of the air in the tank but is designed to provide a layer of nitrogen above the surface of the cargo. A safe practice is to introduce the nitrogen directly into the cargo tank ullage space.

Shippers may, however, specify that nitrogen of a known purity is used and be supplied from shore. In these circumstances it is preferable that the nitrogen is supplied to the tank prior to loading so that a layer of nitrogen remains above the surface of the cargo after loading is complete. Alternatively the nitrogen may be applied via the ship's venting system after loading.

Should it be necessary to supply nitrogen from the shore terminal after loading then it should preferably be supplied direct to the ullage space of the tank and not via the cargo loading line. This is best achieved by connecting the nitrogen hose direct to a small diameter ball valve fitted to the vent line or to the tank hatch. The operation should be stopped when a slight overpressure exists within the ullage space which is less than the tank's P/V valve's opening setting. The vapour space in a loaded tank is usually small, so over pressurization can occur very suddenly if not monitored carefully.

Should it be necessary to supply nitrogen via the cargo line then the following precautions should be observed:

1. Nitrogen (or any other gas) flow should never be controlled through the main cargo or vapour line manifold valve. Instead, flow should be controlled through a small diameter line fitted with a ball valve, enabling the vessel to control the flow of nitrogen;
2. In all cases, the delivery rate of nitrogen (m^3/hr) should not exceed the operational limits of the tank venting system;
3. It is preferable for the shore to provide a dedicated pressure control system fitted at the junction between the shore inlet line and the ship to manage the pressure and flow coming on board the vessel;
4. Oxygen levels must be maintained at or above the minimum level required by oxygen dependent inhibitors used with certain self-reactive chemical cargoes (examples: styrene and acrylonitrile). In such cases, padding (or blanketing) with nitrogen (either at the berth or during transit) should be strictly controlled in compliance with the inhibitor certificate. Using nitrogen during discharging and tank cleaning operations should also be strictly controlled to ensure the oxygen level is maintained within the appropriate limits. Similarly, bubbling nitrogen through these products should be avoided, as this could drive oxygen out of the product;
5. Prolonged purging of an inhibited cargo, via the cargo line, should be avoided as this process will deplete the oxygen within the cargo reducing the effect of the inhibitor; and
6. Monitoring of the ullage space should be carried out at regular intervals during the voyage to ensure that the correct atmosphere is being maintained.

7.4.2 Explain methods of maintaining control of atmosphere by inerting, padding, and drying during cargo operations

The IBC Code recognizes the following methods of environmental control for cargo tanks on chemical carriers:
Inerting: By filling the cargo tank and associated piping systems and the spaces surrounding the cargo tanks with a gas or vapour which will not support combustion, and which will not react with the cargo, and maintaining that position.
Padding: By filling the cargo tank and associated piping systems with a liquid, gas or vapour which separates the cargo from the air, and maintaining that position.
Drying: By filling the cargo tank and associated piping systems with moisture free gas or vapour with a dew point of - 40º C or below at atmospheric pressure, and maintaining that position.

Ventilation: Forced or natural.

7.4.3 Describe requirements for testing of tank atmosphere with regard to: oxygen content, Flammable vapours and toxic Vapours.

- Oxygen content is usually measured for man entry into enclosed spaces but the measurement may also be required in certain spaces to ensure that atmosphere is being maintained inerted and the oxygen content is at the desired level.
  For man entry, a nominal reading of 21% should be achieved. Any space with an atmosphere having less than 21% oxygen by volume should NOT be entered until the reason for the low O2 level has been established.

- Flammable vapours should be measured with a suitably sensitive combustible gas detector. The concentration of flammable vapour must be below 1% of the Lower Flammable Limit (LFL) of that substance before enclosed space entry can proceed.

- Toxic vapours: a toxic gas detector should be used to ensure that the levels of toxic gases are within the required safe Occupational Exposure Limit (OEL). For enclosed space entry this should be 50% of the OEL of the toxic gas being measured.

7.5 INERTING

7.5.1 Explain Inerting on chemical tankers

Inerting is the displacement of air from a previously clean and gas free tank to create an inert atmosphere within the tank. Inerting ensures the tank atmosphere is incapable of supporting combustion by reducing the oxygen content. prior commencement of loading Flammable liquids.
On some chemical tankers Inerting with nitrogen is also carried out to reduce the moisture content of the tank atmosphere for cargo compatibility and quality control reasons.

7.6 Gas-freeing

7.6.1 Explain gas freeing of a chemical tanker

Gas-freeing is done by portable fans or fixed ventilating systems on a chemical tanker. Gas-freeing a non-inerted tank will result in the tank atmosphere being in the explosive range till dilution is below the LFL and that precaution for sources of ignition need to be taken. The

IGS is used for purging and Gas freeing blowers may also be used for gas-freeing. Gas-freeing may take place through displacement or dilution method of gas replacement.

7.6.2 Describe both displacement and dilution methods in general terms

The replacement of a tank atmosphere by inert gas can be achieved by either inerting or purging. In each of these methods, one of two distinct processes, dilution or displacement, will predominate.

Dilution takes place when the incoming inert gas mixes with the original tank atmosphere to form a homogeneous mixture throughout the tank so that, as the process continues, the concentration of the original gas decreases progressively. It is important that the incoming inert gas has sufficient entry velocity to penetrate to the bottom of the tank. To ensure this, a limit must be placed on the number of tanks that can be inerted simultaneously. Where this limit is not clearly stipulated in the operations manual, only one tank should be inerted or purged at a time when using the dilution method.

Displacement depends on the fact that inert gas is slightly lighter than hydrocarbon gas so that, while the inert gas enters at the top of the tank, the heavier hydrocarbon gas escapes from the bottom through suitable piping.

When using this method, it is important that the inert gas has a very low velocity to enable a stable horizontal interface to be developed between the incoming and escaping gas. However, in practice, some dilution inevitably takes place owing to the turbulence caused in the inert gas flow. Displacement generally allows several tanks to be inerted or purged simultaneously.

Whichever method is employed, and whether inerting or purging, it is vital that oxygen or gas measurements are taken at several heights and horizontal positions within the tank to check the efficiency of the operation. A mixture of inert gas and petroleum gas, when vented and mixed with air, can become flammable. The normal safety precautions taken when petroleum gas is vented from a tank therefore should not be relaxed.

7.6.3 Explain Safe procedures for gas freeing after tank cleaning and cleaning by ventilation

The IBC Code as well as the ship's P&A Manual includes requirements for equipment and procedures to be followed to ensure that tanks are gas freed safely.
Gas freeing operations need to be carefully planned, taking into account the vapours to be expected which may be flammable, and/or toxic and/or corrosive.
The below mentioned guidelines should be followed:

- Cargo line valves other than those required for ventilation should be closed and secured;
- Venting of toxic and flammable gas during gas freeing should be through the vessel's approved gas freeing outlets, which may utilise high velocity vent valves, sufficient to carry the vapours clear of the deck;
- Only when the flammable vapour concentration at the outlets has been reduced to 30% of the Lower Flammable Limit (LFL) and, in the case of a toxic product, the vapour concentration (TLV) does not present a significant health hazard, should gas freeing be continued at cargo tank deck level;
- If portable ventilation equipment is to be used, all other tank openings should be kept closed until compliance with the above requirements can be met;
- Electrically powered portable fans should not be used;
- Portable fans should be positioned to ensure that all parts of the tank being ventilated are equally and effectively gas freed. Fans should generally be sited at the opposite end

of the tank from the ventilation outlets and have sufficient power to penetrate to the bottom of the space;

- An effective electrical bond should exist between the portable fans and the ship;
- There is a risk that when fixed equipment is used for gas freeing a tank while being used to ventilate another tank in which washing is taking place, cross contamination could occur. In order to avoid this risk, such equipment should not be used for gas freeing a tank while simultaneously being used to ventilate another tank that is being washed;
- Where cargo tanks are gas freed by permanently installed fans through the cargo lines, the line system should be drained before venting;
- The wind direction should be monitored to ensure cargo vapours do not enter air intakes to the accommodation or machinery spaces;
- Consideration should be given to switching the ship's ventilation systems to recirculation mode. If at any time it is suspected that cargo vapours are being drawn into the accommodation or machinery spaces the gas freeing operation should be immediately stopped; and
- After gas freeing a tank, all ventilation should be stopped to allow the atmosphere within the tank to stabilize. Gas measurements should then be taken to verify that the atmosphere is free of flammable and/or toxic vapours. Even when a tank has been initially confirmed as gas free, cargo vapours trapped within valves, pipelines and the coating may leak out and the atmosphere may become dangerous for entry. The atmosphere of any tank to be entered should be tested, and further gas freeing carried out if the atmosphere is found to be unsafe.

7.7 Ship-to-ship transfers

7.7.1 Explain Ship to ship transfer operations of a chemical tanker

The ship to ship (STS) transfer of cargoes carried on chemical tankers is a frequent operation, and requires strict compliance of safety procedures.
Transfer to a barge from a chemical carrier already at a terminal, is considered to be normal cargo handling under the supervision and control of the port or terminal authorities
Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases' (STS Guide) , should be consulted The STS guide provides check lists and advice about operations, special equipment necessary, and preparation of contingency plans for dealing with emergencies.
In general, it is the responsibility of the ships' operators and agents to obtain any port permission necessary for a ship to ship transfer operation, especially if the transfer area is within the jurisdiction of a port authority
Check List 1 in the STS Guide should be used at the planning stage to ensure compatibility of ships and their cargo handling equipment
The general principles of a transfer, the area in which the transfer will take place, and the compatibility of the ships should follow the advice in the STS Guide with safety always the primary consideration.

7.7.2 Explain with reference to Ship to ship transfer operations:

7.7.2.1 Responsibilities between the 2 ship masters

When preparing for a ship to ship transfer the two masters involved should agree at the earliest opportunity on every aspect of the transfer procedure, and agree which person will be in overall advisory control of the operation (this may be one of them or an experienced

SIS superintendent). At all times, however, each master will remain fully responsible for the safety of his own ship, its crew and its cargo, and must not permit safety to be jeopardized.
'Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases' (STS Guide) needs to be followed for all STS operations. The checklists provided in the guide should be used not only at the time of transfer but also when the operation is being planned. Adherence to check list procedures will ensure that the most important aspects of an operation are covered. The checklists are:
Check list 1 - Pre-fixture information; used between operator and charterer.
Check list 2 - Before operations commence;
Check list 3 - Before run-in and mooring;
Check list 4 - Before cargo transfer; and
Check list 5 - Before unmooring.

7.7.2.2 Communications

Check list 2 - Before operations commence
The STS Guide gives advice on establishing communications at the earliest opportunity, and provides an example of an initial voyage instruction. Satisfactory communication between the two ships involved is an essential requirement for a successful ship to ship transfer operation. Neither approach and mooring, nor unmooring, should be attempted until satisfactory communications are established, and if during cargo operations there is a breakdown of communications on either ship, all operations should be suspended until they are satisfactorily restored.

7.7.2.3 Navigational warnings

The person with overall advisory control should arrange for broadcast of a navigational warning about the transfer, as described in the STS Guide, and should arrange for its cancellation on completion of the operation.

7.7.2.4 Weather conditions and limitations

It is impracticable to lay down the limits of weather conditions under which 5th transfer operations can safely be carried out. All available weather forecasts for the area should be obtained before the operation begins. Thus any decision to proceed will be taken in the light of best available knowledge

7.7.2.5 Pre-transfer preparations on each ship

Preparations on each ship in readiness for the operation, the approach of the ships to each other, berthing and mooring of the ships and safety procedures when alongside, are all well described in the STS Guide. When preparing cargo loading and discharging plans, due regard should be given to ensuring that adequate stability is maintained, hull stresses remain within sea-going limits, and that free surface effects are kept to a minimum throughout.
Normal shore resources will not be available and that prior assessment will help to avoid incorrect decisions that could compound themselves.

7.7.2.6 Information exchange

Check list 3 - Before run-in and mooring;

The cargo operation should be planned and agreed between the two ships, and should include information on the following, where applicable:

- Quantity of each grade of cargo to be transferred, and the sequence of grades.

- Cargo data from data sheets and copies of the data sheets if available
- Details of cargo transfer system to be used, number of pumps and maximum pressure
- Initial, maximum and topping off pumping rates
- The discharging ship should be informed by the receiving ship of the flow rates required for each of the different phases of the cargo operation.
- Notice of rate change, and transfer shutdown procedures If variations in transfer rate subsequently become necessary due to circumstances on one ship, the other should be advised accordingly.
- Emergency and spill containment procedures
- Watch or shift arrangements
- Critical stages of the operation.
- Local and government rules that apply to the transfer

7.7.2.7 Cargo transfer operations

Check list 4 - Before cargo transfer;
When the two ships are securely moored, and before cargo transfer commences, the pre-transfer checks should be satisfactorily completed (see Check List 4 in the STS Guide). In addition, attention should be given to completion, as far as practicable, of the appropriate Ship-Shore Safety Checklist.
Hose strings should be of sufficient length to avoid over-stressing and chafing throughout the cargo transfer To establish the correct hose length, changes in relative freeboard and ship movement must be taken into account Only hoses in good condition and suitable for the cargo to be transferred should be used The agreed transfer rate should not exceed the manufacturer's recommended flow rates for the cargo hoses. Vapour return and vapour balance between ships during an STS operation can be problematic Its main advantage will be to limit the need for vapour release to atmosphere, and crew exposure to the vapour. But attention must be given to provision of a flame arresting arrangement. For some cargoes specified in the IMO Codes, vapour return is mandatory, and STS operations will be dependent on provision of correct vapour return equipment.
Throughout cargo operations, the discharging ship and the receiving ship should each station a responsible person at the cargo manifold area to observe the hoses and to check for leaks In addition, throughout the cargo transfer, the discharging ship should station a responsible per son equipped with a portable radio at or near the cargo pump controls to take action as required.
Regular transfer rate checks and comparisons should be made between the two ships, and the results logged any differences or anomalies revealed should be carefully checked, and if necessary cargo operations should be suspended until the differences are resolved.
During cargo transfer, appropriate ballast operations should be performed on both ships in order to minimise extreme differences in freeboard, and to avoid excessive trim by the stern. Listing of either ship should be avoided, except as required for cargo tank draining on the discharging ship.
Regardless of the type of ship, any ballast which is discharged overboard should be clean all other ballast should be retained on board or transferred to the unloading ship.

7.7.2.8 Completion of cargo transfer

Check list 5 - Before unmooring.
After completion of cargo transfer, all hoses should be drained into the receiving ship prior to disconnecting.
Disconnecting of cargo hoses should receive careful attention, as it is a procedure not usually undertaken by ship's personnel. The precautions for clearing, purging and

disconnecting hoses should be taken. Cargo manifolds and cargo hoses should be securely blanked.
Relevant authorities, if any, should be informed of completion of cargo transfer and the anticipated time of unmooring. Any navigational warning issued should be cancelled.

7.8 Inhibition and stabilization requirements

7.8.2 Describe the Cargo Inhibitor certificate.

Certificate of inhibition must have following:
Which additive has been or should be introduced into the product, and in what quantities;
When the additive was or should be introduced, and for how long it is expected to be effective;
The temperature conditions to be met in order to preserve the effectiveness and lifetime of the additive;
Whether dissolved oxygen must be present in the liquid for the inhibitor to be effective;
The oxygen concentration that is required within the ullage space in order for the inhibitor to remain effective. This is especially important if the tank is to be inerted;
What action should be taken should the length of the voyage last longer than the effective lifetime of the additive.

7.8.4 Explain why close monitoring of the associated cargo systems of inhibited cargo is necessary.

Most inhibitors are not themselves volatile, so they do not vaporize with the cargo and are unlikely to be present in cargo vapours. Therefore, polymerization may occur where cargo vapours condense. Such places as inside vent valves and flame arresters should be regularly inspected, and any blockage by solid polymers promptly cleared.

7.9 Heating and cooling requirements and consequences to adjacent cargoes

7.9.1 Describe the consequences to adjacent tanks cargoes when heating or cooling some cargoes.

Cargoes that need cooling or heating must be monitored daily to keep them within specified limits and a temperature log kept.
It is important for the instructor to state here that the tank structure and tank coating temperature limitations are not to be exceeded.
The effectiveness of the inhibitor in a cargo may be reduced if the cargo temperature exceeds the value shown in the certificate of inhibitor content hence care must be exercised to maintain the temperature limits of the inhibitor to maintain the effectiveness of the inhibitor in adjacent tanks also.
Heated cargoes must never be stowed adjacent to self-reactive cargoes since excess heating of these cargoes may shorten the life of the stabilizing inhibitor.
Heated cargoes should preferably not be loaded adjacent to high vapour pressure cargoes.

7.10 Cargo compatibility and segregation

7.10.1 Explain compatibility of chemical cargo, reactive and Non reactive groups and the use of the compatibility chart.

Several authoritative bodies have divided chemical cargoes into groups, defining criteria for incompatibility between them, and have published lists of incompatible cargoes. The most familiar is published by the United States Coast Guard (USCG) (CFR 46 part 150).

According to the USCG, a mixture of two chemicals is considered hazardous (and the chemicals in question declared incompatible) when, under specified test conditions, the temperature rise of the mixture exceeds 25°C or a gas is produced as a result of the reaction.

The USCG compatibility chart assigns each bulk chemical cargo to one of 22 Reactive Groups and 14 Cargo Groups. Reactive Groups contain those chemicals which are the most reactive, so that dangerous reactions can be identified between members of different Reactive Groups (non reactive) and between members of Reactive Groups and Cargo Groups. Chemicals assigned to Cargo Groups are much less reactive, and do not react dangerously with each other.
Whether cargoes within a pair of groups are incompatible is indicated in a table, known as the Compatibility Chart.
NOTE: While the table gives general indications, the footnotes and data sheets for any two particular cargoes should always be consulted because there are exceptions to the Compatibility Chart.
Exceptions to group compatibility are also stated in the exceptions chart and must be verified for stowage planning.

7.10.2 Explain cargo segregation with respect to reactive, toxic, polymerizable, volatile, and odour sensitive cargoes.

In the case of two or more liquid chemical cargoes which react with one another in a hazardous manner, segregation must be done. The product data sheets, together with the Codes are to be studied carefully to determine the compatibility restrictions when carrying different groups of cargoes.
Inter-reactive cargoes must not be placed in neighboring tanks. Piping systems must be separated by double blind flanges/spool pieces to prevent erroneous handling of valves. Check the cargoes for cargo compatibility.
Toxic cargoes must not be placed in neighboring tanks with edible products (human or cattle). Separate the piping systems by means of double blind flanges.
Polymerizable products (e g styrene, vinyl chloride) should never come in bulkhead contact with heated cargoes. The same refers to drying vegetable oils (e g linseed oil).
Volatile products (aromatics, ketones, alcohols etc.) should not be put into bulkhead contact with heated cargoes in order to avoid unnecessary evaporation losses.
After cargoes with a strong odour (fish oil, phenol, octanol, tall oil, turpentine, molasses) the tanks should not be used immediately for odour sensitive cargoes such as glycols, vegetable oils.
After leaded gasoline, cargoes for human or animal consumption must not be loaded as the next cargo, neither "virgin naphta feedstock". Lead compounds may adhere to the bulkheads after several intermediate cargoes even in coated tanks. Wine cargo may dissolve lead remains, which are many intermediate cargoes "old".
In tanks which have contained products with a high boiling point and/or low water solubility (e g lubrication oils) there will be minute amounts of cargo left after washing. These tanks are then not suitable for a "sensitive" cargo such as methanol.

7.11 High-viscosity cargoes

7.11.1 Explain viscosity with respect to temperature

Viscosity is a measure of a liquid's ability to flow and is usually determined by measuring the time required for a fixed volume to flow under gravity through a thin tube at a fixed temperature. As the temperature of the liquid increases its viscosity decreases and therefore it flows more readily. It can also be described as a measure of the internal friction of a liquid.

The distinction between viscosity and pour point should be made clear. Liquid ceases to flow below its pour point temperature when the wax content solidifies.

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Viscosity is important as regards the pumpability of a product. Centrifugal and deepwell pumps are acceptable for the majority of cargoes but high-viscosity products such as bitumen or molasses are more suited for pumping with positive displacement pumps. High-Viscosity Substance means a noxious liquid substance in Category X or Y with a viscosity equal to or greater than 50 mPa. at the unloading temperature. Low-Viscosity Substance means a noxious liquid substance, which is not a High-Viscosity Substance. MARPOL Annex II requirement for high viscosity substances are to be complied with.

7.11.2 Explain why monitoring of discharge temperature of the cargo must be carried out.

Monitoring of discharge temperature of the cargo must be carried out to ensure cargoes are not damaged due to reactivity or over heating or even by lack of heat and to comply with MARPOL Annex II requirements for high viscosity and solidifying cargoes.

7.12 Cargo residue operations

7.12.1 Describe requirements to comply with cargo residues prior tank cleaning
Before any Tank Cleaning takes place, the pollution categories (X, Y, Z or OS) of the cargo residues in the tanks to be washed must be clearly established from one or more of the following sources: Shipping Document, IBC Code and P and A manual.

For those cargo residues which polymerize or oxidize ("dry"). the Polymerization and drying must be avoided, therefore the first cleaning operation must be carried out cold.

The P&A Manual is concerned with the marine environmental aspects of cleaning of cargo tanks, and the discharge of cargo residues quantity that may or be mixed with a washing medium.

The stripping test is required to be carried out and recorded in the vessels P and A manual to indicate that the chemical tanker complies with the requirements of Annex II, MARPOL regulations and the minimum permissible quantities remain on board prior commencement of tank cleaning.

If pumping capabilities are affected then quantities remaining need to be established and port state informed prior tank cleaning. Adequate Log book entries made and excess residues discharged in accordance with established procedures to shore reception facilities for all pollutant categories of cargoes.

7.13 Operational tank entry

7.13.1 Describe precautions to take prior making an entry into cargo tanks for operational requirements.

On chemical tankers entry of personnel into cargo tanks is a more common practice than it is on oil tankers.
Chemical tanker operators' instructions often make special allowance for this when describing procedures for entry into cargo tanks.
It is essential that procedures are sufficiently stringent to ensure the safety of personnel.
It is essential that the ship's safety management system is robust enough to make certain that instructions are followed.

A system should be in place to indicate which cargo tanks are safe for entry by marking (or tagging) of appropriate tank entry hatches. The marking should be unambiguous, and procedures should be such that absence of the mark will forbid entry. Permit to work systems must be strictly followed.
While Multiple entry permits may be found to simplify the paper administration, there must be rigorous control to ensure cancellation of existing permits, and that the atmospheres of all named tanks are correctly tested at the time of issue so that an effective extension of a period of validity does not occur by default.
After the carriage of animal and vegetable oils, manual sweeping of the cargo.
Tanks may be necessary in order to push the semi-liquid residues towards the pump suction to complete the discharge.
The tank should be mechanically ventilated for at least 1 hour, concurrently with discharge, to ensure its atmosphere is safe for entry before sweeping begins.
An additional risk of sweeping tanks is that animal and vegetable oil makes all surfaces very slippery and therefore all those who enter the tank should be advised to take extra care.
The heating coils should be closed off prior to the entry of personnel to avoid the risk of burns.

7.13.3 Demonstrate making an operational entry into cargo tanks for residue sweeping

This can be demonstrated by role play:
The following guidelines should be followed:
Display documented procedures for entry that should be followed which will involve issue of a permit.

- Ventilation should be continuous
- Proper PPE should be donned
- An experienced person should be appointed to be the leader of each sweeping team. Their role will be to coordinate the work and look out for the safety and welfare of the team.
- The team leader should be able to communicate effectively with the person stationed at the entrance to the tank.
- All members of the team should be encouraged to look out for the wellbeing of their fellow team members.
- If, at any time, a person finds it hard to breath or feels unwell due to the effect of the heat or any other cause, they are to alert the leader who will raise the alarm. The person should vacate the space as soon as possible by whatever means is practicable in the circumstances.

8.0 Development and application of cargo-related operation plans, procedures and checklist.

For this section from the learning objective 8.3 to 8.6, the instructor is required to use the documentation listed below in 8.8 and demonstrate practically with the trainees.

8.7 Explain generally the requirements for tank cleanliness prior to loading cargo

General: Many factors need to be considered in order to achieve the desired tank cleaning result. Planning a tank cleaning operation is the key to success. Planning should be carried out by qualified people only. Planning the cleaning operation should be kept in mind even before loading the cargo, to avoid potential adverse effects from adjacent cargoes.

A good preparation of the cleaning operation will avoid tank rejections as well as incidents during the operation. In general the tank cleaning procedure can be determined from the product properties of the product to be cleaned, the surrounding conditions, the available equipment and last but not least the requirements of the product to be loaded (Next Cargo).

Required cleanliness standard of the next cargo
Although not officially defined in chemical shipping two major cleanliness standards should be distinguished:

Water White Standard means visually clean, dry and odour-free. Wall wash not required.

High Purity Standard is required for very sensitive cargoes to be loaded such as products applied in food processing (Food Grade) or in pharma production (USP), where any contamination is a potentially high risk for the application. Another category of product that typically requires high purity standard are all active solvents, such as chlorinated hydrocarbons, glycol ethers, light alcohols (e.g. methanol), ketones (e.g. acetone) and many hydrocarbons (e.g. hexene). These chemicals tend to dissolve all remaining impurities resulting in potential contamination of the substance.

Sometimes chemical companies require High Purity Standard because the application of the product in chemical processing is very sensitive to contamination (e.g. poisoning of catalyst) and is thus comparable with the requirements for food or pharma grade. In some chemical tank cleaning software, for every product the typical cleanliness standard is listed. Depending on companies and their quality requirements those standards might deviate from the usual cleanliness requirement.

8.8 List the reference publications that provide useful information while planning cargo:

Following are the main reference publications that provide useful information while planning cargo operations.

- MARPOL 73/78 (latest consolidated version)
- International Safety Guide for Oil Tankers and Manuals (ISGOTT)
- ICS Chemical Tanker Safety Guide
- Procedure and Arrangements Manual (Approved by Class)
- Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk
- Ship's "VEC System Operating Manual" (Approved by Class)
- BCH/IBC Code
- CFR 33 Parts 124 to 199
- Guide to Port Entry
- Ship to Ship Transfer Guide (Petroleum)
- Safety in Oil Tankers
- Safety in Chemical Tankers
- IMDG Code
- Supplement to IMDG Code (Including MFAG and Ems)
- SOPEP / SMPEP
- Clean Seas Guide for Oil Tankers
- FOSFA (for Oils, Seeds and Fats)
- Tank Coating Manufacturer's Compatibility List
- Prevention of Oil Spillage through Cargo Pump-room Sea Valves
- CHRIS (Chemical Hazardous Response Info Systems) Guide (USCG)
- USCG Chemical Data Guide for Bulk Shipment by Water
- MSDS for particular cargo carried
- Tank Cleaning Guide

9. Ability to calibrate and use monitoring and gas-detection systems, Portable gas measuring instruments and equipments.

9.1 Explain the requirements of gas detection and monitoring systems for chemical tankers.

In order to maintain a proper control of the tank atmosphere and to check the effectiveness of gas freeing, especially prior to tank entry, several different gas measuring instruments need to be available for use.
The correct one to use will depend upon the type of atmosphere being measured.
All Instruments should be used in accordance with the manufacturers' instructions
Ships carrying toxic or flammable products (or both) should be equipped with at least two portable instruments that are designed and calibrated for testing the gases of the products carried. If the instruments are not capable of testing for both toxic concentrations and flammable concentrations, then separate sets of instruments should be provided.
Vapour-detection instruments may be portable or fixed. If a fixed system is installed at least one additional portable instrument should be provided.

9.2 Explain the use of vapour detection equipment as required by the IBC code.

Vapour detection equipments are used for:
- measuring concentrations of gas in or near the flammable range;
- detecting low concentrations of cargo vapour in air and in inert gas, or in the vapour of another cargo;
- measuring concentrations of oxygen in inert gas or cargo vapour, or in enclosed spaces.

Personnel should fully understand the purpose and limitations of different vapour detection equipment, whether fixed or portable as required by the IBC code.

9.3 Describe
a. Combustible gas detectors and
b. Thermal conductivity meters.

a. Combustible gas indicators:

A gas sample of a combustible gas indicator or explosimeters may be taken in several ways:
- Diffusion.
- Hose and aspirator bulb (one squeeze equates to about 1 metre of hose length).
- Motorised pump (either internal or external).

Flammable vapours are drawn through a sintered filter (flashback arrestor) into the pellistor combustion chamber. Within the chamber are two elements, the Detector and the Compensator. This pair of elements is heated to between 400 and 600ºC.
When no gas is present, the resistances of the two elements are balanced and the wheat stone bridge will produce a stable baseline signal. When combustible gases are present, they will catalytically oxidise on the detector element causing its temperature to rise. This oxidation can only take place if there is sufficient oxygen present. The difference in temperature compared to the compensator element is shown as % LFL.
The reading is taken when the display is stable. Modern units will indicate on the display when the gas sample has exceeded the LFL.
Care should be taken to ensure that liquid is not drawn into the instrument. The use of an in-line water trap and a float probe fitted to the end of the aspirator hose should prevent this occurrence. Most manufacturers offer these items as accessories.

Instrument Calibration and Check Procedures

The instrument is set up in the factory to be calibrated using a specific hydrocarbon gas/air mixture. The hydrocarbon gas that should be used for calibration and testing should be indicated on a label fixed to the instrument.

Precision of Measurement

The response of the instrument depends upon the composition of the hydrocarbon gas being tested and, in practice, this composition is not known. By using propane or butane as the calibration gas for an instrument being used on tankers carrying stabilised crude oil or petroleum products, the readings provided may be slightly in error by giving a slightly high reading. This ensures that any reading indicated will be "on the safe side".
Factors that can affect the measurements are large changes in ambient temperature and excessive pressure of the tank atmosphere being tested, leading to high flow rates which in turn affect the pellistor temperature.
The use of dilution tubes, which enable catalytic filament indicators to measure concentrations in over rich hydrocarbon gas/air mixtures, is not recommended.

Operational Features

Older instruments are fitted with flashback arresters in the inlet and outlet of the detector filament chamber. The arresters are essential to prevent the possibility of flame propagation from the combustible chamber and a check should always be made to ensure that they are in place and fitted properly. Modern pellistor type instruments have sintered filters usually built into the pellistor body.
Some authorities require, as a condition of their approval, that PVC covers be fitted around meters with aluminium cases to avoid the risk of incendive sparking if the case strikes rusty steel.

b. Thermal conductivity meters:
These instruments work by measuring thermal conductivity of samples of gas. They are sometimes called katharometers. Electrical power is applied to a heater filament which is used as the sensing element: the filament temperature stabilizes at a value depending on the thermal conductivity of the gas around it. Any variation in the concentration of the gas affects the filament temperature, resulting in a change in electrical resistance which is in turn indicated by a meter.
The Wheatstone bridge principle which is used for thermal conductivity meters is similar to that of the combustible gas detector, but the filament temperatures are lower and the instruments can be used to detect concentrations of gas from 0-100% by volume (compared to 0-100% LFL in a combustible gas indicator).
The filament may be mounted so that the sampled gas flows directly over it or diffuses into it. The direct flow type responds more quickly to concentration changes but is dependent on flow rates. The diffusion type gives a slower response but is less flow sensitive. It is important to note that changes in operating conditions (e.g. filament voltage or gas flow rate) may alter the filament temperature. The maker's handbook for the instrument should be checked.
A thermal conductivity meter can be set to detect cargo vapour mixed with inert gas. The meter must be calibrated to suit the gas being tested, or manufacturer's correction curves used. Reference should be made to the manufacturer's instructions before every occasion of use.
Note: The roles of combustible gas detector and thermal conductivity meter can be combined into one instrument, although the two functions - measuring percentage of LFL

and concentration of vapour by volume respectively - remain distinct. In some ships, fixed gas detection equipment uses this combination technique.

9.4 Describe Infrared detectors

Organic gases such as butane, methane and petroleum absorb infrared radiation. This property is used in fixed or portable equipment to detect such gases in concentrations over the range 0-100% LFL and/or 0-100% volume. Infrared radiation is passed through two tubes, one containing a known concentration of gas, the other containing the sample to be measured.
The extent of absorption is in proportion to the gas concentration, and the output from the two tubes is compared electronically. The electronic signal can be used to drive an indicating meter or a pen recorder, or to trigger other equipment such as an alarm. Calibration of the instrument is set for each gas to be measured.
Infrared detectors will not reliably detect chemical gases, and are not commonly used on chemical tankers.

9.5 Describe the use of Chemical detector tubes

These instruments, often referred to as Dragger (common make) tubes, normally function by drawing a measured sample of the atmosphere to be tested through a proprietary chemical reagent in a glass tube.
The detecting reagent becomes progressively discoloured if a contaminant vapour is present in the sample. The length of the discoloration stain gives a measure of the concentration of the chemical vapour which can be read from the graduated scale printed on the tube. Detector tubes give an accurate indication of chemical vapour concentration, whatever the oxygen content of the mixture.
It is important that the correct volume of atmosphere sample, according to the manufacturer's instructions, is passed through the tube, otherwise the measurement will not be accurate. Too small a sample volume will give a low value. With some instruments the length of sample hose is a critical factor in obtaining a correct reading. The presence of a second gas may affect readings and cause inaccuracies. Chemical detector tubes are specific for particular gases or vapours, which need not have flammable or combustible properties - for example, oxygen or water vapour (to establish dewpoint).

The tubes are designed to measure low vapour concentrations accurately, and are probably the most convenient and suitable equipment to use. They should always be used when the cargo vapour presents a serious inhalation hazard, e.g. acrylonitrile. The storage life of these tubes is usually limited, and it is necessary to ensure that out of date tubes do not remain available for use.
Read the gas sampling tube instructions carefully. The gas sampling tube instruction sheet gives various numbers of pump strokes (n) or test air volume to be sampled depending on the level of detection needed. (More pump strokes = more air = a more sensitive test.) The ends of the glass tube are broken off using a special cutter provided by the manufacturer of the tube.
The "outlet" end of the detector tube is inserted into the gas collecting pump. The "inlet" end of the tube is exposed to the air to be tested, and the pump is operated for the required number of strokes before looking for a color change on the tube's gas concentration scale. The documentation with each gas detection tube will describe the chemistry of the tube, its accuracy, its calibration, and the color change for which the user is to check.
Effects of temperature on gas level readings
The chemistry and thus the sensitivity and ultimate gas concentration reading shown by a colorimetric gas detection tube may be affected by temperature, it is important to read the

temperature data in the gas detection tube specification sheet included with the particular gas detection tube being used.
Effects of other chemicals and gases on gas level readings
The gas detection tube instructions may also list other gases which, if present, can affect the accuracy of the test. The chemistry and thus the sensitivity and ultimate gas concentration reading shown by a colorimetric gas detection tube may therefore be affected by other gases or chemicals present in the location being measured.
For this reason it is also important to read the characteristics of the gas detector tube being used.

9.7 Explain Calibration and Test Procedures of gas measuring instruments

Calibration Rules
The following are a few basic calibration rules for Gas Instruments.:
Follow the manufacturer's guidelines for proper calibration. Operators cannot perform any job, including Gas instruments calibration, properly or safely without the right tools. The type and concentration of calibration test gas, sample tubing, flow regulators, and calibration adapters are key links in the calibration chain. Operators should conduct any testing to verify the operation of the gas monitor in an environment that is the same as (or similar to) the working conditions (e.g., temperature, humidity, atmospheric pressure).
Only use a certified traceable test gas, and do so before its expiration date. The instrument can only be as accurate as the test gas used to calibrate it. Be certain that the supplier can provide a certificate of analysis for every test-gas cylinder. The concentration of the test gas, particularly reactive gases such as hydrogen sulfide and chlorine, will only remain stable for a limited period. Never use a test gas after its expiration date.
Train operators on the proper methods of calibration. Most instruments are designed to be field calibrated with detailed instructions provided in the manufacturer's user manual, training videos, or computer-based training modules. Ships responsible officers should be trained for performing Gas measuring instrument's check and calibration.
NOTE: The instructor must have a typical gas measuring instrument, and its calibration kit, refer to its manufacturer's instructions and perform the calibration for the trainees.

10. Ability to manage and supervise personnel with cargo-related responsibilities

10.1 Explains how the responsible cargo officer on watch supervises and directs the cargo operations ensuring that the stresses and stability of the vessel are always within limits and that sufficient qualified personnel are on duty

The Chief Officer shall nominate the responsible watch keeping cargo officer. The chief officer who is the Officer in charge of cargo operations shall attend to all critical cargo & ballast related operations to direct the operations at the beginning and end of work, before and after the beginning of deballasting operations, under rough weather and sea conditions, during tank cleaning and at all other major steps of the operations.

Personnel Arrangement during Cargo Operations
Sufficient crew should be available to man the manifold and Gangway at all times, as well as to attend the moorings.
The Second and Third Officers should be on duty as cargo watch officer in two shifts, and the Chief Officer must give adequate instructions to the officer on duty. Such instructions along with the cargo stowage plan which must be adequately followed to ensure the vessel is in a sea going condition all the time ensuring that it is effectively used and effectively be passed on to the next watch keeping duty cargo officer and monitored till completion, it should, as far as possible, be noted down for confirmation.

Deck ratings should be on duty as to cargo operations in two or three shifts depending on the man power availability.
The Watch keeping Officer shall ensure that sufficient personnel are available to safely conduct all activities required for Cargo Chemical transfer operations.
The Chief Engineer shall arrange engineers and ratings as follows:
During cargo transfer operations, the Chief Engineer shall have an engineer & crew member who are well familiar with the cargo handling equipment and machinery of the vessel stay on board in case of any break downs or trouble.
At least for the following operations, assign an engineer on duty to monitor the related machinery and to take necessary measures.
- Start / stop of inert gas system where provided
- Start / stop of cargo pumps located in the engine room
- Tank cleaning related machinery operations
- Start / stop of heating arrangements or cooling systems where provided
- Start/ stop of ballast pump.

The Responsible Engineer shall be present during starting & stopping of cargo operations. Also all critical steps in between shall be attended by him.
The junior engineer shall keep the watches in two shifts.

10.2 Explains how the responsible officer ensures and maintains:

- suitability of cargo containment prior loading.
- Cargo is loaded, as per stowage plan
- Cargo is cared for during passage with respect to monitoring its parameters, ventilation, cooling, heating etc., as required.
- Cargo is unloaded safely as per plan.
- Issuing relevant standing/night orders.
- Records for cargo and ballast operations are maintained as per company procedures.
- Records of cargo parameters, soundings of ballast tank and other spaces are maintained as per company procedures.
- Standard language is employed
- seafarers on cargo watches shall carry out the work as assigned to them by the responsible officer of the watch

The chief officer ensures and maintains:
- suitability of cargo containment prior loading by ensuring tanks have been cleaned up to standards required.
- Cargo is loaded, as per stowage plan by explaining the factors of trim, list, volumetric quantities, loading rate and sequence of loading and deballasting to enable the chemical tanker to be ready to leave harbour immediately in case of any emergency
- Cargo is cared for during passage with respect to monitoring its parameters, ventilation, cooling, heating etc., as required by ensuring charterers instructions are followed and conditioning the cargo as required is carried out.
- Cargo is unloaded safely as per plan by explaining the factors of trim, list, volumetric quantities unloading rate and sequence of unloading and ballasting to enable the chemical tanker to be ready to leave harbor immediately in case of any emergency
- Issuing relevant standing/night orders taking into account requirements relating to prevailing situations.
- Records for cargo and ballast operations are maintained as per company procedures as per masters standing orders
- Records of cargo parameters, soundings of ballast tank and other spaces are maintained as per company procedures and as per masters standing orders

- Standard language is employed especially in case of a multi lingual crew ensuring it is understood by all.
- seafarers on cargo watches shall carry out the work as assigned to them by the responsible officer of the watch keeping in mind the work / rest hours requirements.

11 Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including:

- chemical cargoes categories (corrosive, toxic, flammable, explosive)
- chemical groups and industrial usage
- reactivity of cargoes

Physical properties: These properties describe the physical characteristics of a substance.
Examples of physical properties are: The mass, volume, and colour of a substance are physical properties, and so is its ability to conduct electricity also the colour, smell, freezing point, boiling point, melting point, infra-red spectrum, opacity, viscosity and density. There are many more examples. Note that measuring each of these properties will not alter the basic nature of the substance.
Chemical Properties: Properties that change the chemical nature of matter or substance are their chemical properties.
Examples of chemical properties are: heat of combustion, reactivity with water, or with other substances, corrosivity the pH value etc..
The more properties we can identify for a substance, the better we know the nature of that substance. These properties can then help us model the substance and thus understand how this substance will behave under various conditions.
The chemical properties of cargoes assist to form the Chemical Groups, and the reactivity / compatibility tables to facilitate a safe loading plan to ensure safety to the crew and the environment.

11.1.1 Explain the properties of Corrosive, toxic & flammable cargoes

Acids, anhydrides and alkalis are among the most commonly carried corrosive substances. They can rapidly destroy human tissue and cause irreparable damage. They can also corrode normal ship construction materials, and create a safety hazard for a ship. Acids in particular react with most metals, evolving hydrogen gas which is highly flammable.

Toxicity is the ability of a substance, when inhaled, ingested, or absorbed by the skin, to cause damage to living tissue, impairment of the central nervous system, severe illness or, in extreme cases, death. The amounts of exposure required to produce these results vary widely with the nature of the substance and the duration of exposure to it.
Toxicity is objectively evaluated on the basis of test dosages under controlled conditions, and expressed as threshold limit values (TLVs).
If the cargo to be loaded has an odour threshold which is higher than the TLV-value of that cargo then the danger cannot be sensed in advance, hence more control measures must be taken (e.g. allyl alcohol, carbon tetra chloride, etylene dichloride).

Vapour given off by a flammable liquid will burn when ignited provided it is mixed with certain proportions of air, or more accurately with the oxygen in air. If there is too little or too much vapour compared to the air, so that the vapour-and-air mixture is either too lean or too rich, it will not burn.

The range of flammable vapour concentrations in air between the lower and upper flammable limits is known as its Explosive Range. Mixtures within this range are capable of being ignited and of burning or exploding.

11.2 Chemical groups and industrial usage
11.2.1 Explain Organic and Inorganic chemical groups

Organic and inorganic Cargoes in the chemical trade may be divided into four groups:

- petrochemicals
- alcohol and molasses
- vegetable and animal oils and fats
- Acids and inorganic chemicals

'Petrochemicals' is the collective name for organic chemicals derived from crude oil, natural gas or coal
Alcohols may be derived from hydrocarbons or produced by fermentation
Vegetable and animal oils and fats are products derived from seeds of plants and from fat of animal or fish
Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow) with an alcohol producing fatty acid esters.
Biodiesel can be used in pure form or may be blended with petroleum diesel at any concentration in most injection pump diesel engines.

Coal tars are complex and variable mixtures of phenols, polycyclic aromatic hydrocarbons (PAHs), and heterocyclic compounds. Being flammable, coal tar is sometimes used for heating or to fire boilers. Like most heavy oils, it must be heated before it will flow easily
Acids and inorganic chemicals:
Inorganic chemicals are those that are not produced from living or once-living organisms. However, a number of inorganic chemicals such as sulphur and ammonia can be manufactured using petroleum as the raw material. Acids may be organic or inorganic.

12 Understanding the information contained in a Material Safety Data Sheet (MSDS)

12.1 Explain and demonstrate the information contained in a MSDS

The Contents of a typical Material Safety Data Sheet: It is recommended that the information in an MSDS should be presented in 16 sections and in the order shown below. The length of an MSDS is not fixed and generally reflects the hazards of the substance and the information available. The pages of the MSDS should be numbered and the end of the document should be indicated to ensure that any page is not missed out.

Section 1: Identification – Includes the product name as it appears in the IBC Code or most recent edition of the MEPC.2/Circ. To include the manufacturer or distributor's name, address, phone number; emergency phone number; recommended use and restrictions on use.

Section 2: Hazard(s) identification – Includes all hazards associated with the product.

Section3: Composition/information on ingredients – Includes information on chemical ingredients, water content, any inhibitors, and denaturing agents which may be present.

Section 4: First-aid measures – Includes important symptoms/ effects, acute, delayed, and required treatment.

Section 5: Firefighting measures – List suitable extinguishing media and techniques, equipment; specific chemical hazards arising from fire.

Section 6: Accidental release measures – List emergency procedures; protective equipment; proper methods of containment and clean up.

Section 7: Handling and storage – List precautions for safe handling and storage of cargoes, including incompatibilities with other cargoes/products (e.g. by reference to the use of the USCG Compatibility Chart).

Section 8: Exposure controls/personal protection – List Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); means of vapour detection; appropriate controls and personal protective equipment (PPE).

Section 9: Physical and chemical properties – List the physical and chemical characteristics of the substance.

Section 10: Stability and reactivity – List chemical stability and possibility of hazardous reactions.

Section 11: Toxicological information – Includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

Section 12: Ecological information – Includes eco-toxicity; persistence and degradability; bioaccumulation potential, and mobility in soil.

Section 13: Disposal considerations – Description of wastes and information on their safe handling and methods of disposal. It should be noted that Annex II of MARPOL 73/78 regulates discharge of residues of chemical liquids transported in bulk.

Section 14: Transport information – Hazardous Materials or Dangerous Goods shipping information.

Information under this section should include the information to comply with Marpol Annex 1 or II regulations as applicable.

Section 15: Regulatory information – Safety, health and environmental regulations specific to the product.

Section 16: Other information – Includes the date of preparation or last revision.

13 Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations, including:

13.1 Flammability and explosion

13.1.2 Explain the terms flashpoint, boiling point, flammability limits and auto-ignition temperature

Boiling Point
Is defined as the temperature at which the vapour pressure of a liquid equals that of the atmosphere above its surface; this temperature varies with pressure (for specific pressures information is available in data sheets).

The instructor should inform the trainees that if the temperature of the cargo approaches and exceeds its boiling point, the state of aggregation from liquid phase to vapour phase will take place corresponding to an increasing pressure inside the tanks.

Flash point
Flash point is the lowest temperature at which a flammable liquid will produce enough vapour to form an ignitable mixture with the surrounding air. Every liquid has a vapour pressure, which is a function of temperature. However not all liquids produce a flammable vapour. As the temperature of a flammable liquid increases, the vapour pressure rises and, as a result, the concentration of flammable vapour in the air also increases. Should the temperature of the liquid exceed the flash point, the threat of an explosion from an ignition source becomes real.

Explosive/flammable limits
The explosive/flammable limits of any flammable liquid are defined as the range of concentration of flammable vapour (expressed as % by volume in air) in which an explosion can occur upon ignition. It is the oxygen in air which mixes with the flammable vapour to create an explosive mixture. At the bottom of the range is the lower explosive/flammable limit (LEL/LFL), below which there is insufficient flammable vapour in the air to support combustion. At the top of the range is the upper explosive/flammable limit (UEL/UFL), above which there is insufficient air within the flammable vapour to support combustion. Mixtures of flammable vapours and air which fall between the LEL and the UEL are explosive and are easily ignited by an ignition source.
Auto Ignition temperature is the lowest temperature to which a solid, liquid or gas requires to be raised to cause self-sustaining combustion without initiation by a spark or flame or other source of ignition.

13.1.6 Explain Flammability of chemical cargoes and their control measures

The fire hazard presented by a cargo stowed in a cargo tank is dependent on the flammability of the product and the oxygen content of the atmosphere above it.
An inerted atmosphere will become flammable again if air is admitted. It is therefore important that the oxygen level is regularly checked and the tank topped up with IG as necessary.
The regulations also describe the equipment and control devices necessary to ensure a safe operation.
Not all chemical tankers are fitted with inerting capability but an increasing number of ships are provided with inert gas systems, usually nitrogen.
Regulations require an inert atmosphere to maintain a maximum oxygen content of 8%, although some chemical cargoes will need a lower oxygen content to be maintained.

13.2 Toxicity

13.2.1 Explain degree of Toxicity of chemicals.

The degree of Toxicity can be defined as acute, sub-acute or chronic:
- A substance with acute toxicity is sufficient to cause harm almost immediately after exposure. Substances commonly called poisons have extreme acute toxicity;
- A substance with sub-acute toxicity will only start to show symptoms after repeated exposure in doses too small to cause an immediate acute effect; or
- A substance has chronic toxicity if its effects only appear after repeated exposure over a period of time. Examples are substances which are carcinogenic (cancer inducing) such as benzene.

13.2.3 Explain three defined types of toxicity which relate to the nature of the substance

Generally there are three defined types of toxicity which relate to the nature of the substance:

1. Chemical
This relates to specific chemical compounds. The toxicity of such compounds or mixture of compounds is measured in terms of the exposure time needed to cause an effect.

2. Biological
This relates to the effects of viruses and bacteria. Measuring the toxicity of such compounds is more complicated because it depends on the effectiveness of the immune system of the person exposed.

3. Physical
This relates to compounds that on their own are not specifically toxic, but which can be directly responsible for potentially life threatening consequences, for example the inhalation of dust from coal and asbestos.

13.2.4 Explain how toxic poisons can enter the body:

Toxic poisons can enter the body by:
1. By being swallowed (ingestion)
2. By absorption through the skin, eyes and mucous membranes (dermal toxicity)
3. By inhalation as a vapour or mist (inhalation toxicity)

13.3 Health hazards

13.3.1 Explain the health hazards to personnel exposed to toxic chemicals

Many chemical cargoes contain components that are known to be hazardous to human health. In order to minimise the impact on personnel, information on cargo constituents should be available during the cargo transfer to enable the adoption of proper precautions.
Even the slightest exposure to a highly toxic substance can result in serious health problems.
A highly toxic substance is one where only a small quantity of the substance may cause serious harm.
An exposure limit is the maximum concentration of a chemical substance or vapour in air that a person can safely be exposed to, day after day, without suffering any adverse health effects. Exposure limits are generally expressed as a Threshold Limit Value (TLV).
Exposure limit definitions should not be regarded as the absolute dividing line between what is safe and what is a hazardous working environment. It is always good operating practice to keep vapour concentrations to an absolute minimum and well below the TLV.
The most widely used TLVs are those issued by the American Council of Governmental and Industrial Hygienists (ACGIH).

13.3.2 Explain the three categories of TLV

• TLV – TWA (Time Weighted Average)
The concentration of vapour in air which may be experienced for an eight hour day or 40 hour week throughout a person's working life. This is the most commonly quoted TLV.

• TLV – STEL (Short Term Exposure Limit)
The maximum concentration of vapour in air allowable for a period of up to 15 minutes, provided that there are not more than four exposures per day and at least one hour between each. The STEL is always greater than the TWA however this figure is not always provided for all substances.

• TLV – C (Ceiling)
The absolute maximum concentration of a vapour to which a person should be exposed which should never be exceeded. It is given only for fast acting substances. This is the highest of the three values for a given substance.

13.4.1 Explain inert gas composition of a membrane separator nitrogen generator

In the membrane separator nitrogen generator the flow is adjusted to give nitrogen of the purity required - typically with an oxygen content variable between 0.1% and 2% by volume, with water and carbon dioxide contents below 5ppm.

13.4.2 Explain inert gas composition of an oil fired IG Generator

In the oil fired Inert gas generator, If the plant is efficiently burning good quality fuel, the inert gas can be expected to have approximately the following composition:
Carbon dioxide 15%
Oxygen 1.0%
Carbon monoxide 0.1%
Oxides of nitrogen 120ppm
Hydrogen 100ppm
Sulphur dioxide / sulphur trioxide 120ppm
Nitrogen Balance

13.4.4 Explain the dangers of Nitrogen exposure

The air humans breathe normally contains 78% nitrogen and 21% oxygen with the remaining 1% made up of argon, carbon dioxide and other gases.
When we breathe, part of the oxygen is absorbed by the lungs and replaced by carbon dioxide.
When nitrogen levels increase this displaces the oxygen (hypoxia), and therefore the exchange of carbon dioxide and the stimulation to breathe is reduced. When the oxygen concentration drops from 21% to 16%, pulse and breathing rates drop, and mental functions are impaired. Below 14%, people suffer abnormal fatigue, emotional upset, poor judgment, and faulty coordination. Further reductions result in nausea, vomiting, permanent heart damage and loss of consciousness. At about 5% oxygen or below, a person will fall into a coma within 40 seconds, requiring emergency administration of oxygen to have any chance of survival.
Like the air that we breathe, nitrogen is colorless, odorless and tasteless and is therefore undetectable to the human senses. As the stimulation to breathe is removed by the presence of nitrogen there are no physical warning signs that the atmosphere is dangerous.
Exposure to a high concentration of nitrogen is usually fatal unless immediate action is taken. The trainees must be apprised that it may only take one breath of Nitrogen to end life!
The following risks to crews have been identified with operations involving the use of nitrogen:
- During busy port operations some tanks may need to be inerted while others will necessitate entry by crew or shore personnel for cleaning and inspection purposes;
- Accidentally entering an inerted tank;

- Working in tanks or enclosed spaces which have been inerted with nitrogen or are adjacent to spaces inerted with nitrogen;
- Inhaling nitrogen when working near a tank where nitrogen is being displaced, for example when loading an inerted tank;
- Inhaling nitrogen while working on cargo lines and hoses during and following line clearing operations utilizing compressed nitrogen;
- Inhaling nitrogen from inerted tanks during tank cleaning, especially when portable machines are uses; and
- Working in machinery spaces where nitrogen generating equipment is installed.

13.4.5 Describe precautions to be taken when handling nitrogen.

The shipping company should have procedures to address the hazards of working with nitrogen, and the crew should be trained and familiarised with these procedures;

- Prior to work commencing, a tool box talk should take place to ensure that all involved have been briefed regarding the job and required safety measures including the use of appropriate PPE;
- Operations such as inerting some tanks with nitrogen while other tanks are being cleaned or prepared for inspection must be strictly controlled to avoid tank entry during inerting operations. Company procedures should address all of the risks involved and ensure safety barriers and enclosed space entry procedures are followed at all times. Should tank entry become necessary, all inerting should be stopped and tank entry procedures must be followed.
- Areas where nitrogen operations are taking place should be restricted only to those crew members and shore personnel who are directly involved in the operation. Personnel working in these areas should carry a personal oxygen meter;
- Crew and shore personnel should be aware that deck structures may create areas that can allow nitrogen to accumulate near nitrogen inerted spaces. This can result in an oxygen deficient atmosphere developing especially if there is little wind to disperse the gas;
- Enclosed spaces inerted with nitrogen should be tagged with suitable weather resistant warning signs, such as: "Danger Nitrogen, do not enter";
- Nitrogen supply lines should be capable of being blanked so as to prevent the accidental inerting of a tank. Precautions should also be taken to ensure that nitrogen cannot enter the tank via cargo lines, vent lines or any other tank connections;
- Following unloading, tanks inerted with nitrogen should be kept closed until the tank has been cleaned, ventilated, and tested to ensure it is gas free and the oxygen level restored.
- Access to the nitrogen generating machinery space should be controlled and oxygen alarms and emergency escape breathing apparatus provided.
- Some vessels are provided with tanks to store nitrogen in liquid form. This requires a storage temperature of -196°C and therefore handling presents a low temperature hazard. Skin contact with liquid nitrogen can rapidly result in frostbite, personnel liable to contact with such storage facilities and associated systems should wear appropriate PPE to protect against this risk.

13.5 Electrostatic hazards

13.5.1 Describe the operations where the risk of generating static sparking may occur on board a chemical carrier.

The risk of generating static sparking can occur during the following operations on board a chemical carrier:

1. Loading and unloading
An electrostatic charge is generated within the liquid as it flows through pipelines. The amount of charge generated will depend on the ability of the liquid to conduct electricity, a property known as its electrical conductivity.

2. Steaming
Injecting steam into a cargo tank during tank cleaning can cause a buildup of static within the condensed water droplets.

3. Gas freeing
Forced air, gas freeing devices can cause a static charge to build up on the body of the equipment.

4. Cargo tank cleaning
A static charge will be produced when water is forced, under high pressure, through the nozzle of a tank cleaning machine. As a result, the water mist inside the cargo tanks may become charged. A charge can also build on the nozzle of the tank cleaning machine unless the machine is electrically grounded.

5. Sampling/Gauging
Objects such as ullage probes or sampling equipment may already contain an electrostatic charge prior to being lowered into a tank. Lowering and raising such equipment in and out of a cargo tank may also generate a static charge on the line.

13.5.2 Explain the precautions to be taken for static hazards when loading chemical cargoes.

Splash filling should never be used when loading static accumulating cargoes.
When the rising liquid level in the tank covers the pipeline inlet, turbulence in the tank is considerably reduced and the risk of generating a static charge diminishes.
To avoid excessive turbulence during the loading of a cargo that is known to be a static accumulator, the loading rate should be kept low until the inlet to the cargo tank is well covered.
An insulated flange is fitted on the shore loading system to prevent the generation of a spark due to ship shore voltage differential during the connection/disconnection process.
All metal on the seaward side of the insulating section should be electrically continuous to the ship, and all metal on the landward side should be electrically continuous to the jetty earthing system
In order to avoid the dangers of static electricity all ropes and lines used for sampling and gauging should be made of non-static generating material.
Anti-static precautions must be taken & cargo relaxation periods observed when dealing with static accumulator products;
If it is necessary to clear lines of a static accumulating cargo, only an inert gas in an inerted atmosphere should be used (never compressed air).

13.5.3 Explain hazards of static generation and its controls during tank cleaning in a non-inert tank after unloading flammable cargo

It should be noted that many tanks are washed without the use of inert gas because of the cargo and its vapours being non-flammable, however for flammable cargoes, static electricity generated during tank cleaning operations may create a spark which could ignite a flammable atmosphere.
Compliance with company procedures on tank cleaning operations is essential to ensure that tank cleaning carried out in a non-inerted atmosphere is safe.

- Tank cleaning using water under pressure can generate a significant amount of static electricity. In addition the wash water is often heated and this creates water vapour in droplets which can store an electrostatic charge.
- Washing media other than water may produce greater amounts of static electricity and further precautions might be required.
- Heated wash water may be utilized, but use should be discontinued if the gas concentration reaches 35% of the LFL.
- A hot wash for a low flashpoint product should only take place following a full (i.e. top to bottom) cold wash cycle;
- The tank should be kept drained during washing. Washing should be stopped, as necessary to clear any build-up of wash water;
- Measures should be taken to guard against ignition from mechanical defect of machinery, e.g. in-tank (submerged) cargo pumps, tank washing machines, tank gauging equipment etc;
- Precautions should be taken to eliminate the risk of mechanical sparks from, for example, metallic objects such as hand tools, sounding rods, sample buckets etc. being dropped into the tank;
- Fixed tank cleaning machines are securely bonded to the ship's structure and therefore any static electricity generated will be safely drained away; and
- Portable tank cleaning machines should also be continually electrically bonded through the tank cleaning hoses to the ships structure. This will ensure that any charge is drained so that, when it is lifted from the tank, a spark will not be generated between the machine and the ship's structure as it passes through the tank cleaning hatch.
- When portable washing machines are used, the tank cleaning machine and hoses should be connected to the tank cleaning line before being lowered into the tank. Connections should not be broken until after the machine has been removed from the tank;
- Ropes made of synthetic fibres should not be used to support the tank cleaning machines;
- No nozzle should have a throughput greater than 17.5 m^3 per hour;
- Recirculated wash water should not be used. The presence of traces of cargo in the wash water may increase the generation of static electricity;
- Equipment lowered into the tank should be bonded to the ship's structure
- Steam should never be injected into a tank with an atmosphere that might be flammable; and Low flash or static accumulator products should never be used as a cleaning medium.

13.6.4 Explain how reactive chemicals are categorized.

Reactive chemicals are categorized as follows:

1.Unstable or self-reacting chemicals, either decomposing or polymerizing;
Acetylides (acetylene)
Azides (metal – sodium azide non-metal, organic)
Epoxides

2. Chemicals capable of reacting with oxygen in the air, either forming peroxides or liable to decomposition;
Nitro-group substituted organics
Organic nitrates
Organic nitrites

3.Chemicals which react with water to emit dangerous gases;
Acetic Anhydride
Calcium Hydride
Trichloro Silane

4.Incompatible chemicals, which react dangerously if mixed together
High nitrogen compounds/tetrazoles
Nitrides
Nitroso compounds

5.Chemicals that can polymerize (monomers)
Unsaturated carbon bonds
Nitrile groups

13.7.1 Explain the hazards and their control measures of corrosive chemical cargoes.

Most dangerous corrosive products can cause severe burns even with a very short exposure time.
Some substances become more corrosive in the presence of water, or produce corrosive vapour when in contact with moist air.
Alkalis and acids if mixed can form a violent reaction and these two cargo types should be kept totally separated from each other and not be stowed in adjacent tanks.
The IBC Code requires secure containment of corrosive cargoes within a cargo system constructed of suitable corrosion resistant material.
Acids must not be carried in tanks where any boundary is formed by the ship's shell plating.

13.8.1 Explain why a cargo to be heated is not stowed adjacent to cargoes which have a low boiling point

A cargo to be heated is not stowed adjacent to cargoes which have a low boiling point because the excess evaporation will result in consequent cargo loss, possible vapour hazards and possible over-pressurization.

13.9.1 Explain the dangers of loading high density cargoes and list their control measures

Loading high density cargo may cause structural damage to the ship if the load density is exceeded. Stainless steel tanks of many chemical tankers have developed cracks, and the Master should be familiar with any restrictions that may be imposed when loading high density cargoes.
Especially important is the need to be aware of and avoid the risk of slack loading a tank when high density cargo is to be loaded because of sloshing forces that may cause damage to the tank structure or its internal fittings and equipment.
Classification societies provide information about tank strength in various formats and the Master should ensure that the restrictions are understood and that there is full compliance.

13.10 Solidifying cargoes

13.10.1 Explain the hazards and their control measures of carrying solidifying chemical cargoes

Most liquids have a defined freezing point, sometimes described as the melting point. Some products, like lube oil additives, vegetable and animal oils, poly oils etc. do not have a defined freezing point, but rather a freezing (melting) range or none at all.
The product's viscosity is instead used as a measurement for the products liquidity or handling characteristics.
Products with a freezing point higher than the outside temperature in which the ship is trading will need to be heated in order to remain liquid.
Ship's structure and equipment normally have limitations on high heat. Exceeding this limitation could damage the tanks or their structure.
Non insulated cargo lines used for high heat products pose a safety hazard as they may cause severe burns if touched.
Prewash may be required if discharge temperature as per Annex II cannot be complied with.
The cargo tank vapour pressure is to be monitored in freezing weather conditions to monitor blockage of PV vent lines.

13.10.2 Explain solidifying / non solidifying substances

Solidifying Substance means a noxious liquid substance which:

1) In the case of a substance with a melting point of less than 15°C which is at a temperature of less than 5°C above its melting point at the time of unloading; or
2) In the case of a substances with a melting point of equal to or greater than 15°C which is at a temperature of less than 10°C above its melting point at the time of unloading.

Non-solidifying Substance means a noxious liquid substance, which is not a Solidifying Substance.

13.10.3 Explain pour point

The pour point of a liquid is the lowest temperature at which the liquid will flow.
It should be noted that cargo with thixotropic properties (the properties of showing a temporary reduction in viscosity when shaken or stirred) can be pumped at temperatures well below its pour point, but at very restricted rates.

13.10.4 Explain Viscosity

Viscosity is a measure of a liquid's ability to flow and is usually determined by measuring the time required for a fixed volume to flow under gravity through a thin tube at a fixed temperature. As the temperature of the liquid increases its viscosity decreases and therefore it flows more readily. It can also be described as a measure of the internal friction of a liquid.
The distinction between viscosity and pour point should be made clear. Oil ceases to flow below its pour point temperature when the wax content solidifies.
A viscosity measurement of a liquid depends upon the internal resistance of the liquid to flow. For a simple liquid this internal resistance varies with the temperature in a predictable and regular way.
Viscosity is important as regards the pumpability of a product. Centrifugal and deepwell pumps are acceptable for the majority of cargoes but high-viscosity products such as bitumen or molasses are more suited for pumping with positive displacement pumps.
High-Viscosity Substance means a noxious liquid substance in Category X or Y with a viscosity equal to or greater than 50 mPa.s at the unloading temperature. Low-Viscosity

Substance means a noxious liquid substance, which is not a High-Viscosity Substance. MARPOL Annex II requirement for high viscosity substances are to be complied with.

13.11.1 Explain the dangers of polymerization

Polymerization is a phenomenon by which the molecules of a particular compound link together into a larger unit containing anything from two to thousands of molecules. A compound may thereby change from a free-flowing liquid into. a viscous one or even a solid. A great deal of heat may be evolved when this occurs.
Some chemicals, the polymerisation process starts spontaneously, the product is considered to be self-polymerizing. Although spontaneous polymerisation can occur at ambient temperatures, it is very often initiated by elevated temperatures, either due to environmental conditions or adjacent heat sources.
Spontaneous polymerisation of a monomer cargo presents the following dangers:

- The generation of heat accelerates the speed of the chemical reaction;
- The rapid volumetric expansion of the product causes over pressurization of the cargo tank with a consequent danger of rupture of the containment system;
- The rupture of the tank may lead to chemical reactions with other cargoes in adjacent cargo tanks;
- While a monomer cargo may often be a light and volatile liquid in its stable form, the polymerisation process produces heavier and more viscous liquids, or even solids, which may block the tank vents so that the pressure inside the tank increases even further; and
- Once solidified the polymer occupies a greater volume than the corresponding volume of liquid monomer.

14 Knowledge and understanding of dangers of non-compliance with relevant rules/regulations

14.2 Explain the responsibility of a chemical tanker operator to achieve the objective of safe and pollution free operations.

The operation of chemical tankers is specialised and complex and is governed by comprehensive international Conventions and Codes, most of which have been developed by the IMO.

Compliance of regulation of the technical aspects of chemical tanker operations can only achieve part of the objective of safe and pollution free operations. While the Master is clearly responsible for the safety of the ship and its crew, the overall responsibility for safe operations rests with the owner, or the entity that has assumed responsibility for the ship's operation in accordance with the ISM Code.

It is commonly asserted that around 80% of all shipping accidents are caused by human error. In reality, however, an act or omission by a human being plays some part in virtually every accident. A failure to follow procedures is a clear example of an act or omission that regularly plays a part in accidents. Any decision or action taken on board or ashore needs to be based on a sound understanding of its consequences. The task facing shipping company managers is to minimise the scope for poor human decisions which may contribute, directly or indirectly, to maritime casualties, personal injuries or pollution incidents.

14.3 Explain the direct repercussions on the safety of vessels, the well-being of crews and on the environment for non-compliance with regulations

The purpose of IMO regulations and the IBC Code is to provide an international standard for the safe carriage by sea in bulk of dangerous liquid chemicals listed in Chapter 17 of the Code by prescribing the design and construction standards of ships regardless of tonnage involved in such carriage and the equipment they should carry so as to minimize the risk to the ship, to its crew and to the environment, having regard to the nature of the products involved.
Ships that flout regulations and industry standard pose direct hazard to personnel, environment and the ship itself.
Inspections by authorities could result in detention of such vessels and even loss of business. The chemical industry itself follows a strict regime to inspect ships and substandard ships are often denied business.
Those who intentionally operate their vessels in contravention to these IMO's regulations and Industry standards may be directly held responsible with criminal proceedings, heavy fines and imprisonment.

15 Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers:

15.1 Precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus

IMO Resolution A.1050(27) covers RECOMMENDATIONS FOR ENTERING ENCLOSED SPACES ABOARD SHIPS.
The atmosphere in any enclosed space may be oxygen-deficient or oxygen-enriched and/or contain flammable and/or toxic gases or vapours. Such unsafe atmospheres could also subsequently occur in a space previously found to be safe.
The following contributory factors have been frequently identified following enclosed space accident investigations:
• Non-compliance with procedures
• Poor supervision
• Complacency and over familiarity leading to short cuts being taken
• Monitoring equipment not used or not working properly
• Improper action in an emergency

Prior to entering an enclosed space, all personnel who are to be involved in the work should meet to:
1. Define the purpose of entering the space;
2. Identify the steps required to achieve the purpose;
3. Identify the risks involved
4. Develop a plan of action; and
5. Agree responsibilities.

Under the Master's authority, an appropriate officer should be designated with responsibility for the work and for compliance with related procedures
Atmosphere testing should be done by personnel trained in the use of the equipment used. Manufacturer's procedures should be followed and equipment should be correctly calibrated
An attendant should be designated who should remain outside the entrance to the enclosed space. Their primary function is to maintain a safety watch over the work and personnel involved and to maintain communications. The attendant who should be trained in the company SMS should be responsible for initiating emergency procedures in the event of an accident

Once the space has been ventilated, the atmosphere should be checked as follows:

- The oxygen content should be measured and a nominal reading of 21% achieved.
- Flammable vapours should be measured with a suitably sensitive combustible gas detector. The concentration of flammable vapour must be below 1% of the Lower Flammable Limit (LFL) before entry can proceed.
- A toxic gas detector should be used to ensure that the levels of toxic gases are within 50% the required safe Occupational Exposure Limit (OEL).

Ventilation should be stopped about 10 minutes before the above tests are carried out and not restarted until after the tests have been completed.

Testing equipment should only be used to measure gases for which it is designed and within the limits set by the manufacturer.

As persons move around within a space they should always be aware of the dangers of isolated concentrations of gas and carry out further tests. This is especially important in spaces with a complicated internal structure where effective ventilation is difficult to achieve.

15.1.1 Explains that the ship's SMS requires special procedures to be followed if entering an enclosed space

The safety strategy is required to be adopted in order to prevent accidents on entry to enclosed spaces. IMO recommends that this should be approached in a comprehensive manner by the company.

The company should ensure that the procedures for entering enclosed spaces are included among the key shipboard operations concerning the safety of the personnel and the ship, in accordance with paragraph 7 of the International Safety Management (ISM) Code.

The company should elaborate a procedural implementation scheme which provides for training in the use of atmospheric testing equipment in such spaces and a schedule of regular onboard drills for crews.

Competent and responsible persons should be trained in enclosed space hazard recognition, evaluation, measurement control and elimination, using standards acceptable to the Administration.

Crew members should be trained, as appropriate, on enclosed space safety, including familiarisation with onboard procedures for recognizing, evaluating, and controlling hazards associated with entry into enclosed spaces.

Internal audits by the company and external audits by the Administration of the ship's safety management system should verify that the established procedures are complied with in practice and are consistent with the safety strategy required to be implemented by IMO.

15.1.2 Demonstrates the procedures required to conduct a risk assessment prior to entry into an enclosed space

In order to ensure safety, a competent person should always make a preliminary assessment of any potential hazards in the space to be entered, taking into account previous cargo carried, ventilation of the space, coating of the space and other relevant factors.

The competent person's preliminary assessment should determine the potential for the presence of an oxygen-deficient, oxygen-enriched, flammable or toxic atmosphere.

The competent person should bear in mind that the ventilation procedures for an adjacent connected space may be different from the procedures for the ventilation of the enclosed space itself.

The procedures to be followed for testing the atmosphere in the space and for entry should be decided on the basis of the preliminary assessment. These will depend on whether the preliminary assessment shows that:

.1 there is minimal risk to the health or life of personnel entering the space;

.2 there is no immediate risk to health or life but a risk could arise during the course of work in the space;
.3 a risk to health or life is identified.

Where the preliminary assessment indicates minimal risk to health or life or potential for a risk to arise during the course of work in the space, all general precautions for enclosed space entry including Authorization of Entry, Testing of Atmosphere and precautions during entry should be followed, as appropriate.
Following should at least be considered

- The space has been thoroughly ventilated by natural or mechanical means to remove any toxic, hazardous or flammable gases, and to ensure that there is an adequate level of oxygen throughout the space;
- Adequate illumination is provided;
- All personnel entering the space are properly trained in enclosed space entry procedures, and are familiar with the company's safety and emergency procedures;
- There is a system in use to record personnel entering and leaving the space;
- All personnel entering the space should wear appropriate PPE and should be provided with calibrated personal multi gas detectors to monitor the levels of oxygen, LEL, carbon monoxide and other gases as appropriate;
- All crew members entering the space should understand that the space is to be vacated immediately if any personal multi gas detector alarm is activated;
- A crew member (attendant) who is familiar with the action to take in the event of an emergency is standing by at the entrance and is in direct contact with persons within the space and with the navigating bridge or control room as appropriate;
- A reliable system of communication has been established and is understood, both by those entering the space, and by the crew member (attendant) standing by at the entrance;
- The duty officer(s) on the bridge or in the cargo control room and in the engine room are aware of the enclosed space entry operations;
- Rescue procedures are understood and sufficient trained personnel are readily available to form a rescue party;
- Rescue equipment, suitable for the enclosed space, is ready for immediate use. Rescue equipment should be readily capable of being placed into and recovered from the space and moved to any part of the space in which personnel may work;
- Outside contractors involved in enclosed space operations, comply with the company's enclosed space entry procedures. It should be confirmed that any such contractors are aware of the particular dangers involved and the actions to take in an emergency;
- PPE used by outside contractors should, as a minimum, comply with the ships equipment standards and procedures for use; and
- Irrespective of whether ship's crew or outside contractors are entering an enclosed space the person standing by at the entrance (attendant) should always be a member of the ship's crew.

15.1.3 Explains measures to minimize pump-room hazards

Ventilation must be switched on at least 30 mins. prior pump room entry

Before starting any cargo operation:

- An inspection should be made to ensure that strainer covers, inspection plates and drain plugs are in position and secure.
- Drain valves in the pump room cargo system, especially those on cargo oil pumps, should be firmly closed.
- Any bulkhead glands should be checked and adjusted or lubricated, as necessary, to ensure an efficient gas-tight seal between the pump room and the machinery space.

- During all cargo operations, including loading:
- The pump room should be inspected at regular intervals to check for leakages from glands, drain plugs and drain valves, especially those fitted to the cargo pumps.
- If the pumps are in use, pump glands, bearings and the bulkhead glands (if fitted) should be checked for overheating. In the event of leakage or overheating, the pump should be stopped.
- No attempt should be made to adjust the pump glands on rotating shafts while the pump is in service.

Formal procedures should be in place to control pump room entry. The procedure used should be based on a risk assessment, and should ensure that risk mitigation measures are followed and that entries into the space are recorded.
A communications system should provide links between the pump room, navigation bridge, engine room and cargo control room. In addition, audible and visual repeaters for essential alarm systems, such as the general alarm and the fixed extinguishing system alarm, should be provided within the pump room.
Arrangements should be established to enable effective communication to be maintained at all times between personnel within the pump room and those outside. Regular communication checks should be made a pre-agreed intervals and failure to respond should be cause to raise the alarm.
VHF/UHF communication should not be used as a primary communication method where it is known that reception may not be reliable or practicable due to noise. Where communication by VHF/UHF is difficult, it is recommended that a standby person is positioned on the pump room top and that a visual and remote communication procedure is put in place.
The frequency of pump room entry for routine inspection purposes during cargo operations should be reviewed with a view to minimizing personnel exposure.

Notices should be displayed at the pump room entrance prohibiting entry without formal permission.

15.1.4 Explain and demonstrate the use of SCBA , Positive pressure breathing apparatus and Resuscitation equipment

Breathing apparatus

I. All crew members should be trained in the use of breathing apparatus (BA). This can be ensured by performing regular safety drills and including it in the onboard training procedures. When the responsible person is allocating personnel for the entry, the proficiency of using equipment should be taken into account. This may mean having a designated emergency team trained fully in the use of relevant equipment to respond to this type of emergency.

II. To ensure the efficient operation of the apparatus, they must be tested regularly.

Self-Contained Breathing Apparatus (SCBA).

This consists of a portable supply of compressed air contained in a cylinder or cylinders attached to a carrying frame and harness worn by the user. Air is provided to the user through a face mask, which can be adjusted to give an airtight fit. A pressure gauge indicates the pressure in the cylinder and an audible alarm sounds when the supply is less than 200 ltrs.

Only positive pressure type sets are recommended for use in enclosed spaces because, as their name implies, these maintain a positive pressure within the face mask at all times.

SCBA must be used by rescue party and whenever entry is made into an enclosed space where atmosphere is known or suspected to be unsafe.

Note: Breathing apparatus – amendments require that Self-contained compressed air-operated breathing apparatus of firefighter's outfits provided onboard all ships shall, no later than 1 July 2019, have a capacity of at least 1,200 liters, or be capable of functioning for at least 30 minutes. These amendments do not phase-out existing pump and hose breathing systems which were permitted on ships constructed before 1 January 2002. Each compressed air breathing apparatus is to be fitted with an audible alarm and a visual or other device which will alert the user before the volume of the air in the cylinder has been reduced to no less than 200 liters. All air cylinders for breathing apparatus are to be interchangeable. No later than 1 July 2014, all ships are to carry onboard a means of recharging breathing apparatus cylinders used during drills or a suitable number of spare cylinders to replace used cylinders.

Each Self-Contained Breathing Apparatus unit stored for emergency use shall be inspected monthly to ensure proper operation. The following items noted below are suggested inspection procedures. Since there are numerous types of SCBAs available from different manufacturers, refer to the instructions specified in the owner's manual for proper operating procedures.

The Master shall assign a responsible person(s) to conduct a monthly inspection of each SCBA unit and record the results on a copy of the monthly maintenance checklist form as follows:

- Inspect the hose by stretching it and looking for cracks or holes; check hose connections for deterioration.
- Examine the air cylinder pressure gauge for proper air pressure; check the tightness of the high-pressure air-hose connection at the cylinder. Ensure that the valve on the regulator is "on" and fully open, that the bypass valve is closed, and that the selector is in the demand or off position. Open the air cylinder valve to pressurize the regulator; check that the regulator pressure gauge has approximately the same pressure as the cylinder gauge. Then close the air cylinder valve to see whether the pressure goes down. A noticeable decrease in pressure (more than10 bars per minute within one to two minutes) indicates a defective regulator or hose.
- Cup one hand over the regulator outlet and inhale. The regulator should deliver air during each inhalation. Next, try blowing into the regulator outlet; if air can be blown into the outlet, the regulator is defective.
- Open the bypass valve slightly--air should flow. Then, close the bypass valve, bleed the air out slowly using the "on-off" lever. Watch the regulator pressure gauge to see whether the alarm sounds when the pressure reaches about 500psi.(40 bars approx.)
- Check the harness, backpack, and air cylinder for wear or damage.
- After inspecting the SCBA unit, fill out the Monthly Maintenance Checklist form available. The records should be marked to reflect the month and day of inspection and the inspector’s initials.
- Should defective equipment be found or servicing the unit be required, the inspector shall take immediate action to correct any deficiencies.

15.1.5 Demonstrates the safeguards for Entry procedure in spaces known or suspected to be unsafe

On Chemical Tankers, entry into enclosed spaces should be treated with extreme caution .Entry into Enclosed Spaces procedures, must be adhered to.

It should be emphasized by the trainer that it is a good practice for each member of the team entering the enclosed space to utilize the "Man in Tank" tags by clipping them onto the Entry Tag.

If the atmosphere in an enclosed space is suspected or known to be unsafe, the space should only be entered when no practical alternative exists. Entry should only be made for further testing, essential operation, safety of life or safety of a ship. The number of persons entering the space should be the minimum compatible with the work to be performed.
Entry into such space is prohibited, unless a risk assessment has been carried out and approved by the management office responsible for the vessel.
If this is agreed to, then in such cases, spaces should only be entered by personnel wearing breathing apparatus and appropriate protection against exposure to flammable, toxic or corrosive cargo vapours and, if practicable, a lifeline. Prior to such entry, reference must be made to ISGOTT, Chapter 11, Section 11.4.4, ICS Chemical Tanker Safety Guide, Chapter 3.5 and IBC code concerning entry with Breathing Apparatus. (Trainer to display the books and pages).

The following minimum conditions must be met with respect to such entries and included in the risk assessment.

A permit must be issued by the Master stating that there is no practicable alternative to the proposed method of entry.
Ventilation is provided where possible, ensuring that this does not create a flammable atmosphere.
Personnel must use PPE and positive pressure breathing apparatus and are connected, where practicable, to a lifeline.
Means of communication are provided and a system of signals is agreed and understood by the personnel involved.
Spare sets of breathing apparatus, a resuscitator and rescue equipment are available outside the space and a standby party with breathing apparatus donned is in attendance in case of an emergency.
Persons entering such enclosed spaces should be provided with calibrated and tested multi-gas detectors that monitor the levels of oxygen, carbon monoxide and other gases as appropriate.

15.1.6 Demonstrates the safeguards for Entry procedure into cargo tanks to carry out "squeezing" operations in order to maximise the cargo outturn.

It may be necessary, especially during the carriage of Vegetable Oils etc., for personnel (shipboard or shore contractors) to enter the cargo tanks to carry out "squeezing" operations in order to maximise the cargo outturn. It is essential on such occasions that all Enclosed Space Entry precautions and procedures are in place both prior to and during the entry operations. Familiarity with the practice should not obscure the potential dangers of cargo generated vapours or an oxygen deficient atmosphere.

Cargoes such as of Coconut Oil may give off dangerous concentrations of CO (Carbon Monoxide) and when entry into tanks is required for "squeezing," readings for CO in ppm (in addition to LEL, 0_2, H_2S) must be checked and monitored prior to and during entry of personnel. Tank must be gas free 0% LEL, less than TLV for CO, H2S etc. and personal gas meters with alarms should be used by persons entering the space.

If personnel are required to enter cargo tanks for hand cleaning with all Enclosed Space Entry precautions and procedures must be observed prior to and during entry, in such cases, full protective clothing and self-contained breathing apparatus must be worn.
It is a normal practice in some trades for personnel to be sent into a cargo tank being drained of animal and vegetable oils or fats, in order to sweep the final traces towards the pump suction. Familiarity with this routine practice should not obscure the potential dangers of cargo generated vapours and the presence of an oxygen deficient atmosphere. Personal

multi-gas detectors and appropriate PPE should be used. Adequate lighting and continuous ventilation should be maintained throughout the period that the space is occupied.
Further dangers associated with cargo sweeping include:

- Heat exhaustion
- Burns from heating coils
- Slips trips and falls due to slippery surfaces
- Burns caused by corrosive cargoes.

Where shore workers are employed to carry out this task, confirmation should be obtained that they are fit for such work and at least meet the requirements of the company's SMS.

Even after a cargo tank has been cleaned, there will always be a possibility of some cargo remaining, which could be a source of further flammable or toxic gas, including hydrogen sulphide (H_2S).

15.2 Precautions to be taken before and during repair and maintenance work

It is important that proper PPE is used in all operations concerning repair work.
The Instructor should start this topic with a safety orientation stating in general, the more complete the body cover, the better.
Wear suitable gloves suitable to protect against the dangers of ropes, sharp or rough objects, acids and chemicals, wet or oily gloves may be slippery and so one should take care, especially when climbing ladders.
Working apparel should be comfortable but sufficiently close-fitting so as not to catch on projections or machinery parts when you are working in cramped positions or are moving about the ship.

Although work on board ship can be hazardous at times, many incidents could be avoided if proper safety procedures, as laid down in Code of Safe working Practices for repair and maintenance work were followed.

SMS procedures regarding Permit to work system must be strictly followed.
When one is working in cramped positions or is moving about the ship, gaping pockets, trailing straps, sweat rags, watch straps and rings are easily caught in moving machinery.

The work place Ventilation should be continuous while personnel are inside the space and the atmosphere should be continuously monitored, including the use of personal multi gas detectors. If personnel begin to feel dizzy or unwell they should leave the space immediately. In particular, tests should be made before the resumption of work after a break and prior to re-entry.

15.2.1 Describes the benefits and limitations of the permit to work system including:

- enclosed space entry
- Cold work
- Hot Work.
- Electrical isolation.
- Working aloft
- Working on pressurized vessel
- Working over the side
- Other hazardous tasks

The Permit to Work form is designed to lead the operator through an appropriate process in a logical, detailed and responsible manner. The permit is produced as a joint effort between

those authorizing the work and those performing the work. The permit should ensure that all safety concerns are fully addressed.
The structure and content of Permit to Work forms will be determined by the specific individual requirement of a ship's SMS, but are typically as follows:

- Type of permit.
- Number of permit.
- Supporting documents – e.g. details of isolations, gas test results.
- Location of work.
- Description of work.
- Hazard identification.
- Precautions necessary.
- Protective equipment to be used.
- Period of validity.
- Authorization for the work including duration, endorsement by the Master or department head.
- Acceptance by those performing the work.
- Management of changes to workforce or conditions.
- Declaration of completion.
- Cancellation.

Adherence to the requirements of the permit, and the identification of any deviations from the specified controls or expected conditions, are essential in completing the task safely. The system should also identify any conflicts between tasks being carried out simultaneously on board.

Permits should normally be used for tasks such as:
- Hot Work.
- Work with a spark potential.
- Work on electrical equipment.
- Diving operations.
- Entry to enclosed spaces
- Work aloft
- Work over side
- Work on pressure vessels

Benefits
1) Risk is identified
2) Job is authorised and informed to all the concerned people
3) It is ensured that only trained people are at the job
4) Work area is specified
5) Job duration is specified
6) People doing the job are identified
7) Recorded with the safety department and acts as a help during incident investigation
8) Ensured that people get the required protection
9) Ensured that area is free of hazards
10) Ensured that the work is closed safely

Limitations
There are practically no limitations for a Permit to work system, if enforced and followed as per the established industry procedures and those prescribed in vessel's safety management system. Following may be considered as some minor drawbacks:
1) The administrative burden involved could increase the workload on the person responsible for issuing permits. The additional workload may cause some delay in work but same must be borne in interest of safety.

2) Maintaining records of all permits issued and closed involves some extra work which many consider avoidable but this work is necessary for purpose of audits held to confirm that safety practices have indeed been followed.

15.2.2 Explains the practical benefits of appropriate drills prior to commencing onboard repair work with shore facility.

When repairs and maintenance is carried out by shore facility the Emergency alarm signals should be agreed and, whenever practicable, a drill held prior to commencing on board repair work. Subsequent drills should be arranged when the repairs are to be carried out over an extended period. This will facilitate the ship/shore management to iron out any mis-concepts or language barriers which may reduce the risks involved.

15.3 Precautions for hot and cold work

Any **hot work** to be undertaken onboard outside the engine room workshop should be subject to a risk assessment and require a hot work permit.
Hot work is to be strictly controlled and governed strictly by vessel's SMS procedure.
Hot work should be prohibited within or on the boundaries of cargo tanks, ballast tanks, slop tanks, bunker tanks, pump rooms and forward cofferdams, including the deck and ship's shell plating, except when special preparations have been made prior to entering the berth or facility and the necessary special conditions have been met.
"Designated space" in ER for carrying out hot work should be defined and assessed for risks and the conditions under which hot work could be carried out in such space.
First preference should be given for carrying out hot work in the designated space in ER.

During the conduct of hot work fire-main should be continuously pressurized, either by ship's pumps or from a shore supply.
All areas where hot work is being carried out should be monitored by fire patrols at all times.

Use of electrical welding equipment should be controlled and correct grounding cables should be used. Welding current should not be returned to the transformer via the ship's hull.
Hot work should not be carried out within 30 meters of any non-gas free spaces unless specific permission has been received from the controlling authority.
Notices should be posted to indicate the current state of any tank or void space, e.g. stating whether it is either gas free and suitable for Hot Work, or only safe for entry
All pipelines interconnecting with cargo spaces should be flushed, drained, vented and isolated from the compartment or deck area where hot work is to take place.
Hot work on pipelines and valves should only be permitted when the section of line needing repair has been removed from the cargo system by cold work and the remaining system blanked off. The removed section of line should be cleaned and gas freed to a standard that is safe for hot work, regardless of whether or not it is removed from the hazardous cargo area.
If hot work is interrupted for any reason for an extended period, hot work should not be resumed until all the precautions have been rechecked and a new hot work permit has been issued.
On completion of hot work, the work area should be secured, and all hot work and related equipment used should be removed. The company should be informed of the completion of all hot work as specified in the hot work permit.

Cold work refers to work with tools that may expose the user to hazardous situations such as:

- Working on electrical equipment within a hazardous environment. This should only be done when electrical power has been cut off and tagged;

- Opening up of pipelines and cargo equipment which may expose personnel to trapped toxic or flammable products; and
- Chipping and scaling of the ship's structure which may cause contact sparking.

Whenever cold work is planned within the cargo area or other hazardous areas, a permit to work should be issued for each intended task. The permit should specify the duration of validity, which should not exceed one working day.
The atmosphere within any enclosed space in which hot or cold work is to take place should be tested for hydrocarbons and a reading of less that 1% LFL obtained on suitable monitoring equipment.

15.3.1 Explain how hot work is to be strictly controlled and governed by vessel's SMS procedure

Hot Work undertaken outside the designated space should be controlled under the SMS by means of a permit to work system.
The Master should decide whether the use of Hot Work is justified and whether it can be safely undertaken. The Master or Responsible Officer must approve the completed permit before any Hot Work can begin.
Consideration should be given to performing only one Hot Work operation at a time, due to the resource limitations usually present on board a tanker. A separate permit should be approved for each intended task and location.
A risk assessment should be carried out to identify the hazards and assess the risks involved. This will result in a number of risk reduction measures that will need to be taken to allow the task to be carried out safely.

Suggested Class room Exercise:

The instructor can identify a work location where welding work is to be carried out, the students may be provided with the below table and asked to list the requirements to be fulfilled prior to job execution.

WORK LOCATION Minimum Requirements	Engine workshop	Other parts of non-hazardous area	Open deck aft of accommodation	Enclosed spaces (other than pump-rooms)	Main Deck (deck plating)	Work on fixtures/fittings in the main deck area	Work on any cargo-related pipelines incl. Heating coils in a cargo tank	Cargo pump-rooms	Cargo or ballast tanks
Work planning meeting to be held and risk assessment completed	√	√	√	√	√	√	√	√	√
Work in designated space with shield or curtain erected	√								
Adequate ventilation	√	√		√			√	√	√
Confirmation from Master or designate that work is OK to proceed	√								
Tank atmosphere checks carried out and entry permit issued				√			√		√

Tank to be washed and gas freed					√		√		√
Cargo tanks to be purged and inerted to not more than 8% O_2 and not more than 2% HC					√	√	√	√	√
Work to be carried out further than 500mm from the tank deck or bulkheads				√		√		√	
Work to be carried out more than 500mm from a fuel oil tank deck or bulkheads			√	√		√		√	
Local cleaning to be carried out as per requirements				√			√	√	√
All interconnecting pipelines flushed and drained							√	√	√
Tank valves isolated							√	√	√
Hotwork permit to be issued on board									
Hotwork permit issued in agreement with Company		√	√	√	√	√	√	√	√
Hotwork permit approved by Master or Responsible Officer		√	√	√	√	√	√	√	√

15.4 Precautions for electrical safety

In a tanker, certain areas/spaces are defined by international convention, flag administrations and classification societies as being dangerous/hazardous for the installation or use of electrical equipment either at all times or during specific periods such as loading, ballasting, tank cleaning or gas freeing operations.
Definitions of dangerous areas on tankers, detailed in the classification society rules, are derived from recommendations by the International Electro-technical Commission (IEC) as to the types of electrical equipment that can be installed in them. It should be noted that for terminals the IEC definitions follow a rigid classification based on a zonal concept.

Fixed electrical equipment in dangerous areas, even in locations where a flammable atmosphere is to be infrequently expected, must be of an approved type. This equipment should be properly maintained so as to ensure that neither the equipment nor the wiring become a source of ignition.
Fixed electrical equipment and installations in tankers will be in accordance with classification society or national requirements, based on the recommendations of the IEC.
All apparatus, systems and installations, including cables, conduits and similar equipment, should be maintained in good condition. To this end, they should be inspected regularly.
Correct functional operation does not necessarily imply compliance with the required standards of safety.

Maintenance of Electrical Equipment
The integrity of the protection afforded by the design of explosion-proof or intrinsically safe electrical equipment may be compromised by incorrect maintenance procedures. Even the simplest of repair and maintenance operations must be carried out in strict compliance with

the manufacturer's instructions in order to ensure that such equipment remains in a safe condition.
This is particularly relevant in the case of explosion-proof lights where incorrect closing after changing a light bulb could compromise the integrity of the light.
In order to assist with routine servicing and repair, ships should be provided with detailed maintenance manuals for the specific systems and arrangements fitted on board.

Insulation Testing
Insulation testing should only be carried out when no flammable gas mixture is present.
All maintenance work on electrical equipment should be undertaken under the control of a permit or an equivalent safety management system, with procedures that ensure that electrical and mechanical isolations are effectively managed.
The use of mechanical lock-off devices and safety tags is strongly recommended.

Cold Work on electrical equipment
Cold Work should not be carried out on any apparatus or wiring, nor should any flame-proof or explosion-proof enclosure be opened, nor the special safety characteristics provided in connection with standard apparatus be impaired, until all electrical power has been cut off from the apparatus or wiring concerned. The electrical power should not be restored until work has been completed and the above safety measures have been fully reinstated. Any such work, including changing of lamps, should only be done by an authorised person.

Hot Work on electrical equipment
For the purpose of repairs, modifications or testing, the use of soldering apparatus or other means involving a flame, fire or heat, and the use of industrial type apparatus, is permitted in a hazardous area within a terminal, provided that the area has first been made safe and certified gas free by an authorised person and is then maintained in that condition as long as the work is in progress. When such Hot Work is considered necessary on a berth where a tanker is alongside or on the berthed tanker, the joint agreement of the Terminal Representative and the Responsible Officer should first be obtained and a Hot Work Permit issued.

15.5 Use of appropriate Personal Protective Equipment

15.5.1 Demonstrate the use of adequate PPE on chemical tankers

PERSONAL PROTECTIVE EQUIPMENT (PPE)
Personal Protective Equipment provides last barrier against injury from specific hazards, including health hazards. In this section the primary concern is providing protection against exposure to products during routine and special operations. All routes of exposure must be evaluated when considering appropriate PPE and the barriers selected based on risk of and consequence of exposure. These shall be determined from all available sources including but not limited to MSDS, Tanker Safety Guide, and other available sources. It must be noted that PPE does not reduce the hazard posed by the cargo. The effectiveness of this barrier will be lost if the PPE is used incorrectly or is of the wrong type or is defective.

PPE Maintenance: PPE shall be maintained in accordance to manufactures recommendations The SCBA sets supplied under the IBC Code shall be inspected/tested as required by the Section 14.2.6 of the IBC Code. Records of maintenance and inspection / checks shall be maintained on board. PPE must be properly cleaned and inspected after each use and confirmed by the Chief Officer to be in good order ready for immediate use prior returning to stowage.

Respiratory Protection

GENERAL
Respiratory protection is designed to prevent exposure to gas, vapors, mists, or liquid droplets via lungs, mucous membranes, and respiratory tract. This is of great importance since inhalation of toxic vapours can result in severe consequences. Respiratory protection provided by SCBA is designed to provide the user with adequate supply of fresh air. A filter mask provides protection by filtering air prior to the user breathing it.

CANISTER OR FILTER TYPE RESPIRATORS
Use of Canister or filter type respirators on board chemical tankers is not recommended.

SELF CONTAINED BREATHING APPARATUS (SCBA)
Breathing apparatus shall be used if necessary during cargo operations involving toxic cargoes and when entering a space, which is oxygen deficient or containing hazardous vapour. The air bottles must be kept fully charged and ready for use. Appropriate tests / checks and maintenance of this equipment must be done in accordance with the maker's instruction and section 14.2.6 of IBC.

EMERGENCY ESCAPE RESPIRATORY AND EYE PROTECTION
Ships carrying cargoes, for which .Yes.is indicated in column n of chapter 17, shall be provided with suitable respiratory and eye protection sufficient for every person on board for emergency escape purposes, subject to the following:
.1 filter-type respiratory protection is unacceptable;
.2 self-contained breathing apparatus shall have at least a duration of service of 15 min;
.3 emergency escape respiratory protection shall not be used for firefighting or cargo-handling purposes and shall be marked to that effect.

Body Protection

GENERAL
The primary level of protection against risk of exposure to cargo and its vapours during cargo operations is containment. However, due to the high risk of exposure during cargo operations, it is important to have a body protection. While Chief Officer is responsible for determining the potential risk and required PPE from the sample matrix below, each crewmember is responsible to wear the same. The Duty Officer is in turn responsible to ensure that all members of his watch team are wearing the appropriate PPE.

Body protection is designed to prevent exposure to gas, vapor, mist, liquid droplets, and liquid splash to the body including skin, eyes, and mucous membranes. All necessary care should be taken to prevent contact of cargo with skin and eye. This protection consists of barrier clothing, shields, and barrier creams. Barrier clothing includes gloves and boots; shields include chemical resistant goggles, aprons, and splashguards. The level and type of protection required is to be determined by evaluating exposure risk and hazard risk.

Contaminated clothing should always be washed or hosed down before the wearer takes it off. Once used, it must never be brought into the accommodation or any other living spaces and kept in containers.

Chemical suits and Gas tight suits shall be used for cargoes which pose a hazard to health through skin absorption or those that destroy tissue, cause the skin to burn or leave scars.

PPE for Visitors: In case visitors arrive to the gangway without necessary safety PPE they shall be provided such from the ships equipment or be denied access to the deck. If the operation being carried out involves a high risk cargo requiring PPE as per Option 4 mentioned in the matrix below, a notice shall be placed at the base of the gangway which states as follows:

"A HIGH HAZARD CARGO OPERATION IS IN PROGRESS. AUTHORIZED VISITORS TO CONTACT VESSEL AT THIS POINT AND NOT PROCEED TO VESSEL UNESCORTED"

When contacted, the vessel will arrange for a ship staff to meet the visitor at the base of the gangway. The ship staff shall confirm if the required PPE is donned by the visitor. Any shortfall of PPE shall be provided by the vessel. Should the person reach the deck level without appropriate PPE, the vessel shall stop cargo operations, until the person is taken to safe areas.

During the handling of those cargoes considered as high hazard risk, visitors shall not be permitted access to the cargo deck area while any high-risk operation is in progress or if there is any exposure risk present; i.e. when level 4 PPE is in use by operational crew members. During routine cargo operations of high hazard risk cargoes, where exposure risk is low, visitors wearing the appropriate PPE may be allowed access to the main deck at Master's discretion. For persons (E.g. Cargo surveyor), whose presence in such areas is necessary during the cargo operation, the duty officer must ensure that appropriate PPE is donned by the person.

PPE MATRIX:

Special considerations are given to the requirements of PPE on chemical tankers.

The following matrix may be used to assist in determining required PPE levels for specific exposure and hazard risk.

Table 1 below gives the various levels of PPE (level 1 to 4) and the PPE required for each level.

Table 2 mentions the level of PPE for various tasks that need to be performed. Should there be tasks other than those listed, the Chief Officer shall decide the level of PPE. For cargoes with multiple hazards, PPE worn shall be for the higher level of protection.

TABLE 1

PPE Level	PPE Level 1	PPE Level 2	PPE Level 3	PPE Level 4
Operation	Normal Working Equipment	Normal Working Equipment	Special Operations Equipment	Special Operations and Spill Response
PPE Equipment	- Coveralls -Safety Shoes -Gloves -Chemical Goggles -Helmet	-Coveralls -Safety Shoes -Chemical Gloves - Chemical Goggles -Helmet	-Chemical Suit with Hood -Chemical Boots -Chemical Gloves -Chemical Goggles and Face Shield - SCBA	-Gas Tight Chemical Suit -Integral Boots -Sealed Gloves -SCBA
Determined Hazard and Exposure Risk	Low Exposure Risk Low Hazard Risk	Low Exposure Risk Moderate Hazard Risk	Moderate Exposure Risk High Hazard Risk	High Exposure Risk High Hazard Risk
Example Products	Molasses Animal Oils Vegetable Oils Tropical Oils	Mineral Oils Glycols Waxes Diesel Oils	Acids Alkalis, Toluene Acetone Xylene Styrene Monomer VAM	Phenol HMD TDI/MDI ACN All Carcinogens

TABLE 2

Hazard / Operation	Non T/F/C	Toxic (T)	Corrosive (C)	Flammable (F)
Watch during cargo operations	1	2	2	1
In manifold area	2	3 or 4	3 or 4	2
Sampling / Gauging/Purging pump cofferdam / Clearing line / Tank cleaning with portable machines	2	3 or 4	3 or 4	2
Tank Cleaning w/Fixed Machines	1	2	2	1
Spill Response	2	3 or 4	3 or 4	2
Squeezing inside Cargo Tanks	2 + Chemical boots	N/A	N/A	N/A

PPE for Entering Enclosed spaces

It is important to assess each "enclosed space entry operation" on a case by case basis as the type of equipment (approved type only) required would be dependent upon the circumstances at the time.

Basic equipment may include:

- Hard hat, with chin strap.
- Gloves.
- Goggles / protective eyewear.
- Ear defenders.
- Intrinsically safe torch.
- Foot protection.
- Overalls (protective clothing).
- An ELSA, EEBD or other emergency escape breathing device.
- Personal gas monitors for O_2, HC, CO and H_2S

The Emergency Escape Breathing Device (EEBD) and emergency escape sets such as an ELSA should not be considered as a SCBA. They are designed to enable escape from a hazardous environment by providing a limited supply of air delivered via a plastic hood or mask. It should be borne in mind that these devices must not be used as a means to enable the entry into the enclosed space as its intended purpose is to enable the user to exit a space safely, should the atmosphere become oxygen deficient or not gas free.

Personal gas monitors are designed to be used during an enclosed space entry to continuously monitor the gases such as O_2, HC, CO and H_2S. They alert the user with audible and visual alarms before reaching dangerous gas concentrations. Some also have a system of giving a vibrating signal/alarm.

The monitor can be clipped onto the user's overalls and because it operates passively no further action is required from the user.

The instruments should be tested and calibrated on a regular basis in accordance with manufacturer's instructions.

If the person entering the tank is using a personal monitoring device it is important that this is not used to ascertain the gas concentrations for determining if the space is safe to enter. A separate independent remote instrument should be used prior to entry for this purpose.

16 Knowledge and understanding of chemical tanker emergency procedures, including:

16.1 Ships emergency Response plans

16.1.1. Explain a chemical tanker emergency organisation and response plan

Emergencies on a vessel may arise at any time. These are unplanned events and hence there is no time for preparation. It is impossible to predict the nature of every potential emergency that may occur on a Chemical tanker. Hence standard emergency procedures are prepared and kept available for immediate implementation, so that basic actions are taken quickly and further decisions may then be taken in an orderly manner.

On any vessel, especially Chemical Tankers, emergencies may have catastrophic consequences, unless proper action is taken. Actions, therefore, must be prompt, timely and adequate.
It is essential that personnel are properly trained for emergency procedures. The overriding consideration of those responsible for operations should be the continued safety of all personnel on board and anyone in the immediate vicinity.
It is very essential for the ship's staff to comprehend the various properties of the cargo. The MSDS sheets are the best guides for understanding the hazards and properties of the concerned cargoes on board.
The Master must ensure that the Duty Officer is authorized to stop cargo in the event of an emergency or if in the opinion of the Duty Officer such stoppage is necessary to prevent an emergency situation. The duty officer must inform the Cargo Officer and / or the Master in any event of an emergency situation at the earliest opportunity.
Emergency procedures have to be pre-planned and be ready for immediate implementation in the event of an emergency. The procedures must anticipate and cover such foreseeable types of emergencies which might be encountered at sea or in port as grounding, fire, collision and cargo spill. In each situation, the first stages of a plan should be:

- Raising the alarm.
- Taking a headcount.
- Locating and assessing the emergency and the dangers involved.
- Deciding the actions to be taken.
- Organizing manpower and equipment.
- Ensuring visitors and non-essential personnel are in the safe location.
- Notifying all concerned authorities.
- Notifying the Company.

16.2 cargo operations emergency shutdown

16.2.1 Explain the Emergency shut down procedure

Prior to commencing cargo operations the vessel's emergency shut down system must be tried out and the procedure for its use should be agreed with the terminal
All Watchkeeping officers should understand that they have full authority to take immediate effective action to prevent a situation developing that threatens the safety of the ship.
An emergency shutdown procedure should be formally recorded and signed by both the ship and terminal representatives.
The agreement should state the circumstances in which operations have to be stopped immediately.

Due regard should be given to the possible introduction of dangers like surge pressures, the hazardous nature of the cargo or other associated dangers with the emergency shutdown procedure.

16.3 Actions to be taken in the event of failure of systems or services essential to cargo

16.3.1 Describes Action to be taken in the case of Deck valve \ deck pipeline leakage

If leakage due to failures of a deck cargo system or services such as pipeline, deck valve, cargo hose or metal arm, the cargo operations through that connection should be stopped and the situation treated as an emergency until the cause has been identified and the defect remedied. Permanent means for the retention of any slight leakage at ship and shore connections should be provided. Operations should not be restarted until the fault has been rectified and all hazards from the released cargo eliminated.
If a pipeline, hose or arm bursts, or if there is an overflow, all cargo or bunker operations should be stopped immediately and the situation treated as a cargo spill.

16.4 Firefighting on chemical tankers

16.4.1 Explain how a fire caused due to chemicals is different than that caused by other substances

Fire requires a combination of three elements: fuel, oxygen and heat or a source of ignition, and chemicals need the same combination in order to burn. The principal means of controlling and extinguishing a fire is to remove one or more of the elements, either by removal of the fuel, by cooling, or by excluding a supply of oxygen (air). But in chemical fires, the source of ignition may be heat from a reaction within the chemical itself or from a reaction after mixing chemicals. A supply of oxygen may be released from the chemical through heating by the fire. So fire fighting will be made more difficult. Without doubt, the best course is to prevent any fire occurring.

16.4.2 List the typical properties of some chemicals that require specific firefighting requirements

Properties of some chemicals that require specific firefighting requirements are:

- soluble in water and at certain concentrations they may be flammable;
- soluble in water will and generally destroy normal foam, so alcohol resistant or dual purpose foam is required;
- heavier than and insoluble in water and can be extinguished by a carefully applied blanket of water;
- not requiring an external supply of oxygen to sustain fire.
- reacting with water to produce heat and thus give off increased amounts of flammable and (in some cases) toxic gases;
- evolving large volumes of toxic vapours when heated;
- comparatively low auto-ignition temperature which increases the chance of re-ignition.

16.4.3 List the action to take in the event of a fire.

The following sequence of events should be considered in the event of a fire:

- Activate the alarm;
- Stop cargo operations – close all valves and hatches;
- Activate ship's emergency plan;
- Organize firefighting teams;

- If alongside a berth, alert terminal staff and agent if time allows and request them to alert port authorities;
- If at anchor in port, alert the port authorities;
- If other ships or craft are alongside, alert them and instruct them to depart immediately;
- Identify the chemical or chemicals involved, and any chemicals that may be at risk if the fire spreads;
- Select the firefighting equipment and fire extinguishing agent to be used; and
- Be alert to the risk of toxic fumes entering the accommodation, and that an evacuation of non-essential crew may be necessary.

Any craft alongside should be instructed to leave immediately. Decks, bulkheads and other structures in the vicinity of the fire, and adjacent tanks which contain flammable cargoes or are not gas free, should be cooled with water and if appropriate, inerted.
The ship's general alarm should be raised and, if alongside, the terminal should be notified with details of the chemicals involved. The terminal control room should be requested to summon any necessary outside assistance and, if appropriate, activate their emergency procedures.
Any cargo handling, ballasting, tank cleaning or bunkering operations should be stopped immediately and all valves closed. Any craft alongside should be instructed to leave immediately. Decks, bulkheads and other structures in the vicinity of the fire, and adjacent tanks which contain flammable cargoes or are not gas free, should be cooled with water and, if appropriate, inerted. Chemical cargo fires may initially be small. However there is a significant risk that without the deployment of immediate and sufficient firefighting resources such a fire will develop resulting in an explosion.

16.5 Enclosed space rescue

16.5.3 Describe enclosed space rescue procedures

Team composition
The rescue team should comprise a dedicated team of personnel drilled and trained as appropriate in all aspects of enclosed space rescue Entry into an enclosed space where the atmosphere is known or suspected to be unsafe should only be conducted in an emergency including in the use of resuscitation equipment. All team members should be familiar with the ship's SMS, and its operating and emergency procedures.
Although a dedicated team offers major advantages it is essential that back up personnel are also identified in case one of the dedicated team members is unavailable.

Team roles
The Rescue team should consist of the following personnel:

Team leader. This should be a senior officer. The role will be to direct the rescue effort and therefore the leader should not form part of the team that enters the enclosed space;

Entry team. The number of entry team personnel should be kept to a minimum. However, at least two persons should enter the space to carry out the rescue;

Back up personnel. These should be employed to rig the rescue equipment, ensuring that the entry team have the equipment and support necessary to carry out their task and to monitor the enclosed space atmosphere. One crew member should be assigned to assist the rescue team leader with communications and to maintain a record of events.

The rescue operation

The person on watch at the entrance to the enclosed space (attendant) should, as soon as they are aware that a person in the space is in difficulty, immediately raise the alarm. It is therefore essential that a method of raising the alarm is agreed in advance together with a means of communicating the details of the emergency. It is also essential that the rescue team is advised regarding the nature of the accident and how many persons are affected.
Rescue team personnel should proceed immediately to the entrance to the enclosed space together with any additional equipment. No one should enter the space without the team leader's permission.
NO ONE SHOULD ATTEMPT A RESCUE WITHOUT WEARING BREATHING APPARATUS AND A RESCUE HARNESS AND, WHENEVER POSSIBLE, USE OF A LIFELINE.
On reaching the casualty the entry team should ascertain if the casualty is still breathing. If the casualty is not breathing the entry team should remove the casualty from the space as soon as possible, for resuscitation.
If the casualty is breathing, any injuries should be assessed before the casualty is removed from the space. If the condition of the atmosphere in the enclosed space is not verified as safe, the casualty should be provided with a safe independent air supply in the enclosed space.
During the incident the team leader and back up personnel should be:
• Monitoring the rescue team and ensuring the supply of spare air supplies;
• Rigging rescue equipment such as hoists;
• Monitoring the atmosphere of the space;
• Communicating with the vessel's command team;
• Arranging additional lighting, ventilation and improving access to the space, as appropriate;
and removal of the casualty should be carried out utilizing the most appropriate equipment such as stretchers, lifting harnesses and hoisting apparatus.

16.6.1 Explain early indicators of reactivity and precautions to prevent reactivity in chemical cargoes.

An increase in cargo temperature that is not related to ambient weather conditions or adjacent cargo temperatures may be an early indication that a polymerisation process has started. The cargo manufacturers should be contacted immediately to advise appropriate counter-measures which may include the addition of more inhibitor or the cooling of adjacent structures.
If the increase in temperature be rapid then jettison of the cargo may be the only option in order to avoid serious structural damage to the cargo tank and the ship.

16.7 Jettisoning cargo

16.7.2 Describe the precautions to take when jettisoning of chemical cargo has been taken.

If it is necessary to jettison cargo there will be a possibility of releasing large amounts of flammable or toxic vapours.
The following precautions are recommended:
- Where possible and if time permits fully discuss the planned action with the company;
- Engine room personnel should be alerted. Consideration should be given to changing over engine room sea water intakes from high to low level;
- Discharge should preferably take place through a sea valve and where possible on the side opposite to the engine room intakes;
- All non essential inlets should be closed;

- If discharge has to be from the deck level, flexible hoses should be rigged to extend below the water surface;
- Ships course may have to be altered to ensure that cargo vapours remain clear off the accommodation
- All safety precautions relating to the presence of flammable or toxic gas in the vicinity of the deck should be observed;
- A radio warning should be broadcast for the information of ships nearby; and
- A complete detailed record of events and accompanying evidence should be meticulously made and maintained in the event of any discharge.

16.8 Use of a Material Safety Data Sheet (MSDS)

16.8.1 Describe the information a typical MSDS contains relevant to chemical emergencies

The MSDS will contain information, which is relevant in case of chemical emergencies, the instructor is expected to read and explain the relevant sections of an MSDS sheet appended in figures of this section including the following:

- Emergency Telephone Number where more information can be obtained, if necessary;
- First Aid Measures after exposure

Inhalation;
Skin contact;
Eye contact;
Ingestion;
Immediate medical attention, special treatment.
Thermal hazards.
Toxicological Information
Likely routes of exposure;
Skin corrosion/irritation;
Serious eye damage/irritation respiratory irritation; and
Respiratory or skin sensitization aspiration hazard.

17 Actions to be taken following collision, grounding, or spillage

17.2 Explain standard initial and follow up actions to be taken subsequent to a collision/grounding

Standard initial and follow up actions to be taken subsequent to a collision:
Inform Master.
Stop engines
Raise General Emergency Alarm (Internal / External).
If possible announce on public address system.
Inform the traffic in vicinity on VHF Channel 16 / DSC S-VDR/ VDR - Data backed up and kept prepared for further recording as per Ship specific procedure.
Check Angle of Contact.
Switch on deck lighting & display appropriate nav. lights / shapes.
Ascertain extent of damages.
Check for Pollution around the vessel.
Initiate damage control measures.
Update Vessel's position to radio room / GMDSS Console.
* NOTE DOWN THE FOLLOWING: Time of Collision. Own vessel's course & speed at the time of collision Plot own vessel's position at the time of collision (). Mark Course Recorder trace for actual time of collision.
* Mark Engine Data logger with date & time of collision.

If own vessel is not in an immediate danger of sinking, offer to render / render assistance to other vessel.
Exchange information with other vessel
Other actions to consider depending on severity of damage to mitigate any effect of pollution
Prepare engines as required by bridge.
Check condition of Machinery & hull damage in E/R.
Check Propeller / Rudder / Steering for damage.
Prepare pumps to pump out sea water from E/R or cargo spaces. Inspect Piping / Valves / Equipment for any ingress of water.
Shut valves if required.
Check for hull or any structural damage Sound all hold bilges, cargo tanks including ballast & fuel oil tanks to check ingress of water. Positive air pressure from any sounding pipe or ingress of air from any air pipe will indicate breach of that compartment.
Check extent of damage and ascertain rate of flooding (tons / second) by following formula: 3 x Area of hole in sq m x Sq. root of (depth of hole in meters below sea level.). $=3A\sqrt{h}$ If area of hole is halved then rate of flooding will also be halved. Therefore any makeshift plugging is better than nothing
Start pumping out immediately to list / trim the vessel to bring the hole above water line.
Support Team Close all water tight doors and fire doors.
Check all compartments are shut.
Check for Fire & prepare all firefighting equipment.
Consider prepare lifeboats for launching.
Consider removing anchor lashings.

Follow up Actions

- Check if any one injured, if yes refer appropriate section for emergency response.
- Inform office after immediate actions for safety have been taken
- Check damaged Stability
- Check for cargo damage
- If there is any pollution as a result of collision refer to Shipboard Marine Pollution Emergency Plan (SMPEP), Vessels Response Plan (VRP) and any State Plan, or other National Plan. Activate plan as required and nearest coastal state should be informed using standard reporting format.
- Monitor prevailing weather / sea conditions and visibility.

For chemical exposure prevention the following should be considered:
Issuing protective clothing and gas masks if necessary,
Reporting and communication as per company's SMS.

Standard initial and follow up actions to be taken subsequent to grounding

Bridge Team Action Taken
Stop Main Engines.
Sound General Emergency Alarm (Internal & External)
Call Master.
Inform Engine Room to change to high sea suction & check for damages.
Display appropriate Lights & Shapes as per Rules of the road regulations.
Make appropriate sound signals.
S-VDR/ VDR - Data backed up and kept prepared for further recording as per Ship specific procedure.
Switch On deck lighting.
Prepare Urgency Message & inform nearest coast State.
Inform the traffic around on VHF Channel 16.
Check if any hull rupture and for Pollution around the vessel.
Initiate damage control measures

Check for Timing of High tide & Range. Check direction of current.
Consider if vessel can be lightened by pumping out any Ballast / FW or in extreme cases Cargo.
Consider possibility to change trim by internal transfer.
Use Engines to refloat after assessing the situation as per reports from other teams. Avoid too many astern movements especially if the nature of bottom is such that, the ship is likely to dig in deeper into the seabed. Preferably wait for high tide.
Update Vessel's position to radio room / GMDSS Console
* Note down
Time of grounding
Vessel's course & speed at the time of grounding
Vessel's position at the time of grounding
* Check Echo sounder sounding Fore& aft. Compare with charted sounding.
* Mark Course recorder Trace for actual time of grounding
Engine data logger with data & time of grounding
Keep a record of Time, Name of Party contacted. How contacted (Tlx / Fax / Tel) & brief details of all communications.
Engine team Action Taken
Check condition of Machinery & hull damage in E/R.
Change over to High sea suction.
Check Tail shaft for Oil Loss.
Check Propeller / Rudder / steering for damage.
Prepare pumps to pump sea water from E/R or Holds.
Inspect Piping / Valves / Equipment's for any ingress of water. Shut valves as required.
Turn M/E on turning gear & hammer test foundation bolts.
Check for Hull damage.
* Sound all hold bilges, cargo tanks including ballast & fuel oil tanks to check ingress of water. Positive air pressure from any sounding pipe or air ingress from air pipes will indicate breach of that compartment.

Inform original and current Ballast / FW distribution to Bridge.
Inform original and current Bunker distribution on Bridge.
Close all water tight doors. Check all compartments are shut.
Check for "Fire" and prepare all firefighting Equipment.

Follow up Actions

- Inform office after immediate actions for safety have been taken.
- Monitor prevailing weather / sea conditions and visibility
- Check weather forecasts
- Consider risk of heavy waves that might cause slamming Check timing of high tide & range. Check direction of current
- Consider if vessel can be lightened, in extreme cases, by lightering cargo. Jettisoning cargo may be considered if ship is in serious danger.
- Consider if additional ballast is required for preventing vessel from going further aground
- Inspect all fuel / Steam lines for damages at regular intervals up to 3 days after grounding
- Check M/E crankshaft deflections (prior using engine to re-float vessel) compare with normal readings.
- If there is any pollution as a result of grounding refer to SMPEP/VRP/State Plan/National Plan. Activate plan as required and nearest coastal state should be informed using standard reporting format.
- Consider whether assistance regarding structural condition is required. If yes, send report in the Classification Society format or in the format given in SMPEP if the ship is not entered in an emergency response arrangement such as SERS or RRDA.
- Compare vessel's Draft Fore& aft. before and after the grounding.

Evidence Collection
Grounding position
- Description of the part of the ship aground
- Description of the area of the seabed where the grounding took place
- Course (charted course, steered course, gyro and magnetic compass) at the time of the grounding
- Speed, propeller revolutions or propeller pitch of the ship at the time of the grounding
- Rudder position at the time of the grounding
- Any alteration to course and / or speed immediately before the grounding and the exact time of such alteration
- Any communications including orders given to the engine room
- Any communications exchanged between the ship and shore radio stations or traffic control centers.

If under pilotage any communications between the pilot and the ship's command including helmsman prior to the grounding.

17.3 Explain standard initial and follow up actions to be taken subsequent to a spillage and activate SMPEP

In the event of a spill, the following actions should be taken immediately:

Initial Action
Activate the alarm;
Stop all cargo operations and close valves and hatches;
Activate ship's emergency plan and follow SMPEP
Report to coastal state in standard format. If in port local reporting procedures may need to be followed
If alongside a berth, notify the terminal staff of the chemicals involved and the possible risk to personnel;
Notify local port authorities, usually through the terminal;
Prohibit smoking and use of naked lights throughout the ship;
Clear all non-essential personnel from the area;
Close all accommodation access doors, and stop all non-closed circuit ventilation;
Arrange for main engines and steering gear to be brought to stand by; and
Erect barriers to secure contaminated areas;
Minimise potential for pollution; and Decontamination of exposed personnel.

Follow Up Action
Should the Master consider it necessary to wash a cargo spillage overboard this should be carried out using large quantities of water from as far away as practicable. A spray nozzle should be used and not a direct jet of water. The emergency team should wear appropriate protective equipment, approach the spill from upwind and direct the spray of water to the edge of the spill, gradually working towards the centre. The use of water on a fuming acid and other strong acids will initially cause a vigorous reaction that will cause increased fuming. However, this should be temporary and the spillage will normally be dealt with rapidly. If at sea, the ship should be turned off wind. For small, localized and contained spills, it may not be necessary to implement all the action points in the ship's contingency plan. However, the Master should always keep in mind the local circumstances, the nature of the chemical involved, and the potential harm to personnel, ship's structure and the environment.

17.4 Explain the importance of evidence collection and emergency reporting requirements

Evidence – objective as well as subjective will be analysed by lawyers, investigators, auditors, insurers, underwriters, consultants, etc. Such facts would be required to be thoroughly understood including the background data that lead to the casualty.

This explains why one is required to gather as much data as possible including past records, registers, crew data, ship's technical aspects, and data from the safety management systems.
It is imperative to understand the need of the evidence during an accident on ships. Practically, whatever data that is available related to the accident should be collected almost "immediately" after the incident / accident took place. Some of the useful data that can be collected for investigation includes daily records in the form of logbooks, daily registers, photographs VDR etc.
Ships' Masters have an important role in the collection of evidence that will help the insurance agencies evaluate the damage and establish liability.
Evidence should be collected, recorded and preserved. Memories fade. It is therefore imperative to collect the foregoing mentioned evidence.
The basic rules to remember in case of any accident or incident on board your ship are:
• Keep your owner and manager informed;
• Notify the local P & I correspondent;
• Investigate the accident or incident as soon as practical;
• Collect and retain any evidence or documentation relating to the accident;
• Ask witnesses to write down what happened, and keep detailed records of all relevant facts;
• Take photographs wherever possible.
When the ship is involved in an incident which results in the discharge or probable discharge of pollutants (Cargo or bunker fuel), the Master is obliged under the terms of MARPOL 73/78 to report details of the incident, without delay, to the nearest Coastal State by means of the fastest telecommunication channels available.
The intent of these requirements are to ensure that Coastal States are informed, without delay, of any incident giving rise to oil pollution, or threat of oil pollution, of the marine environment, as well as of assistance and salvage measures, so that appropriate action may be taken.
Company procedures for emergency notification, their formats/forms must be used.

18 Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Aid Guide

The instructor should preferably be a medical practitioner or a certified first aider and should briefly discuss the use of the Medical First Aid Guide

18.1 List the contents of the MFAG as:
TABLES
Table 1 - Rescue
Table 2 - CPR (Cardio-Pulmonary Resuscitation)
Table 3 - Oxygen Administration & Controlled Ventilation
Table 4 - Chemical-Induced Disturbances Of Consciousness
Table 5 - Chemical-Induced Convulsions (Seizures, Fits)
Table 6 - Toxic Mental Confusion
Table 7 - Eye Exposure To Chemicals
Table 8 - Skin Exposure To Chemicals
Table 9 - Inhalation Of Chemicals

Table 10 - Ingestion Of Chemicals
Table 11 - Shock
Table 12 - Acute Kidney Failure
Table 13 - Pain Relief
Table 14 - Chemical-Induced Bleeding
Table 15 - Chemical-Induced Jaundice
Table 16 - Hydrofluoric Acid and Hydrogen Fluoride
Table 17 - Organophosphate and Carbamate Insecticides
Table 18 - Cyanides
Table 19 - Methanol (Methyl Alcohol) And Ethylene Glycol
Table 20 - Radioactive Material
APPENDICES

Appendix 1 Rescue

Integrated Response
Emergency Response Plan
Arrival At The Scene
Establishment Of An Exclusion Or Hot Zone
Assessment, Decontamination And Initial Treatment Of Casualties
Decontamination
Considerations For Casualty Treatment
Transport Of Casualty To Medical Area Of Ship
Medical Management Of Casualty
Appendix 2 CPR (Cardio-Pulmonary Resuscitation)

Assessment Of Breathing
Assessment Of Heart Function
Breathing, Heart Is Beating, Unconscious
Not Breathing But Heart Is Beating
Breathing And Heart Have Stopped
Appendix 3 Oxygen Administration & Controlled Ventilation

Suffocation
Oxygen Resuscitation Kits
Insertion Of Guided Airway
Oxygen For The Casualty Who Is Not Breathing
Oxygen For The Casualty Who Has Difficulty In Breathing
Appendix 4 Chemical-Induced Disturbances Of Consciousness

The unconscious position
Unconscious causalities
Appendix 5 Chemical-Induced Convulsions (Seizures, Fits)
Appendix 6 Toxic Mental Confusion
Appendix 7 Eye Exposure To Chemicals
Appendix 8 Skin Exposure To Chemicals

Appendix 9 Inhalation Of Chemicals

Suffocation (asphyxia)
Chemical irritation of the lungs: dry cough, breathlessness and wheezing
Chemical irritation and edema of the lungs: severe breathlessness and frothy sputum
Chemical irritation and secondary infection of the lungs: productive cough
(sticky white, yellow or green phlegm [sputum])

The chemical hazards from fire
Chemical hazards from welding
Chemical hazards from explosive chemicals
Appendix 10 Ingestion Of Chemicals

Perforation of the gut and peritonitis
Appendix 11 Shock

Fainting
Circulatory collapse and shock
Heart failure
Appendix 12 Acute Kidney Failure
Appendix 13 Fluid Replacement

Oral fluids
Intravenous fluids
Rectal fluids
Appendix 14 List Of Medicines And Equipment

List of equipment
Appendix 15 List Of Substances

UN Number
Alphabetic Listing

18.2 Explain the use of the MFAG on board a chemical tanker

The Medical First Aid Guide MFAG gives general information about the particular toxic effects likely to be encountered. Treatments in the guide cater to the accidental human consequences of the carriage of dangerous goods at sea.
Accidental ingestion of toxic substances during voyage is rare, the guide does not cover ingestion by intention.
To ensure rapid access to the recommendations in an emergency the guide is divided in 2 sections which are grouped to facilitate a 3 step approach as follows:
Step 1: Emergency Action and diagnosis --------Start
Step 2: Tables-The Tables give brief instructions for special circumstances.
Step 3: Appendices The Appendices provide comprehensive information, a list of medicines/drugs, and a list of chemicals referred to in the tables.
Emergency action flow chart uses the symptoms to direct to the tables to be used The Instructor should display the appended flow chart

18.3 Describe procedures to use Oxygen resuscitators

Patients who are unable to breathe on their own will require positive pressure to move oxygen in to their lungs for gaseous exchange to take place. Systems for delivering this vary in complexity starting with a basic pocket mask adjunct which can be used by a basically trained first aider to manually deliver artificial respiration with supplemental oxygen delivered through a port in the mask.
It is important to state here that if the first aider is not trained to operate the resuscitator, it will be easier to use a bag-valve-mask (BVM) or Ambu bag, which is a malleable bag attached to a face mask (or invasive airway such as an endotracheal tube or laryngeal mask airway), usually with a reservoir bag attached, which is manually manipulated by the healthcare professional to push oxygen (or air) in to the lungs.

Automated versions of the BVM system, or resuscitator deliver measured and timed doses of oxygen direct to patient through a facemask or airway. These systems are related to the anesthetic machines used in operations under general anesthesia that allows a variable amount of oxygen to be delivered, along with other gases including air, nitrous oxide and inhalational anesthetics.

18.4 Explain methods of resuscitation for conscious and unconscious stages.

An unconscious patient is unable to give an account of what has happened to him. Try and gain as much history from those at the scene and from any injuries sustained as to what may have happened.
Vital Signs - Monitor

- Respiratory Rate
- Pulse Rate
- Blood Glucose Levels (Correct hypoglycemia with Glucagon/Hypos top if required)
- Oxygen Saturations
- Temperature

Treat any obvious injuries e.g. bleeding, fractures (support and immobilize)
Continue to Observe:

- Airway
- Respirations
- Circulation
- Bleeding

Note: Even though the patient may appear unresponsive it doesn't mean they can't hear you. Keep talking to the patient as hearing is the last sense lost.
The most common and efficient method of artificial respiration is mouth-to-mouth resuscitation.

Mouth-to-Mouth Resuscitation

Assess the responsiveness of the patient by gently shaking the victim and shouting "Are you OK?" This precaution will prevent us from injuring during resuscitation someone who is not truly unconscious.
Ask someone nearby to call for Medical Help.
Move the victim away from any dangerous location, that is, locations close to harmful gases, fire, etc. Place the victim face up on a firm surface, such as the floor or the ground.
Open the Airway. One very important step in the resuscitation process is to immediately open the airway. Quite often the tongue may block the passage of air into the air passages. To open the airway, one hand must be placed on the victim's forehead and firm, backward pressure with the palm is applied to tilt the head back. If there is a suspicion of neck injury, the head should not be moved unless it is absolutely necessary to open the airway. Place the fingers of the other hand just under the chin and lift to bring the chin forward. If there is material like vomits or any foreign body that appears to block the air passages it must be removed.
Ascertain whether the patient is breathing: With the airway open, look at the chest for signs of breathing. Put your ear next to the nose and mouth and listen for breathing. Feel for the flow of air. If there is no breathing, begin artificial respiration.
Mouth-to-Mouth Resuscitation: Place one hand on the victim's forehead to pinch the victim's nose closed. Ensure that your breathing is regular. Take a deep breath and place your mouth tightly over the victim's mouth. If you wish you may place a thin handkerchief between your mouth and the victim's mouth. However, do not use a very thick cloth, as it may be difficult to blow through it. Blow until the victim's chest rises. Listen for air being passively exhaled. Repeat with breaths at the rate of 12 times

NIELSEN METHOD TURNING
- if the casualty is lying on his back turn him to the prone position (face downwards) as follows.
- cross his far leg over the near leg
- go down on the left knee opposite the casualties head, placing the right foot on the ground out of the side
- place the casualty's arms carefully above his head, and keep them there during the turn.
- grasp his right upper arm and turn him over, protecting his face with the other hand.
- adjust the position of the casualty's hands.

POSITION OF THE CASUALTY
- lay the casualty in the prone position on a flat surface
- place the casualty's hand one over the other, under his forehead.
- the head must be turn slightly on one side
- the nose and mouth must be unobstructed. per minute. Children should receive smaller breaths repeated at the rate of 20 times per minute.

The operator raises and pulls the arms until tension is felt for a period of two seconds counting "four, five". (Take care not to raise the chest from the ground)
- This movement causes inspiration, the operators arm should remain straight for the whole period.
- counting "six" for one second the operator lowers the casualty's arm to the ground and replaced his hands in the original position.
- the whole operation occupying 6 seconds that is ten times a minute, should be rhythmic in character and be continued until breathing recommences.
- The use of artificial resuscitators equipment are to be with utmost care, done by trained personnel and giving due respect to the manufacturer's instructions.

18.5 Describe procedures to transfer patients to hospitals.

In the event of an emergency aboard the vessel, wherein time may be of vital essence to save the injured person, helicopter operation may become inevitable. Proper preparation on board the vessel for the ambulance or helicopter rescue transfer will help facilitate the rescue effort and save precious time.
Preparation of patient before the helicopter arrives:
- move the patient as close to the helicopter pick-up area as the patient's condition permits;
- ensure the patient is tagged to show details of any medication which has been administered;
- prepare the patient's seaman's papers, passport, medical record, and other necessary documents in a package ready for transfer with the patient;
- ensure that personnel are prepared as necessary to move the patient to the special stretcher (lowered by the helicopter) as quickly as possible;
- The patient should be strapped in the stretcher face-up, in a lifejacket if the patient's condition permits.

The ICS Guide to helicopter ship operations should be referred to.

Ensure a Tag is attached to the outgoing patient stating his name, address in his home town, Name of the ship, History of medication, Type of illness, Name of the agent and if allergic to any medication.
Any other information for example the MSDS for the chemical, thought necessary for assistance to medical and immigration authorities.

19 Understanding of procedures to prevent pollution of the atmosphere and the environment

19.2 Describes how operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment

Due to growing focus on improving environmental performance, the crews of chemical tankers need to have a clear understanding of anti-pollution prevention regulations. Many tasks undertaken during cargo handling operations on a chemical tanker are dictated by the need to comply with environmental regulations in order to avoid pollution of the sea and air.
These additional tasks must be performed safely, and an understanding of their purpose is essential for those in charge of cargo operations.
Ships' officers should familiarize themselves thoroughly with the types of cargo the vessel is permitted to carry, and adhere at all times to operational procedures with respect to cargo handling, tank cleaning, slop handling ,residue discharge, ballasting and de-ballasting operations.
The Master should ensure that the vessel does not discharge into the sea any cargo residues, or mixtures of residue with water, unless such discharges are made in full compliance with the applicable regulations The Procedure and arrangement manual must be followed at all times.
Check Lists and procedures mandated by the ISM code must be strictly followed for all operations.

20 Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied

20.2 Explain important definitions of regulation 1, Annex II 'en route', 'Noxious liquid substances', 'solidifying' and 'non-solidifying substances', 'nearest land' and others relevant to the requirements of Prevention of Pollution

"En route" means that the ship is under way at sea on a course or courses, including deviation from the shortest direct route, which as far as practicable for navigational purposes, will cause any discharge to be spread over as great an area of the sea as is reasonable and practicable.
Solidifying/non-solidifying
Solidifying Substance means a noxious liquid substance which:
.1 in the case of a substance with a melting point of less than 15°C which is at a temperature of less than 5°C above its melting point at the time of unloading; or
.2 in the case of a substances with a melting point of equal to or greater than 15°C which is at a temperature of less than 10°C above its melting point at the time of unloading.
Non-solidifying Substance means a noxious liquid substance, which is not a Solidifying Substance.

Chemical tanker means a ship constructed or adapted for the carriage in bulk of any liquid product listed in chapter 17 of the International Bulk Chemical Code;
NLS tanker means a ship constructed or adapted to carry a cargo of Noxious Liquid Substances in bulk and includes an "oil tanker" as defined in Annex I of the present Convention when certified to carry a cargo or part cargo of Noxious Liquid Substances in bulk.

Nearest land. The term "from the nearest land" means from the baseline from which the territorial sea in question is established in accordance with international law, except that, for the purposes of the present Convention "from the nearest land" off the north-eastern coast of Australia shall mean from the line drawn from a point on the coast of Australia as per co-ordinates stated in the regulations.

20.3 Interpret 'exceptions', 'exemptions' and 'equivalents' as per the requirements of Annex II MARPOL

Exceptions
The discharge requirements of Annex II shall not apply to the discharge into the sea of Noxious Liquid Substances or mixtures containing such substances when such a discharge:
.1 is necessary for the purpose of securing the safety of a ship or saving life at sea; or
.2 results from damage to a ship or its equipment:

Exemptions
This deals with specific exemptions permitted to take care of new amendments to annex II including for specific cargoes as a result of amended designated pollution categories.

If application of an amendment is considered unreasonable then any exemptions granted by the administration for changes to fitting / equipment / construction, such relaxation is determined with respect to each substance by the administration;

Typically for ships certified to carry individually identified vegetable oils identified by the Code, where the NLS tanker meets the requirements of ship type 3 and the entire cargo tank length shall be protected by ballast tanks or spaces other than tanks that carry oil are located inboard of the moulded line of the side shell plating nowhere less than 760 mm and the bottom of the cargo tanks measured at right angles to the bottom shell plating is not less than B/15 (m) or 2.0 m at the centerline, whichever is the lesser. The minimum distance shall be 1.0 meter;

The relevant certificate shall indicate the exemption granted.

Equivalents
The Administration may allow any fitting, material, appliance or apparatus to be fitted in a ship as an alternative to that required by this Annex if such fitting, material, appliance or apparatus is at least as effective as that required by this Annex.

The construction and equipment of liquefied gas carriers certified to carry Noxious Liquid Substances listed in the applicable Gas Carrier Code, shall be deemed to be equivalent to the construction and equipment requirements contained in regulations 11 (minimize uncontrolled discharge) and 12 (pumping arrangements suitable for minimizing amount of cargo remaining on board) of this Annex

20.4 Describe pollution categories of chemical cargoes in accordance with MARPOL 73/78 Annex II regulations

• Category X
NLS which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and which therefore, justify the prohibition of the discharge into the marine environment;

• Category Y
NLS which, if discharged into the sea from tank cleaning or ballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment;

• Category Z
NLS which, if discharged into the sea from tank cleaning or ballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment; and

• Other substances (OS)
Substances found to fall outside of category X, Y or Z, as defined in the MARPOL Annex II regulations, and considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning and ballasting operations.

20.5 Explain surveys and certification requirements of a Chemical tanker

Under the requirements of the IBC code the structure, equipment, fittings, arrangements and material (other than items in respect of which a Cargo Ship Safety Construction Certificate, Cargo Ship Safety Equipment Certificate and Cargo Ship Safety Radio Certificate or Cargo Ship Safety Certificate are issued) of a chemical tanker shall be subjected to the surveys as mentioned herein below.

Chemical tankers which have been surveyed and certified by States Parties to the present Convention in accordance with the provisions of the International Bulk Chemical Code or the Bulk Chemical Code, as applicable, shall be deemed to have complied with the provisions of the MARPOL Annex II regulations.
The requirements for the IOPP survey shall be such as to ensure that the structure, equipment, systems, fittings, arrangements and material fully comply with the applicable requirements of Annex II.

An initial survey before the ship is put in service
A renewal survey at intervals specified by the Administration, but not exceeding 5 years
An intermediate survey within 3 months before or after the second anniversary
date or within 3 months before or after the third anniversary date of the Certificate
An annual survey within 3 months before or after each anniversary date
An additional survey either general or partial, according to the circumstances, shall be made after a repair

The COF or the Certificate of Fitness and the International pollution prevention certificate for NLS cargoes are issued on completion of the foregoing mentioned initial and renewal surveys.

20.6 Explain control of operational discharges of residues of NLS

Unloading (discharging) of cargoes and the disposal of residues after cleaning should be carried out in accordance with the vessel's "Procedures and Arrangement (P&A) Manual."

IMO publishes a list of current tripartite agreements on an annual basis in a document titled MEPC.2 Circular. The circular also list the tank cleaning agents that have been approved for use on board chemical tankers.
The latest version of this document should be kept on board the vessel.

After completion of any operation, the operation is to be promptly recorded in the Cargo record book.

Note: It is recommended that the instructor may execute an exercise on the filling up of the CRB by simulating a table top exercise of various annex II tank cleaning and discharge procedures

The P&A Manual will describe how the vessel's pumping and stripping system is to be operated in order to ensure that the tanks are effectively stripped in order to comply with the MARPOL Annex II regulations.

- Category X residues cannot be discharged overboard. On completion of discharge, the tank is washed and the tank washings pumped ashore. This procedure is called a prewash. This operation has to be monitored and approved by the relevant port authority representative and an entry must be made in the Cargo Record Book;
- Category Y residues remaining in the tank after stripping in accordance with the P&A Manual can be discharged to the sea while tank cleaning provided that the conditions in MARPOL Annex II are met. High viscosity or high melting point Category Y products may also require a prewash (the same as for category X products) if, on discharge, the temperature or characteristics of the product mean that the tank cannot be stripped in compliance with the stripping criteria;
- Category Z residues remaining in the tank after stripping in accordance with the P&A Manual can be discharged to the sea while tank cleaning, provided that the conditions in MARPOL Annex II are met; and
- Tank washings can be discharged overboard via an underwater discharge outlet, provided that the conditions in MARPOL Annex II, Chapter 5, regulation 13 are met. This ensures that any small traces of the product are dispersed by the action of the ships propeller. The regulations require that the vessel is proceeding en route at a speed of at least 7 knots, at least 12 miles from the nearest land and in a water at least 25 metres deep.

20.7 Explain bio-fuels and blending of bio-fuels, what regulations are applicable for their transportation tank cleaning and disposal procedures.

Bio fuels typically consist of MARPOL Annex II products such as alcohols, fatty acid methyl esters (FAME) or vegetable oils blended with MARPOL Annex I products such as gasoline and diesel. The proportion of each product in the final blend determines under which MARPOL Annex the cargo is to be transported.

- Under present regulations, all blended bio fuels with more that 25% of the blend made up of an Annex II product have to be transported according to MARPOL Annex II regulations.
- For blended bio fuels with less than 25% of the blend made up of an Annex II product, the bio fuel can be transported under MARPOL Annex I regulations providing that the vessel's oil discharge monitoring equipment (ODME) has been approved for the mixture being transported
- for Annex I cargoes, If the ODME is not approved the regulations require that all residues and tank washing slops are disposed of to an approved shore reception facility.

20.10 Explain briefly the contents of a shipboard marine pollution emergency plan for NLS

The shipboard marine pollution emergency plan shall consist of:

.1 the procedure to be followed by the master or other persons having charge of the ship to report a Noxious Liquid Substances pollution incident.

.2 the list of authorities or persons to be contacted in the event of a Noxious Liquid Substances pollution incident;

.3 a detailed description of the action to be taken immediately by persons on board to reduce or control the discharge of Noxious Liquid Substances following the incident; and

.4 the procedures and point of contact on the ship for coordinating shipboard action with national and local authorities in combating the pollution.

The coastal state contact list of the SMPEP must be kept updated

20.11 Explain requirements of reception facilities and cargo unloading terminal arrangements.

Regulation 18 of Annex II MARPOL requires terminals to provide arrangements to facilitate stripping of cargo tanks of ships unloading Noxious Liquid Substances at these terminals. Cargo hoses and piping systems of the terminal, containing Noxious Liquid Substances received from ships unloading these substances at the terminal, shall not be drained back to the ship.
Each Party shall notify the Organization, for transmission to the Parties concerned, of any case where facilities required under paragraph 1 or arrangements required are alleged to be inadequate.

21.0 Proficiency in the use of the IBC/BCH code and related documents.

21.1 Explain the purpose and demonstrate the use of the IBC code

The purpose of the IBC Code is to provide an international standard for the safe carriage, in bulk by sea, of noxious liquid substances. The Code specifies design and construction standards and specifies the equipment that vessels must carry in order to ensure the safety of the crew and minimise risk of damage to the environment.
The Code addresses both safety and environmental issues and there is a degree of overlap with the MARPOL Annex II regulations.

The instructor should give a few chemical cargo names along with some synonym of the cargo, The students should be able to find out the product name as given in chapter 17 and 18 using the index in chapter 19;
The student should also be able to interpret each column requirements and refer to the special requirements for that cargo as given in column. "O" in relevant chapters.

SOLAS

21.7 Explain the purpose and use of the ICS Tanker Safety Guide for Chemicals

The purpose of the guide is to provide those serving on chemical tankers with up to date information on recognized good practice in safety chemical tanker operations.

The recommendations do not cover all situations that can be encountered on a chemical tanker, but they do provide general guidance on safe working practices and procedures when handling chemicals in bulk.

Chemical tankers should also have on board International Safety Guide of Oil Tankers and Terminals (ISGOTT) which should be consulted in conjunction with this guide when oil cargoes are carried.

The guide is meant to complement and not supersede any company safety and operational guidelines or Emergency plans.

APPENDIX 1

DIAGRAMS FOR USE BY THE INSTRUCTOR
PRINT OFF AS HANDOUTS
OR
USE FOR Power point presentations
IF SUITABLY ENLARGED

NOTE: The numbering of the figure appended herein is that of the General Learning Objectives (GLO)

e.g. Figure no: 2 (A to G) represents GLO 2.0 Knowledge of pump theory and characteristics, including the types of Cargo Pumps and their safe operations and should be used with their respective Specific learning Objectives (SLO) included in Part "C" and Part "D" respectively.

Diagrams from the Basic course may also be used.

Fig. 1.1 A Sophisticated Parcel Chemical Tanker with Transverse and vertically corrugated Stainless Steel Bulkheads

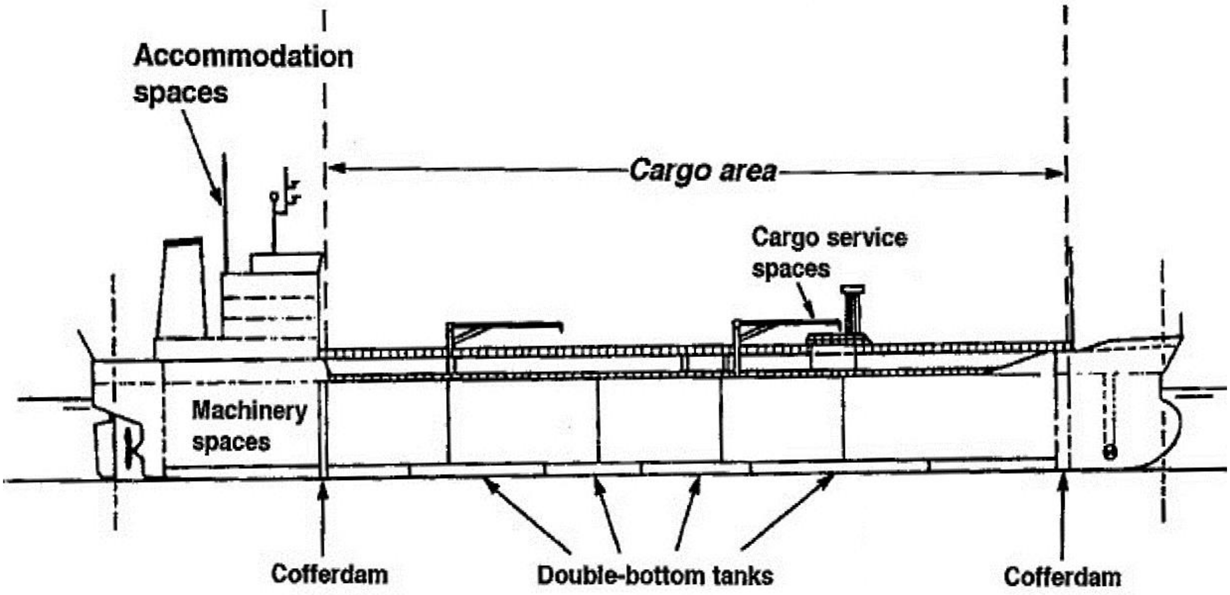
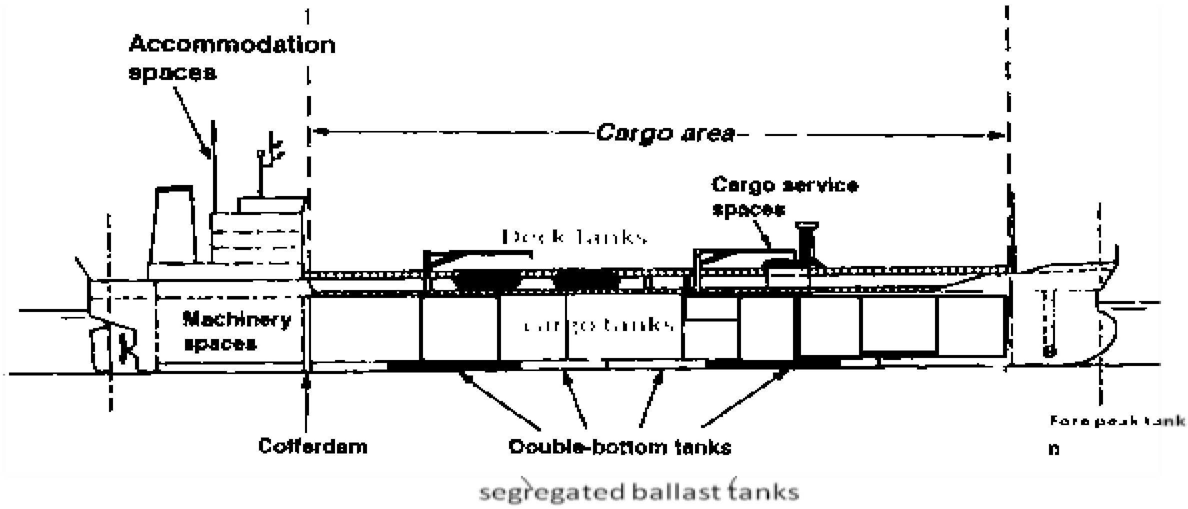
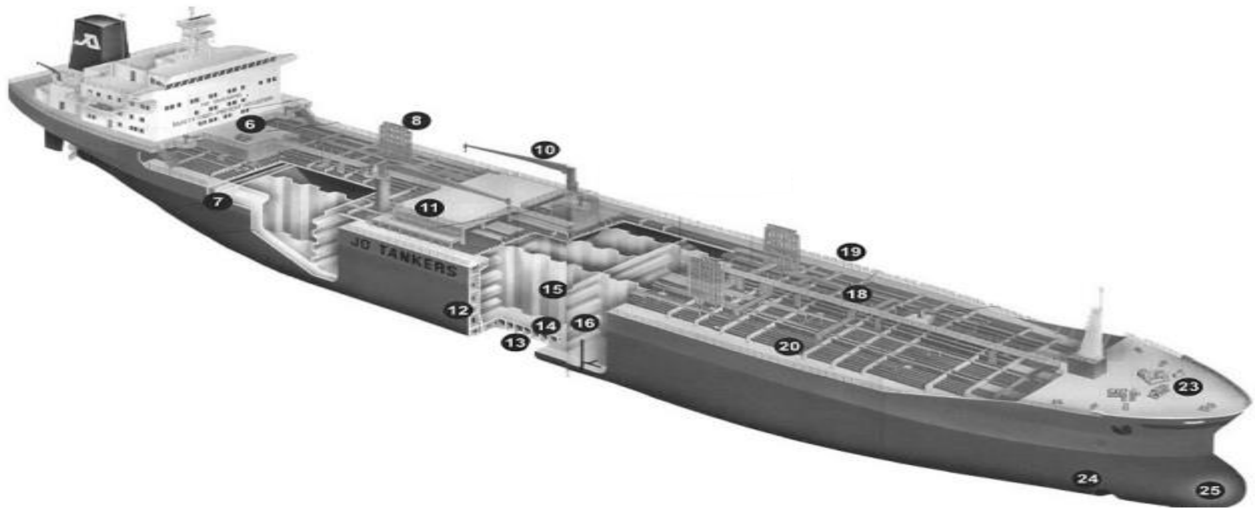


Fig. 1.1B: General Arrangements of a Tanker



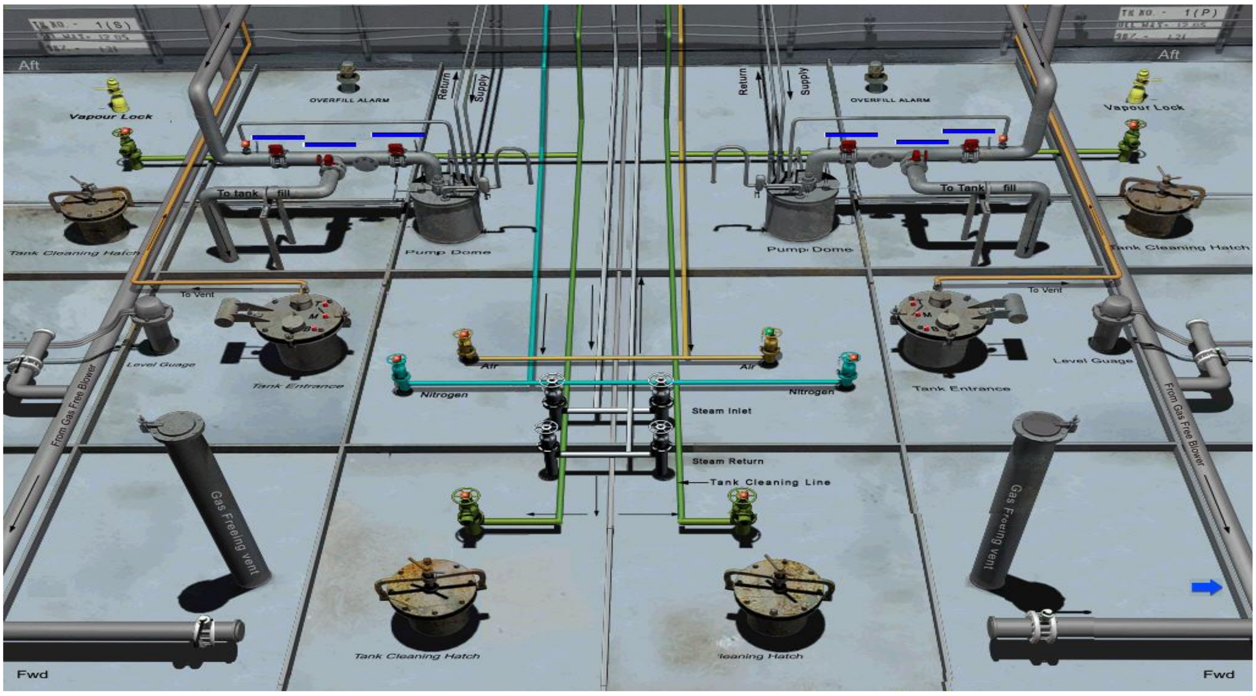
SLOP Tanks: No regulatory requirements for a slop tank, any tank can be nominated

Fig. 1.1C Cargo Area of a Chemical Tanker



1. Balanced rudder with conventional propeller
2. Auxiliary unit
3. Lifeboat in gravity davits
4. Hydraulic prime mover
5. Cargo control room
6. Tank heating / tankwash room
7. Cofferdam, empty space between two tanks
8. Vent pipes with pressure-vacuum valves
9. Hydraulic high pressure oil-and return lines for anchor and mooring gear,
10. Hose crane
11. Manifold
12. Wing tank in double hull
13. Double bottom tank
14. Tank-top
15. Longitudinal vertically corrugated bulkhead
16. Transverse horizontally corrugated bulkhead
17. Cargo pump
18. Catwalk
19. Railing
20. Deck longitudinal
21. Deck transverses
22. Cargo heater
23. Forecastle deck with anchor-and mooring gear
24. Bow thruster
25. Bulbous bow

Fig. 1.1D: Ship arrangements of a chemical tanker



Chemical Simulator Fig 1.1E: Main Deck arrangements of a Chemical Tanker

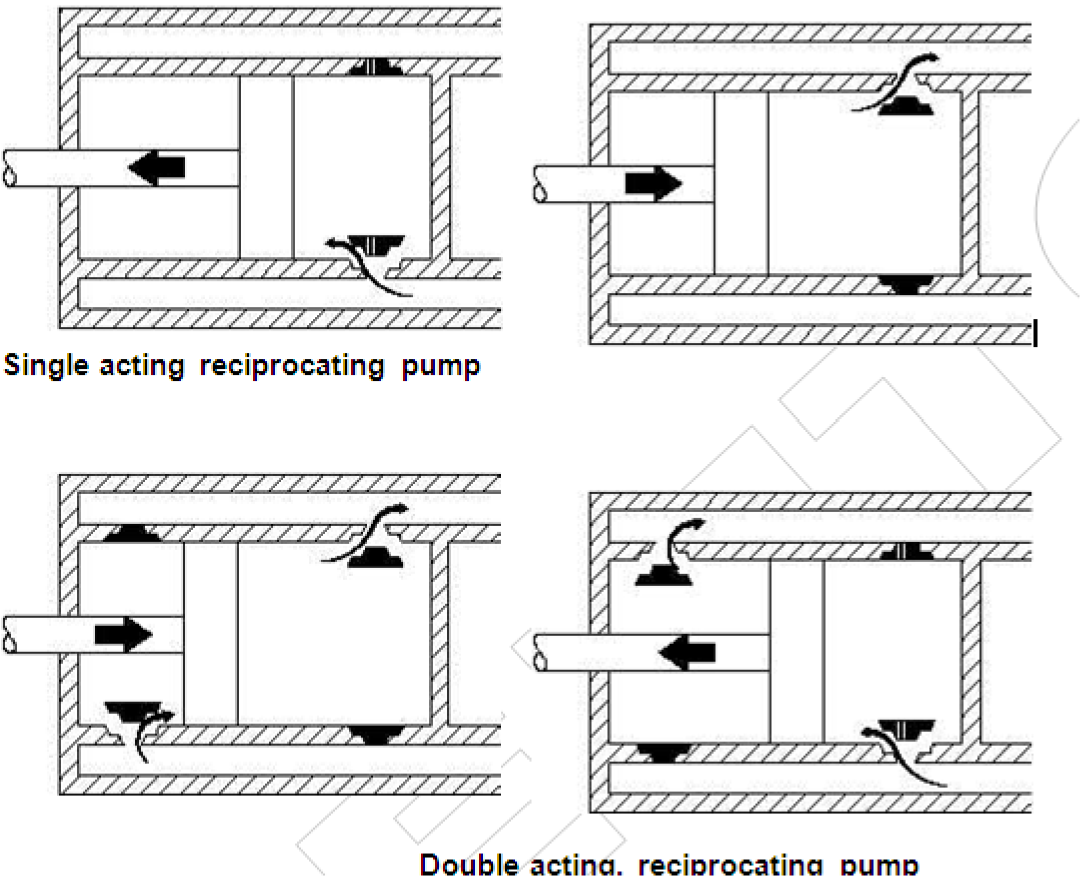


Fig: 1.2A. Single and double acting reciprocating pumps.

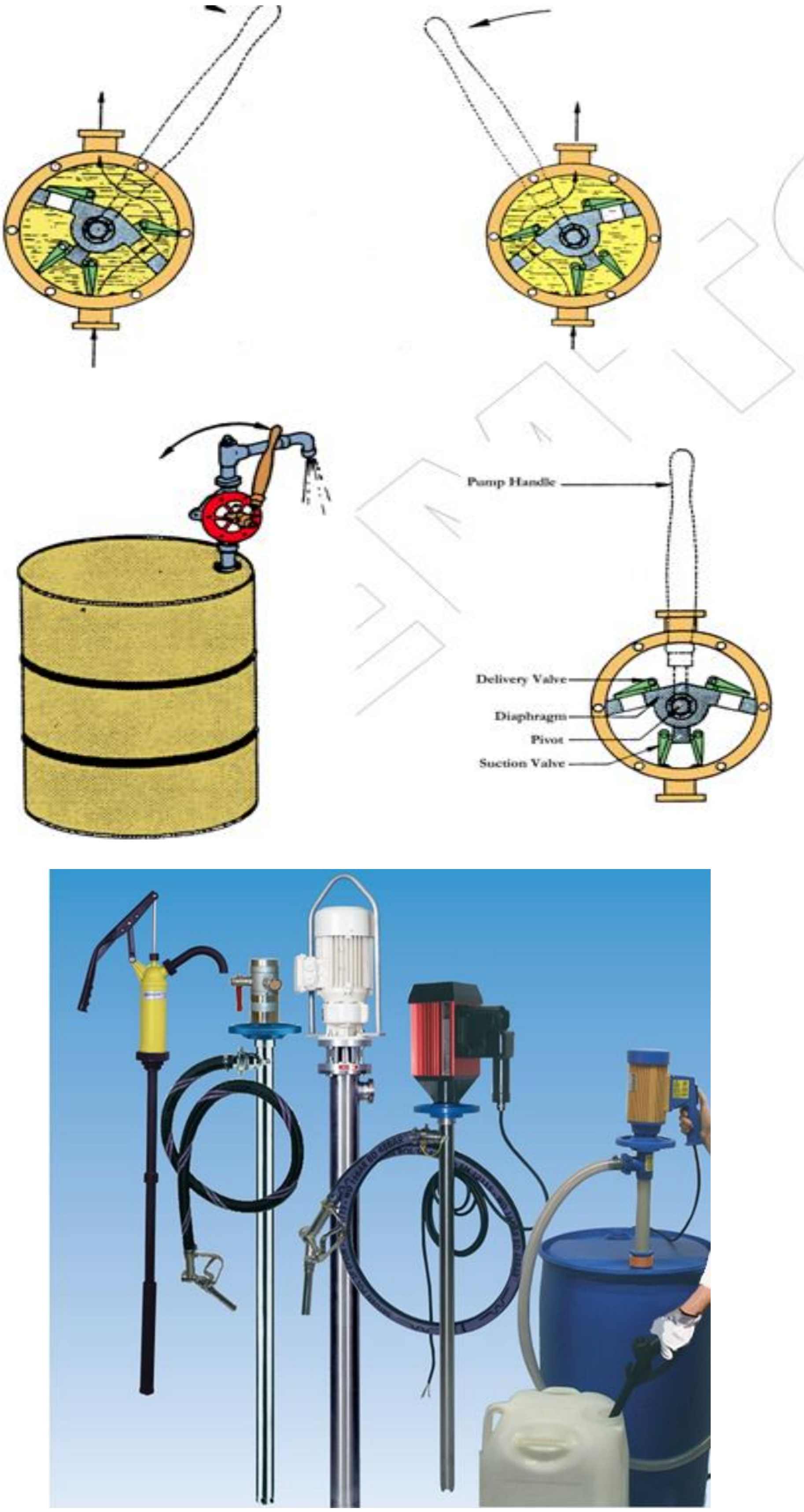


Fig. 1.2B Pumps for extracting tank cleaning chemicals from Chemical drum

Fig. 1.2C: Eductor used for stripping oil tanks

Fig 1.2D: Portable Chemical Emergency Cargo pump

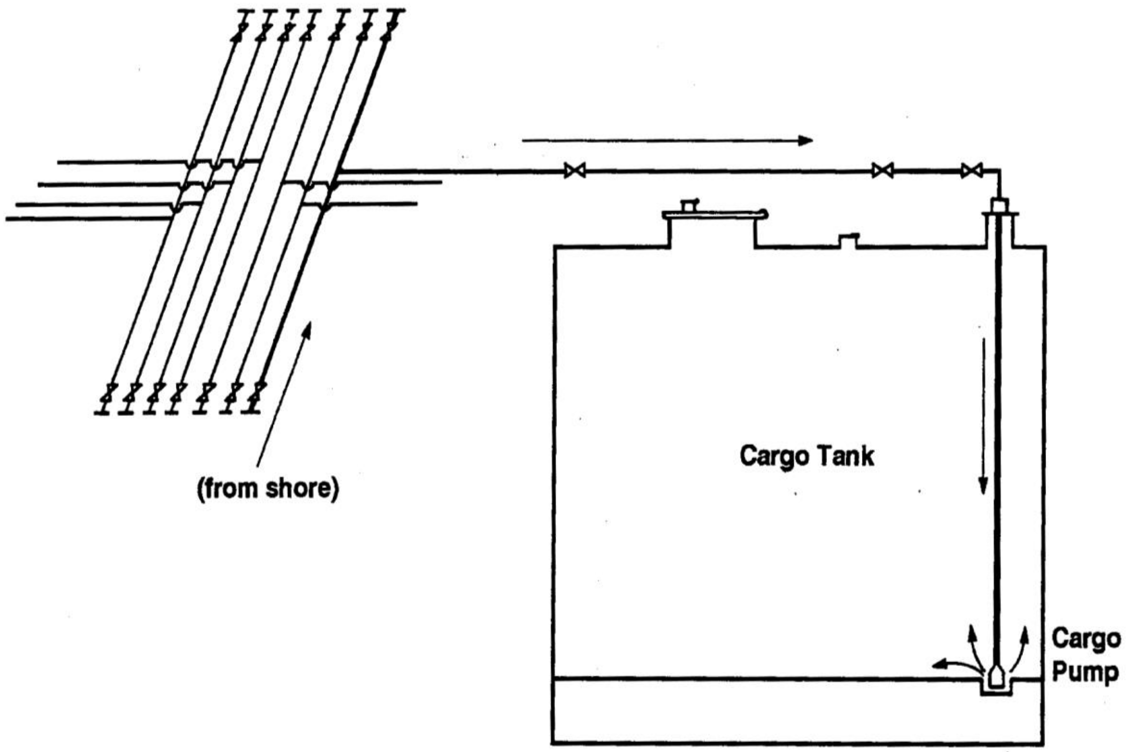


Fig. 1.2E Arrangements for loading through the deepwell pump

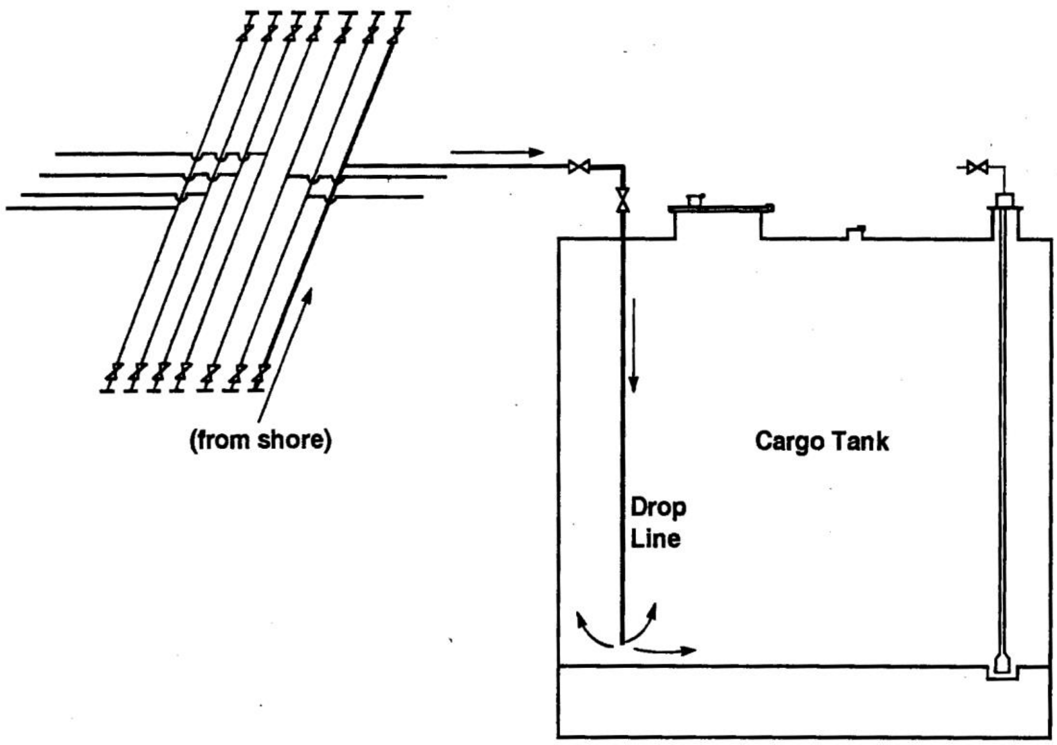


Fig. 1.2F Arrangements for loading through the drop line

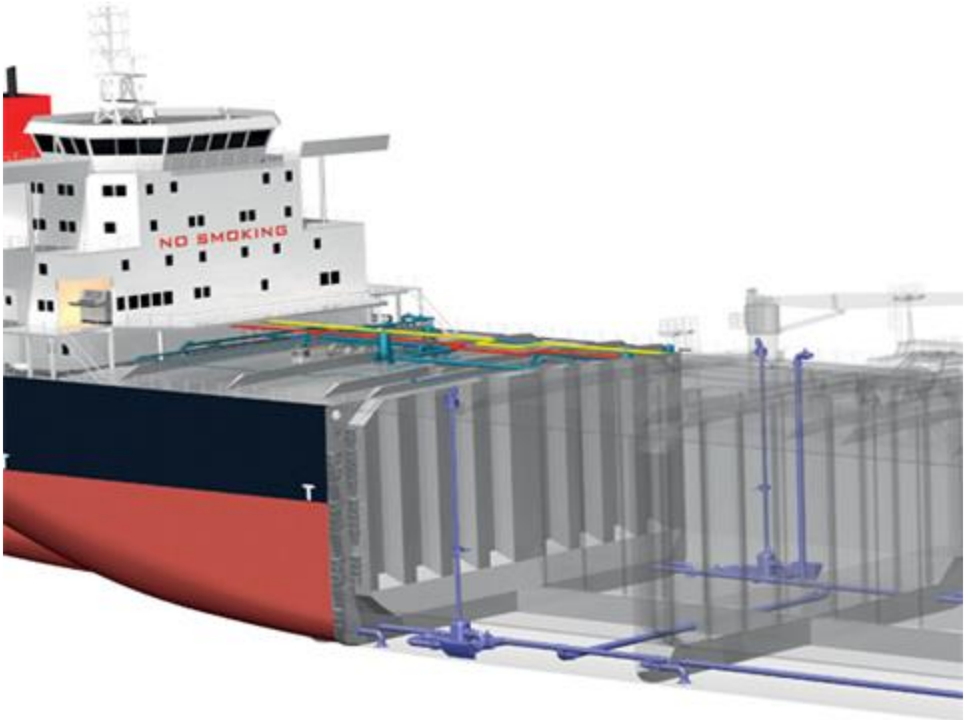


Fig: 1.2G Pumping arrangements and equipments of a chemical tanker

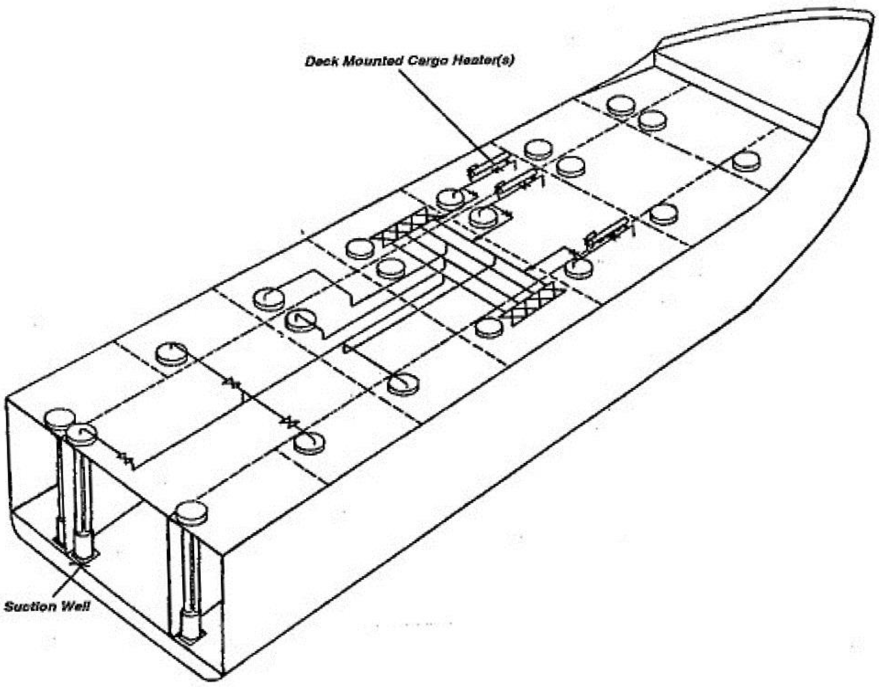


Figure 1.2 H: Tank section of a product/chemical tanker with deepwell pumps

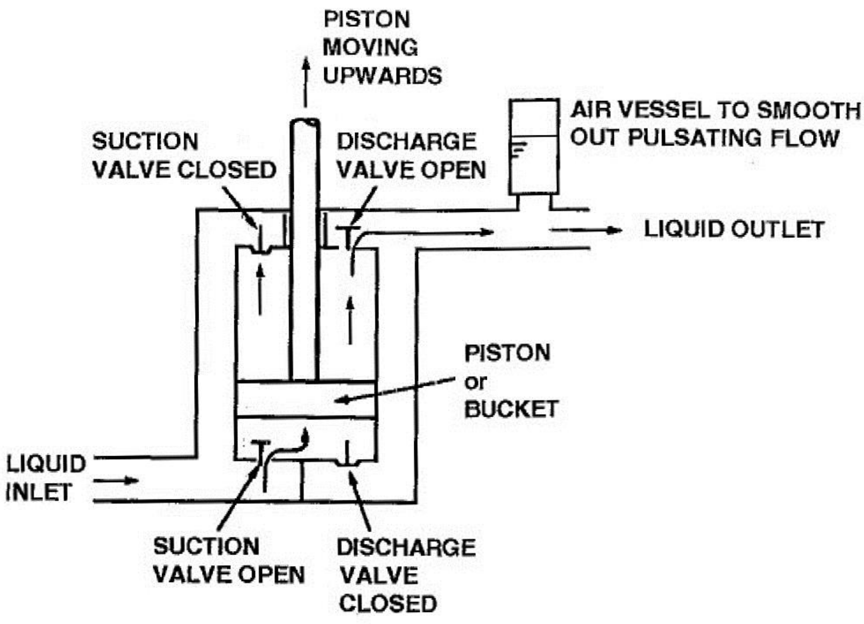


Fig. 1.2.I: Operation of a Reciprocating piston pump

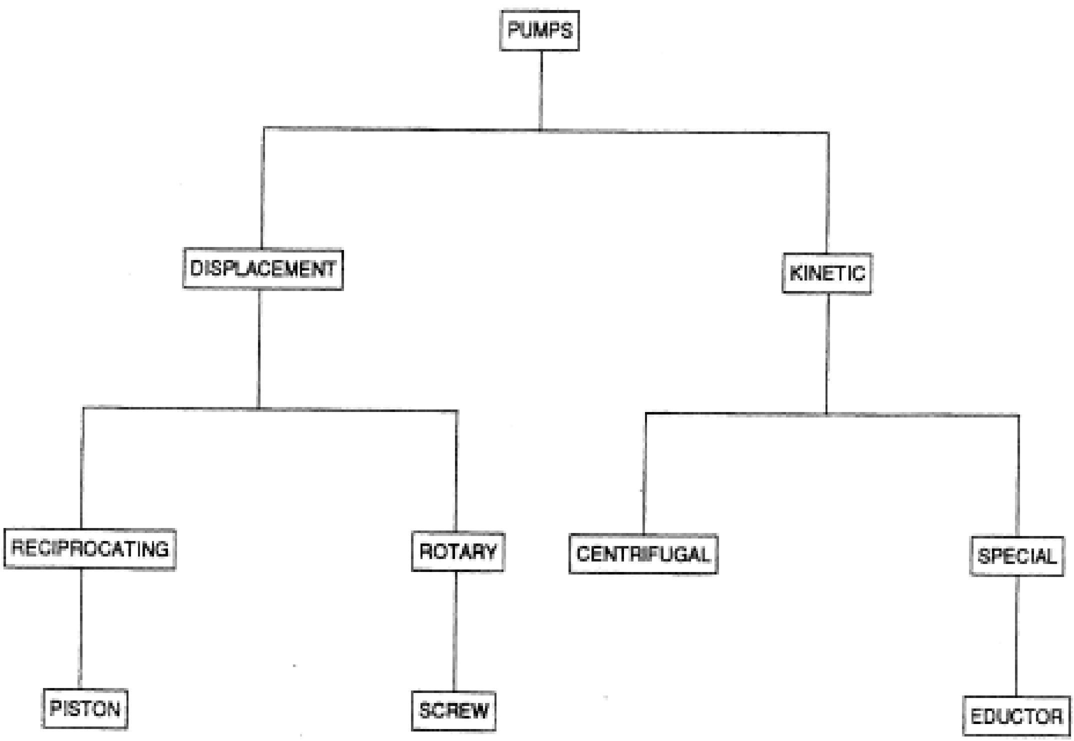


Fig 1.2.J Types of pumps and pumping concepts

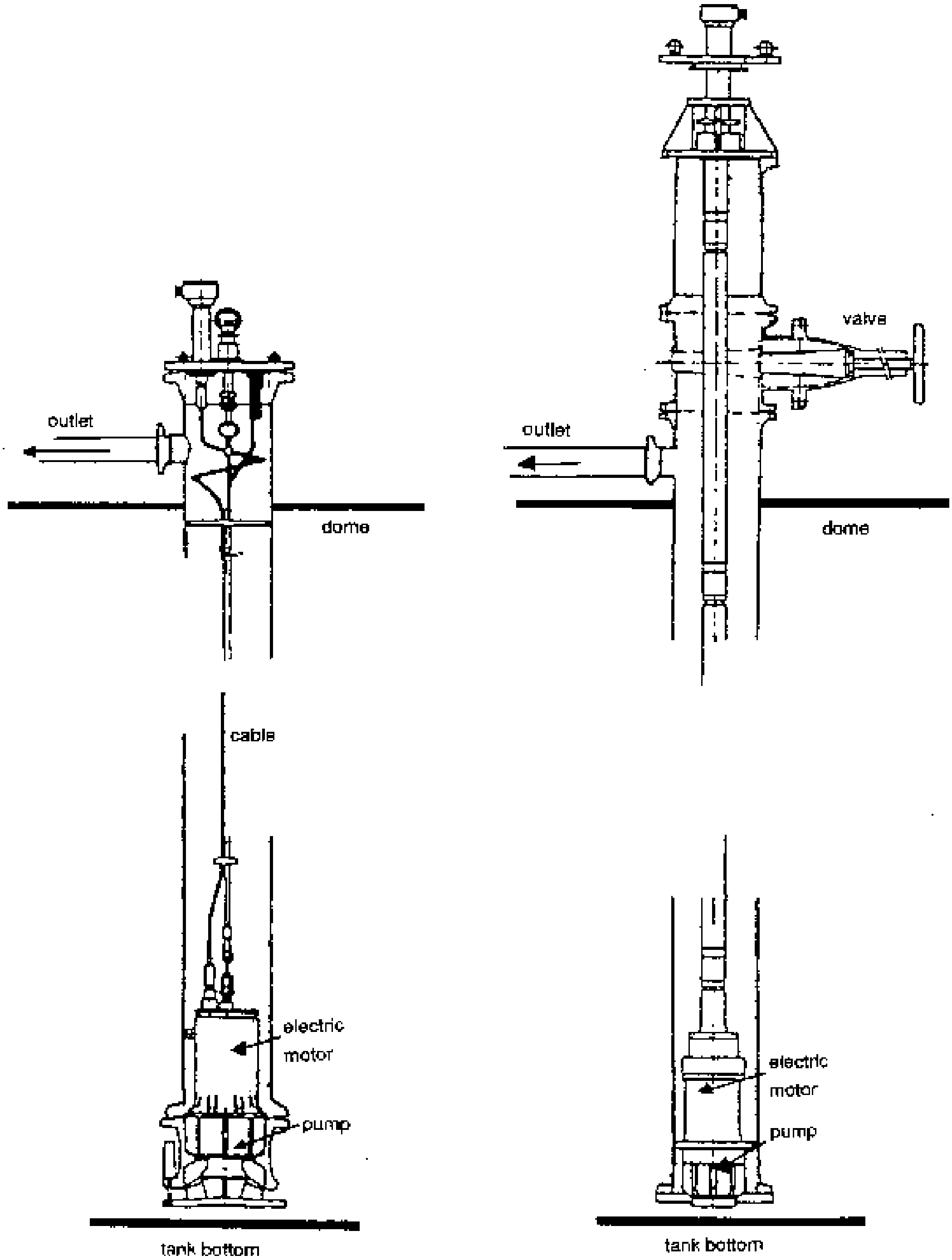


Fig: 1.2.3A Deep well pumps

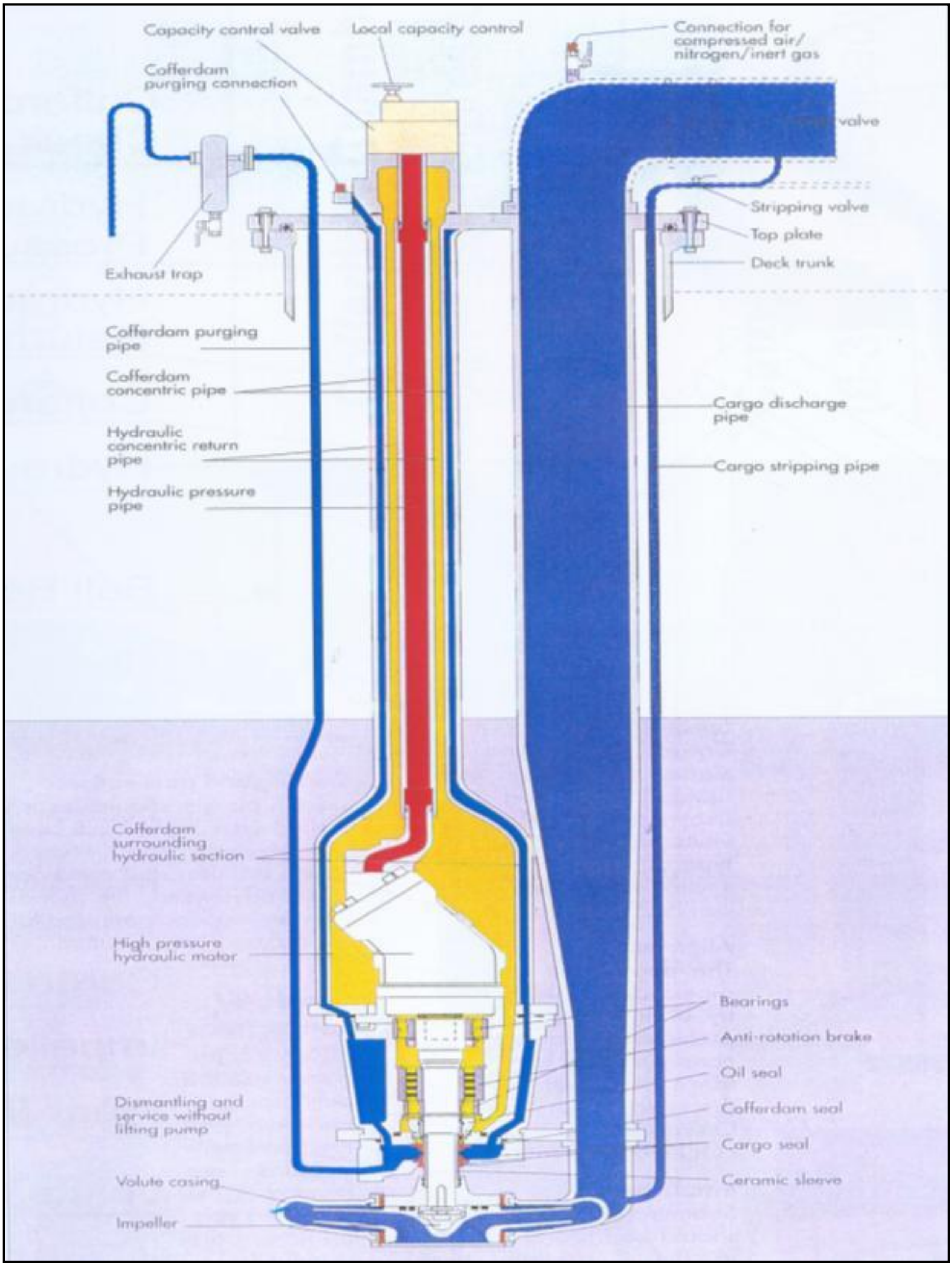

Capacity control valve
Local capacity control
Connection for compressed air/ nitrogen/inert gas
Cofferdam purging connection
valve
Stripping valve
Top plate
Deck trunk
Exhaust trap
Cofferdam purging pipe
Cofferdam concentric pipe
Cargo discharge pipe
Hydraulic concentric return pipe
Cargo stripping pipe
Hydraulic pressure pipe
Cofferdam surrounding hydraulic section
High pressure hydraulic motor
Bearings
Anti-rotation brake
Oil seal
Dismantling and service without lifting pump
Cofferdam seal
Cargo seal
Volute casing
Ceramic sleeve
Impeller

Fig.1.4 A: Chemical tanker Deck pipeline arrangements

Figure 1

Fig. 1.4B: Manifold arrangements of a chemical tanker

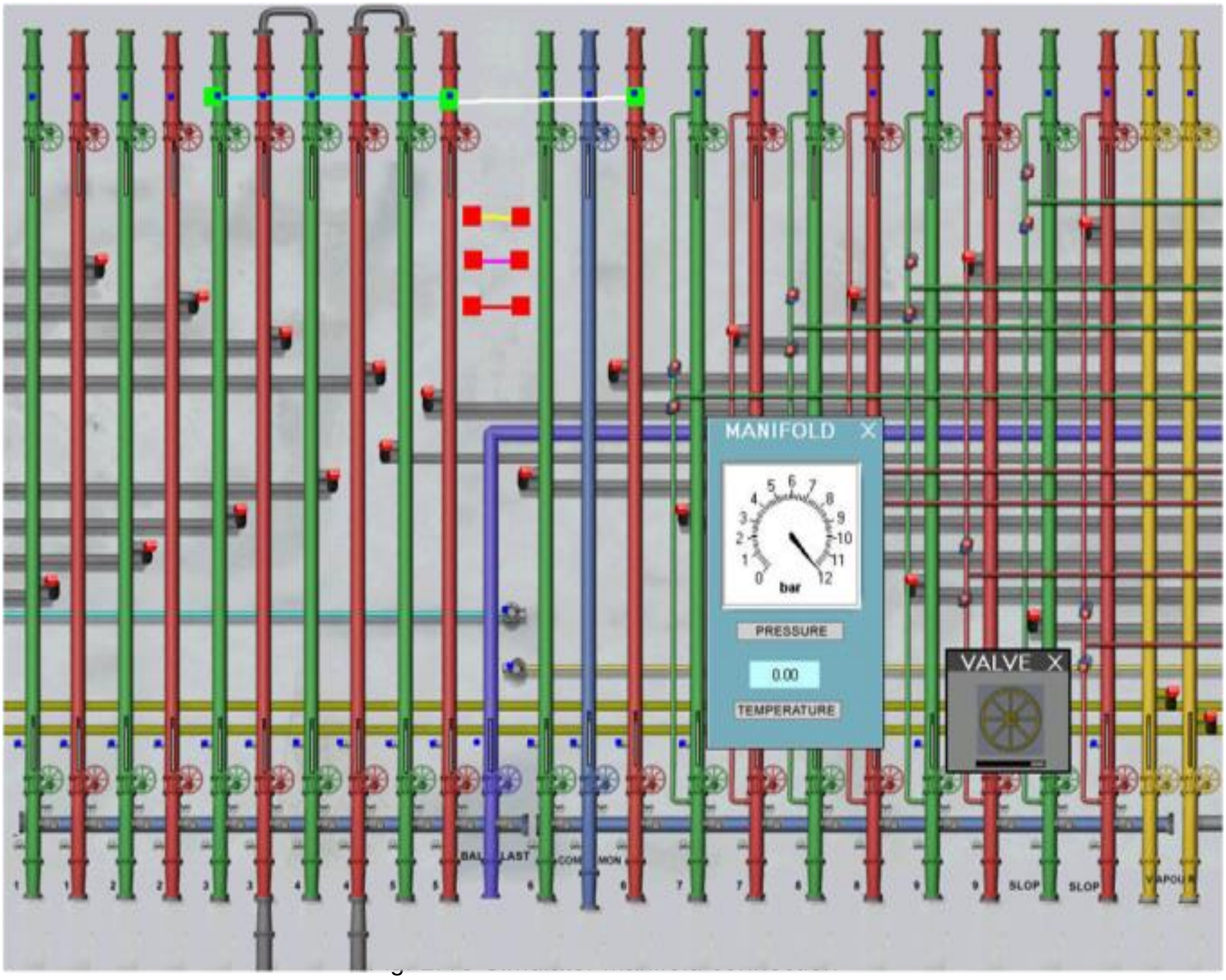

MANIFOLD
bar
PRESSURE
0.00
TEMPERATURE
VALVE
SLOP
SLOP

Fig: 1.6D: Restricted gauging and sampling equipment

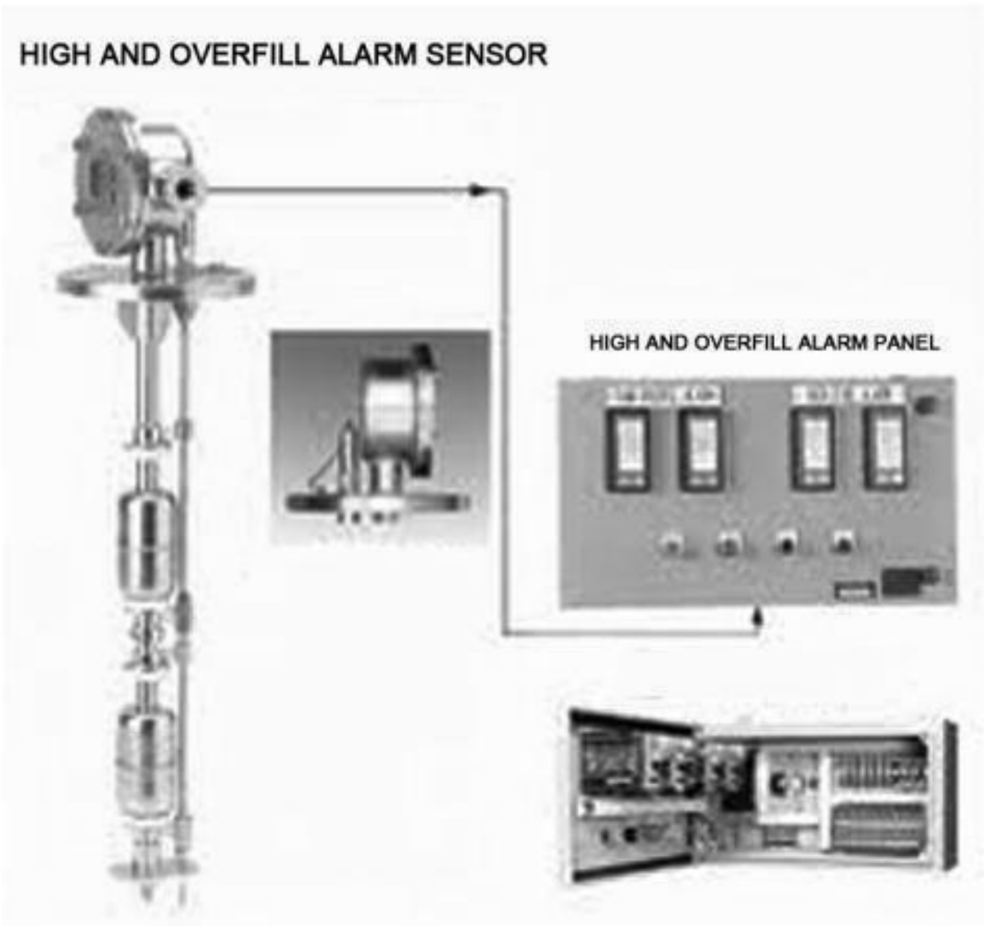
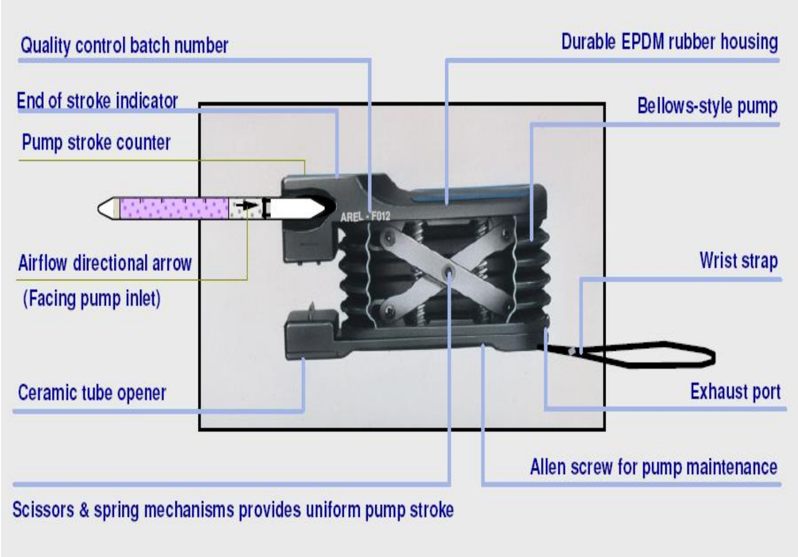
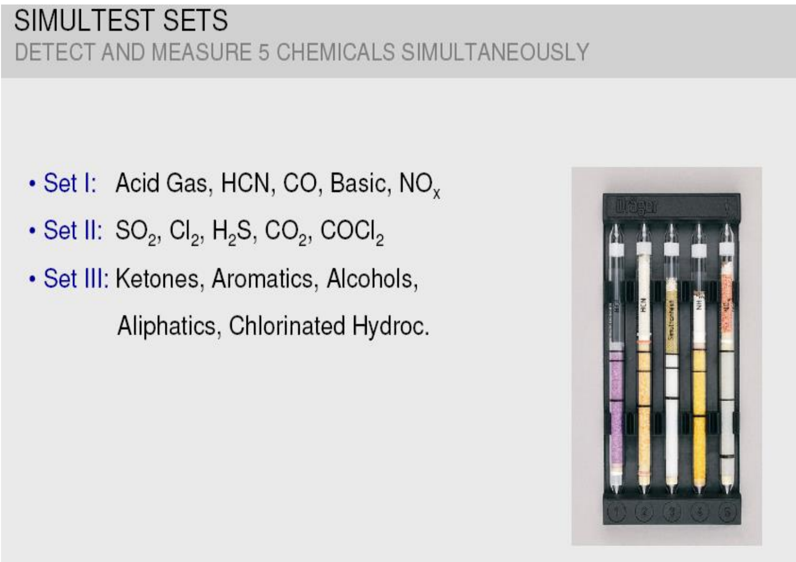


Fig. 1.6E: High level and overfill alarms





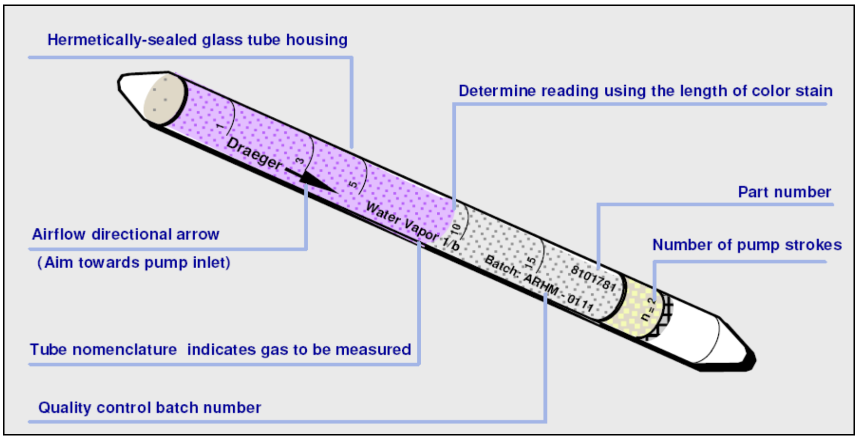
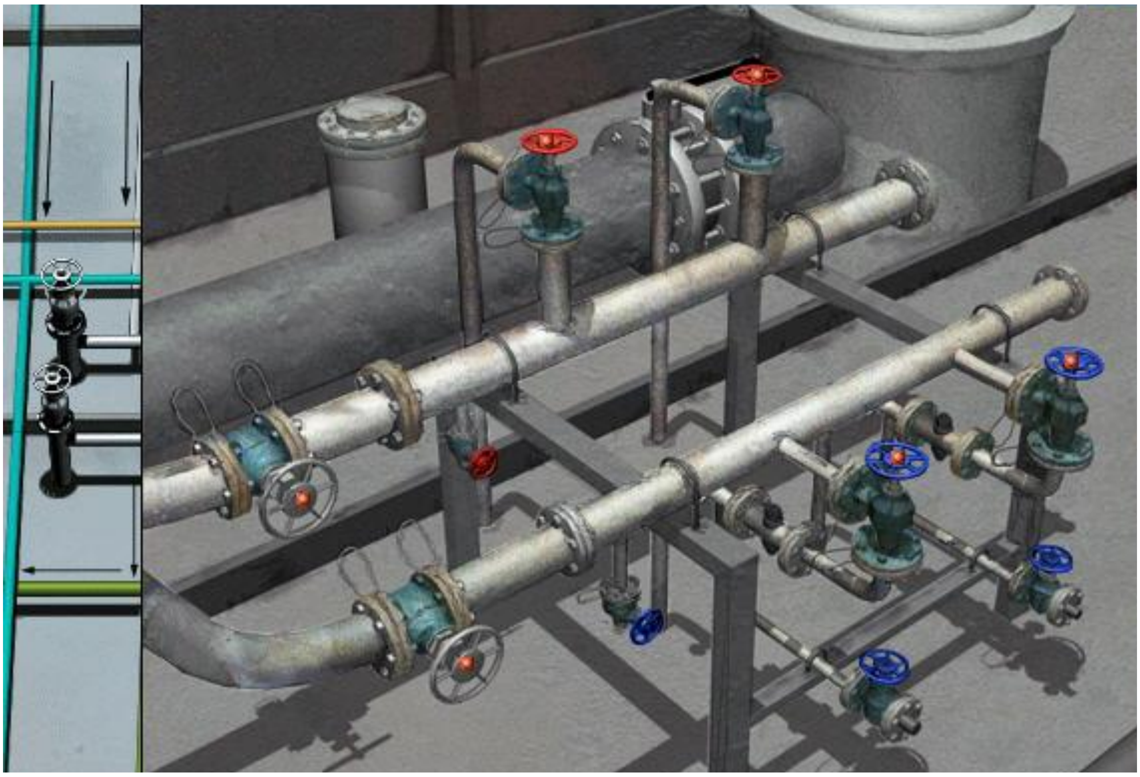


Fig: 1.7F Gas detector tubes

Fig. 1.8 G: Heating arrangements of a Chemical Tanker



Chemical Simulator Fig1.8H Tank Heating arrangements on a Chemical Tankers main deck

Chemical Simulator Fig 1.8 I: Tank Cleaning heater

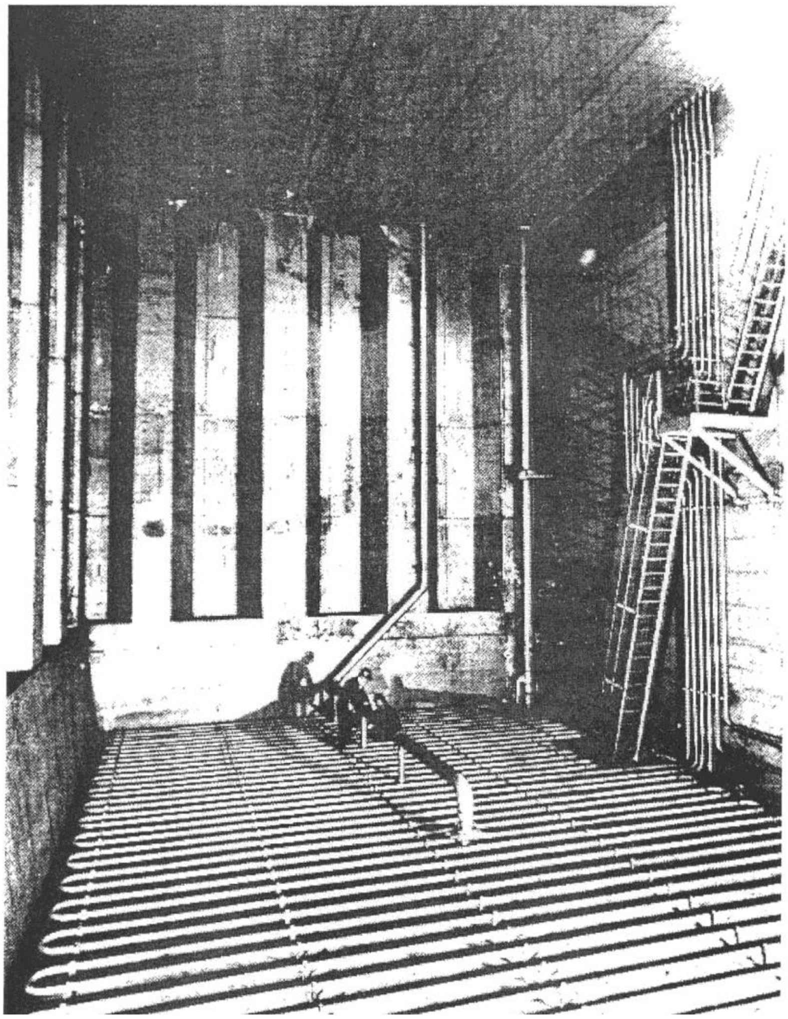


Fig1.8J Chemical tank with heating coils, pumps and cargo diffuser

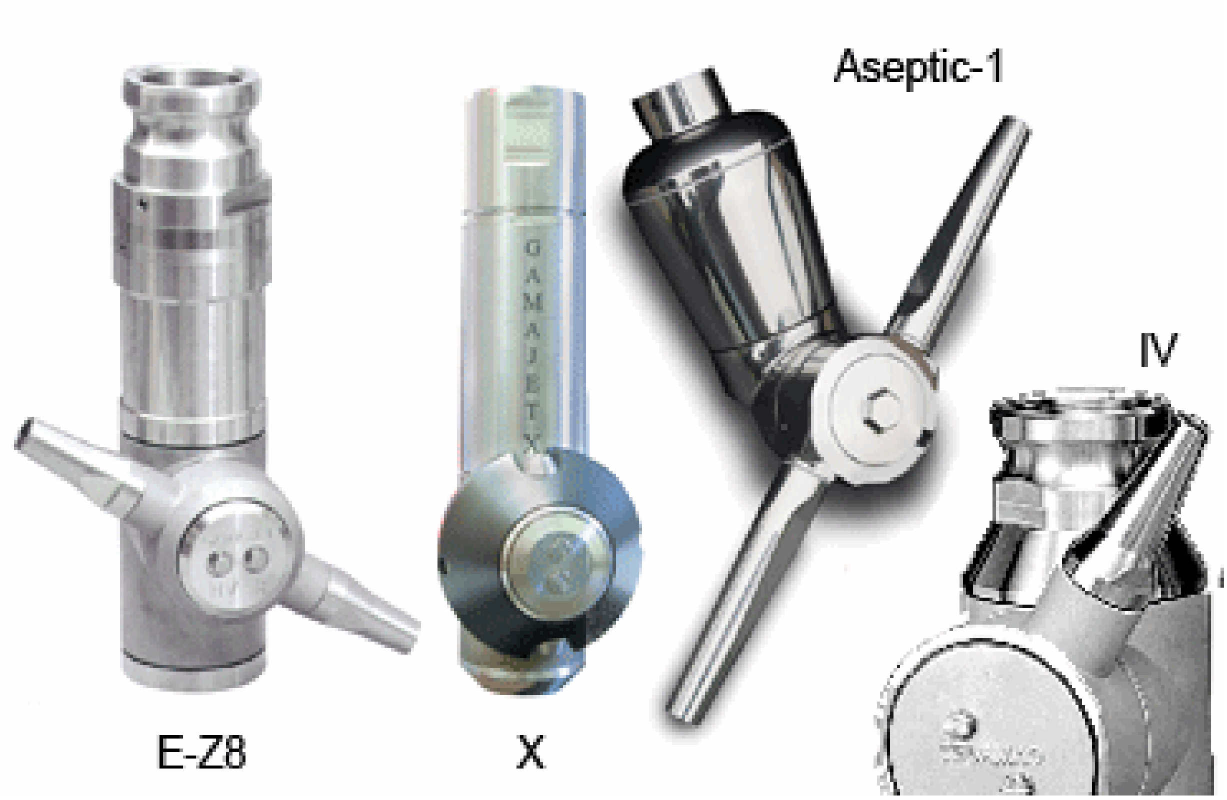
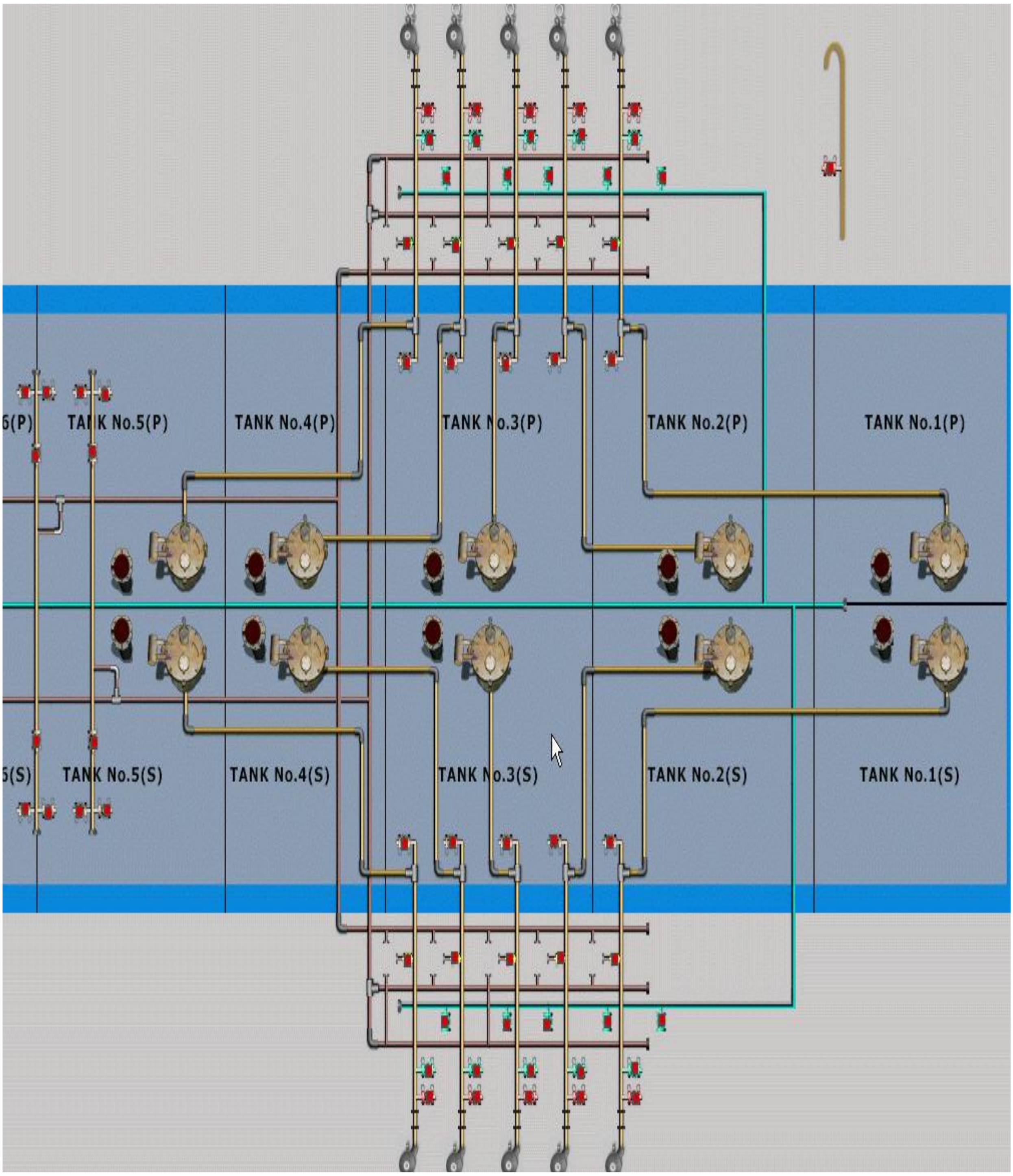


Fig: 1.9 Tank cleaning machines



Chemical Simulator Fig 1.10: Venting system of a Chemical Tanker

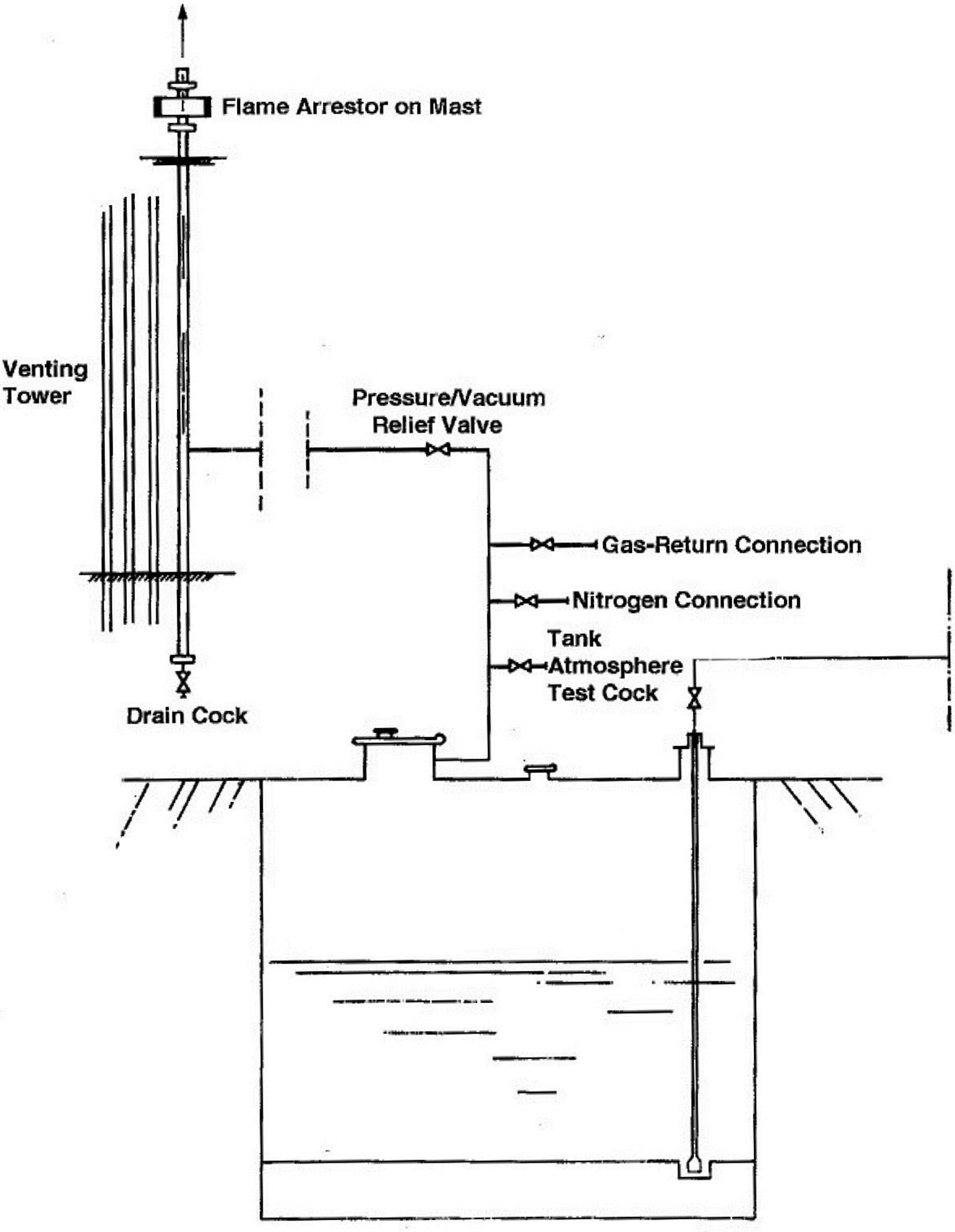


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Fig. 1.12 Cargo area Venting arrangements of a Chemical Tanker

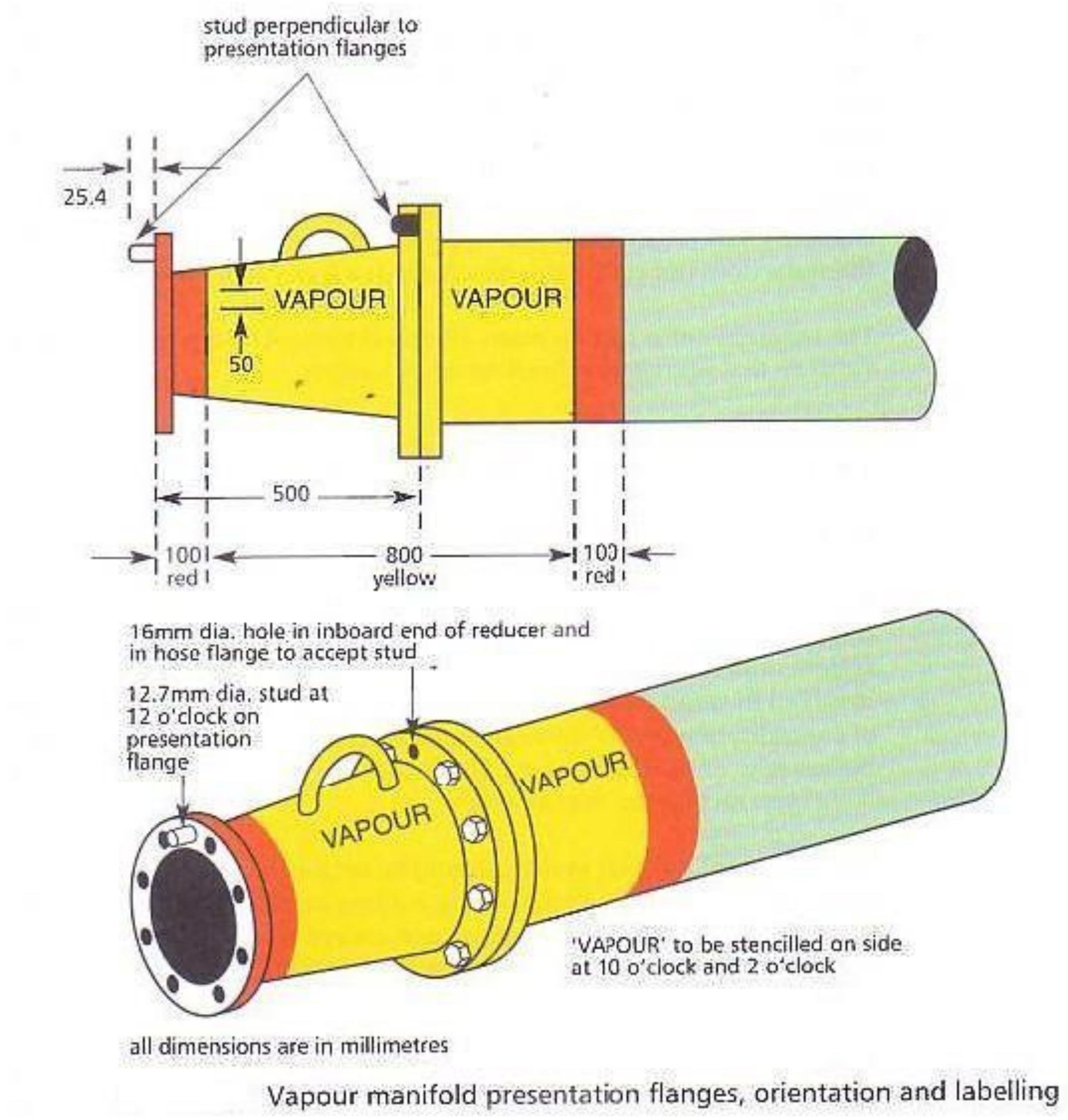


Fig 1.13.7 Vapour return system for emission control.

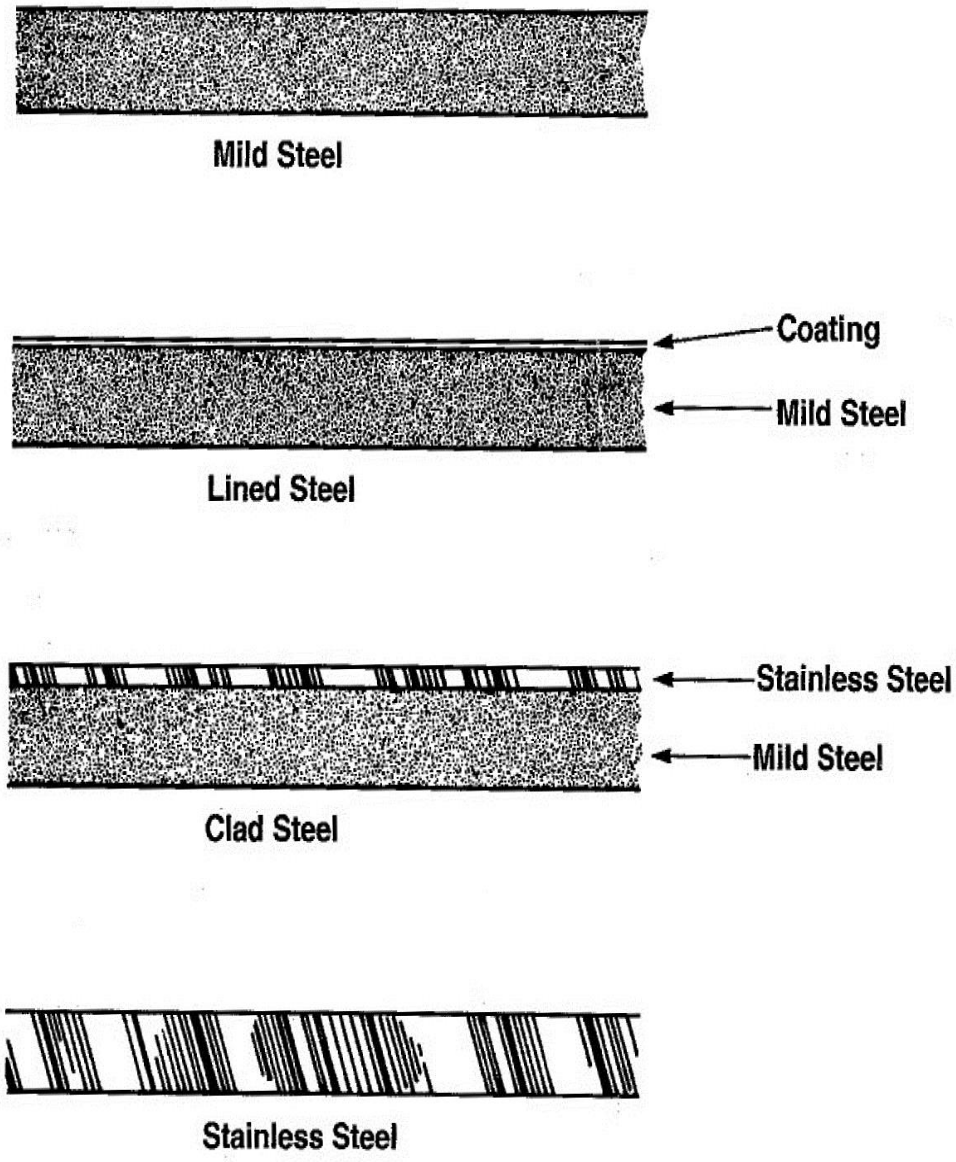


Fig.1.15: Tank construction materials & Coatings

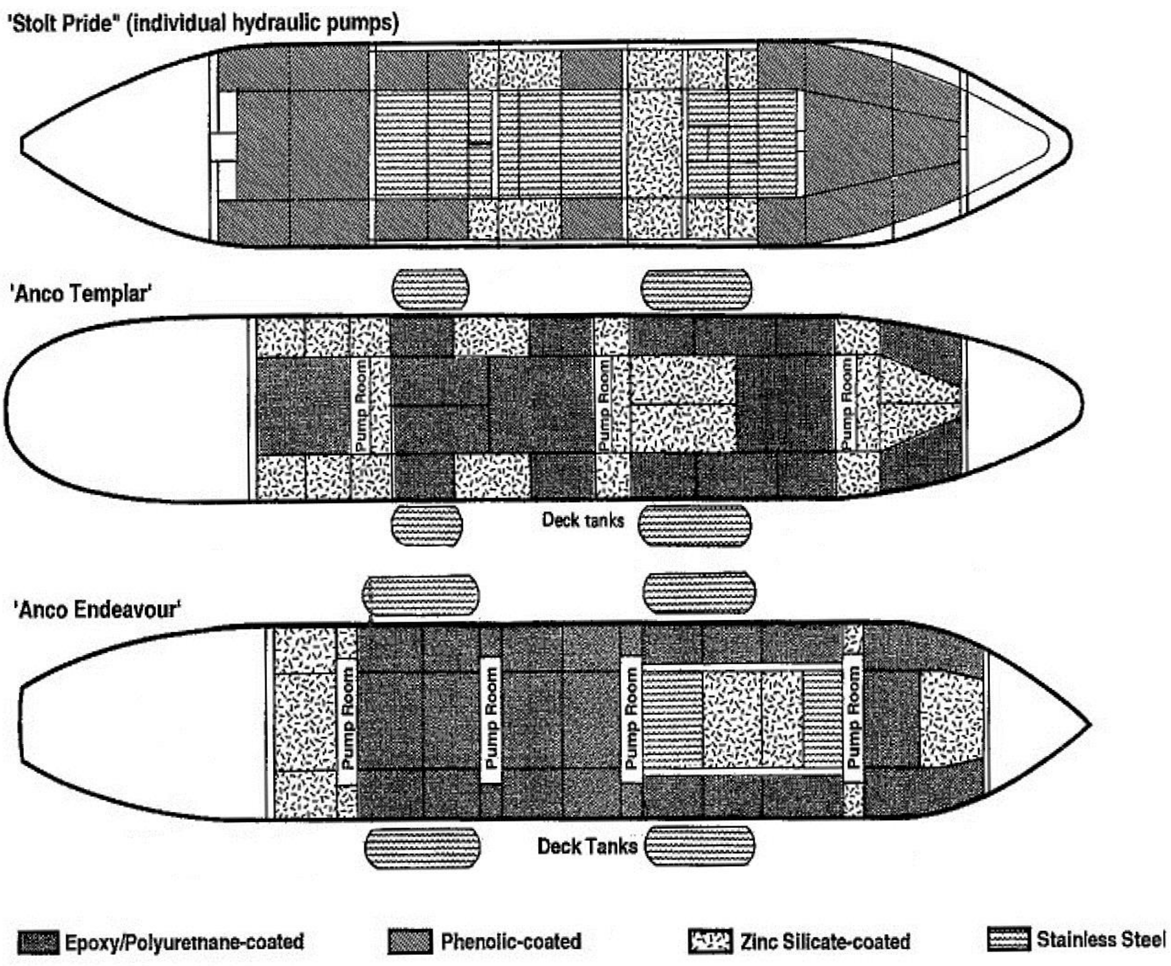


Fig. 1.15 and 8.0: Stowage planning for parcel tankers as per tank coatings

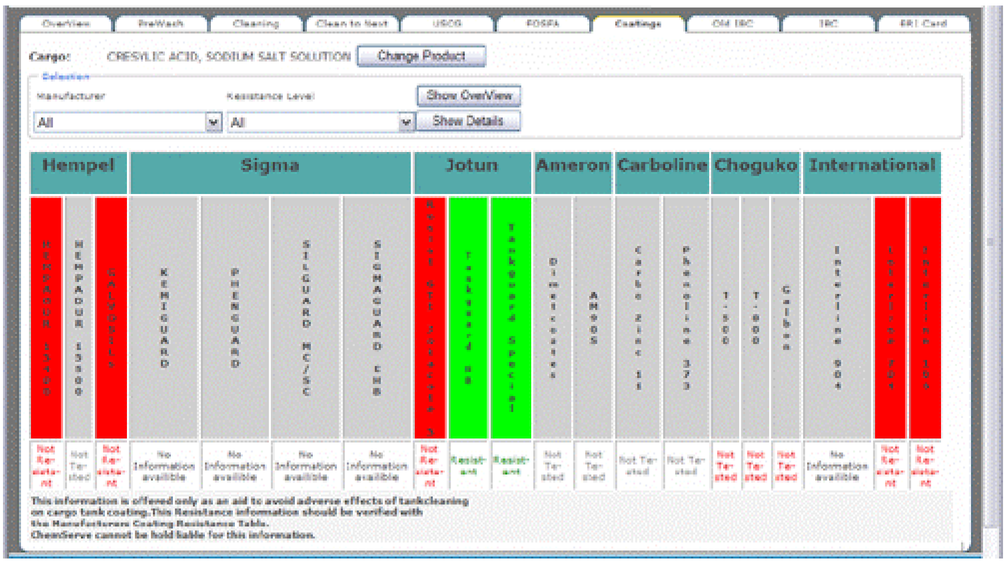


Fig 1.15.10 Tank coating resistance list

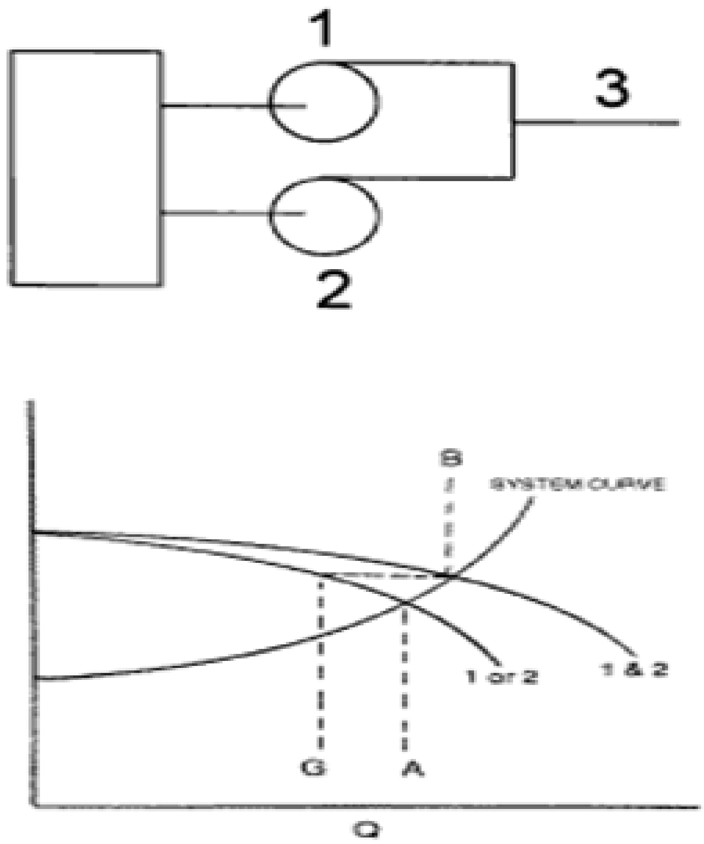
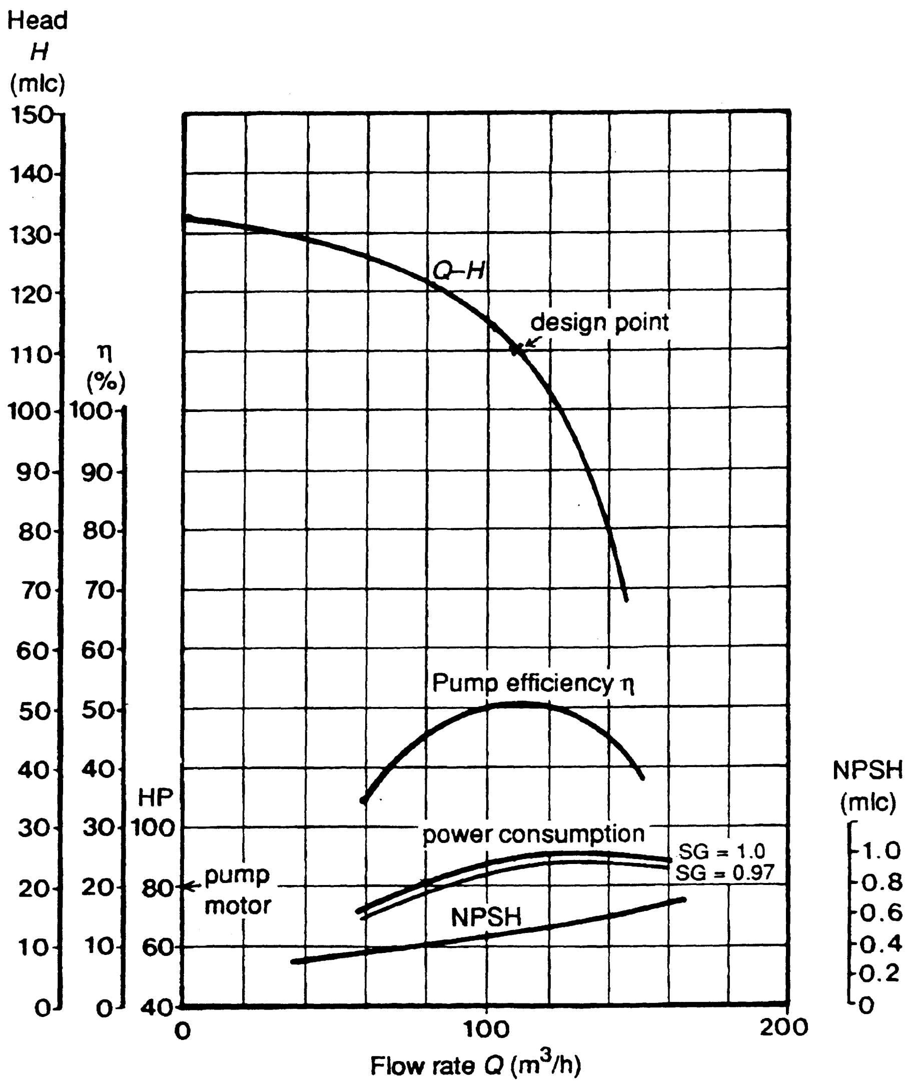
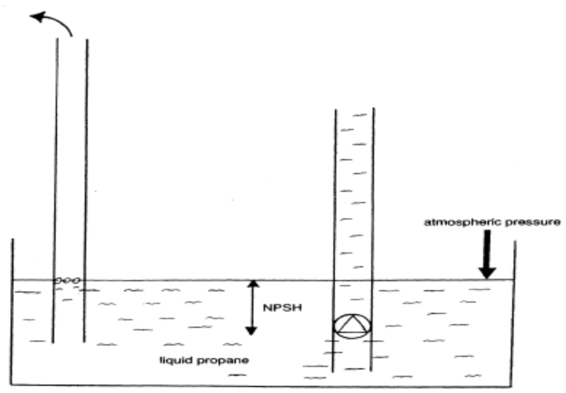


Fig: 2.0 A Pump in Parallel



2.0 B Pump curves

Fig 2.0.C Net



positive suction head

Fig: 2.0C Pump Q-H curves

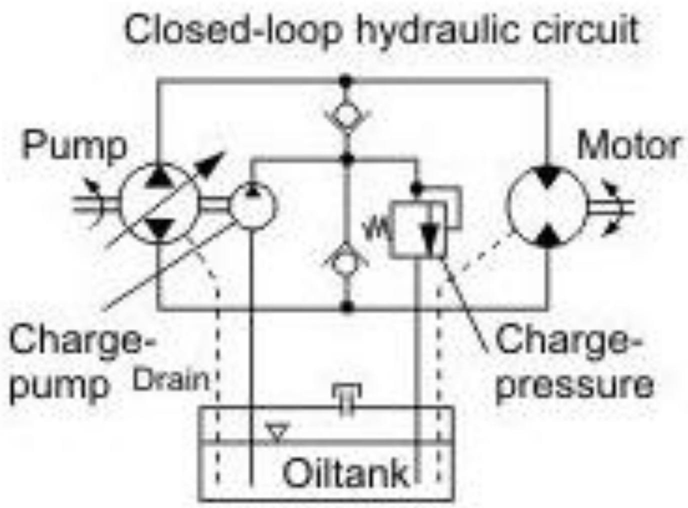


Fig 2.0 D drawing of a closed hydraulic system

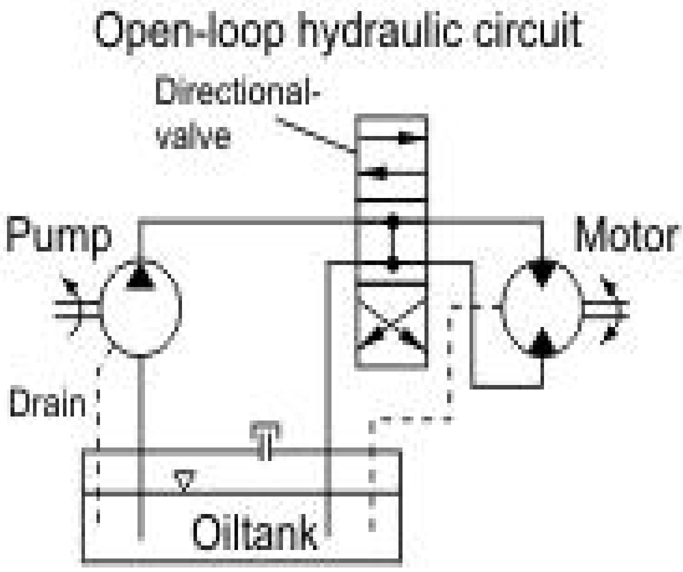


Fig 2.0 E drawing of an open hydraulic system

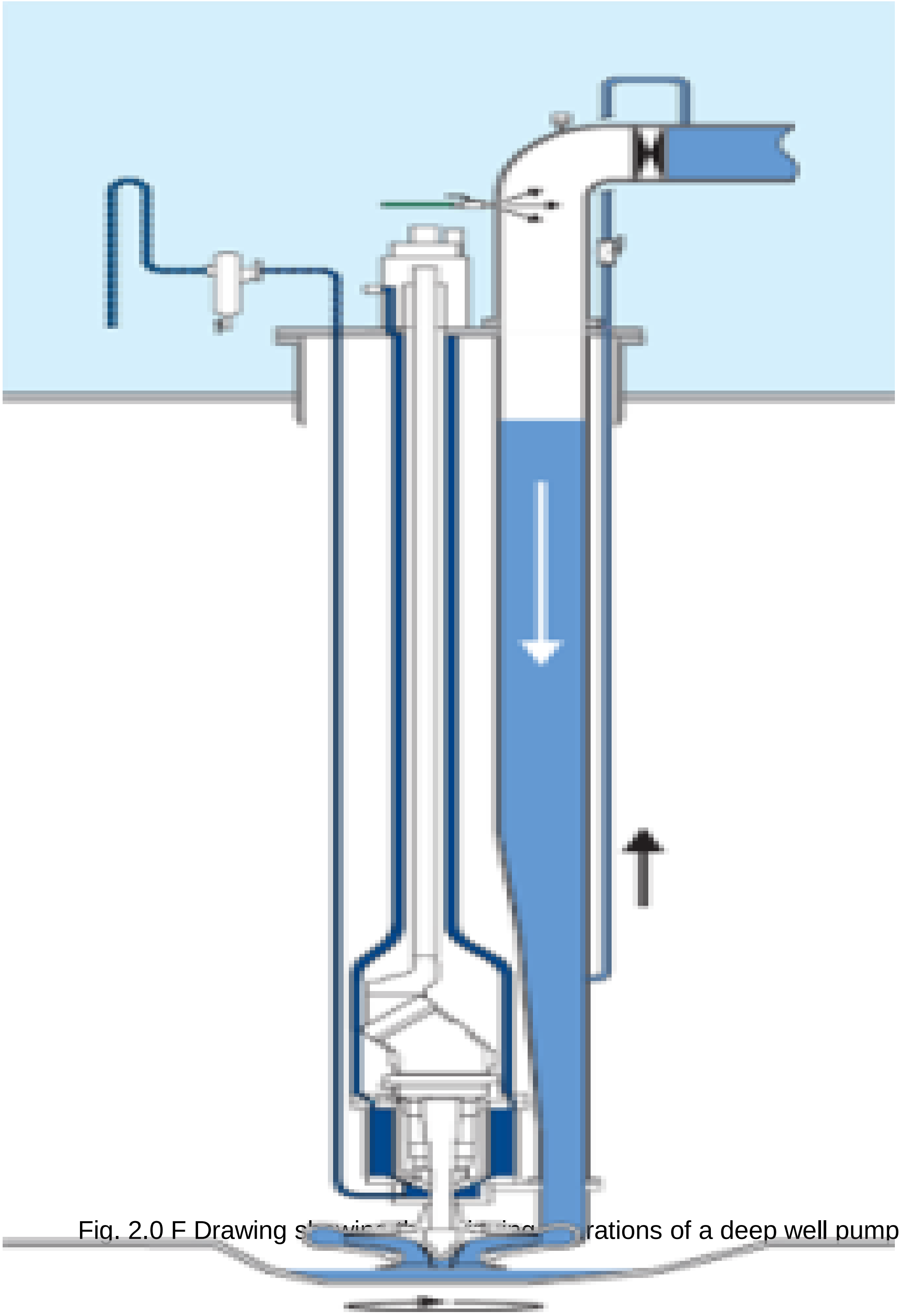


Fig. 2.0 F Drawing s[illegible]rations of a deep well pump

Self Checklist for Company Safety Management System

IMO Company ID. No.: ____________ **Number of relevant employees who carry out or have responsibility to the SMS of the Company ashore.** [ ]

Company Name: ____________ **Type of Audit** ____________ **Record No.** ____________

Company Address: ____________ **Country:** ____________

Designated Person(s): ____________ **Tel.:** ____________ **Fax:** ____________

Date of Checking: ____________ **Checked by:** ____________ **E-mail:** ____________

Title & Latest Revision Date of Manual: ____________ **Website:** ____________

Note:
(1) This Checklist indicates items to be included at least in the samples at self checking.
(2) In principle, the verification over the Company's implementation of SMS should be made comprehensively for the past one year. However, in the Renewal, the verification over the Company's implementation of SMS should be extended to include the reports issued by the external audits, PSC or marine casualties, and the company's investigation and analysis conducted in response to them, for the past five years.

(1) Items to be checked prior to audit

Items to be checked	*CHK*	*Remarks*
1-1 Changes of ships under management		As for new acquisition, a copy of owner's report to the Administration as required in ISM Code 3.1 to be available.
If there are any SMC of ships left from the Company's management, the SMC should be returned to ClassNK Head Office for "Termination of ISM registration".		
1-2 Changes in Company's name/address		If Additional Audit has not yet started, an Additional audit for changes shall be applied to the ClassNK Local Office.
1-3 Confirmation of ship types covered by DOC		If any ship type no longer exists under management for more than 1 year, rewrite of DOC shall be requested at next Audit.
1-4 Confirmation of ship flags covered by DOC		If no ship under management remains with any Flag, the DOC of same Flag shall be returned at next Audit.
1-5 Confirmation of reporting to Flag States		A copy of owner's report to the Administration as required in ISM Code 3.1 to be confirmed, for every ship.

(2) Items to be confirmed prior to audit

Type of ship*	Flag & number of ships under management	Type of ship*	Flag & number of ships under management
Oil Tanker		Bulk Carrier r**	
Chemical Tanker		Other Cargo Ship	
Gas Carrier		Passenger Ship	
* Refer to SOLAS IX/1 & 2		** Dry cargo ships assigned with "ESP" within the Class Notation	
Active Crew nationality			
Masters		Chief Engineers	
Deck Officers		Engineers	
Deck Ratings		Engine Ratings	
Radio Operators		Cooks	
Language	Manual, Procedures and Instructions	Working Language Onboard	

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Fig.3: Safety Management checklist

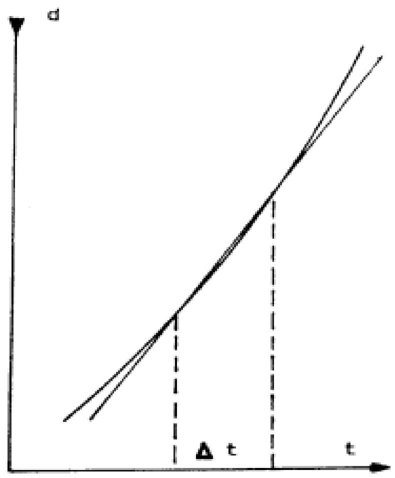


Fig. 5.0 A: Density Correction Factor curve is a straight line for small temperature differences for unsaturated hydrocarbons and most chemicals.

TABLE 54B, GENERALIZED PRODUCTS
VOLUME CORRECTION TO 15 C

TEMP. C	690.0	692.0	694.0	696.0	698.0	700.0	702.0	704.0	706.0	708.0	710.0	TEMP C
	DENSITY AT 15 C — FACTOR FOR CORRECTING VOLUME TO 15 C											
10.00	1.0068	1.0068	1.0067	1.0067	1.0067	1.0067	1.0066	1.0066	1.0066	1.0065	1.0065	10.00
10.25	1.0065	1.0064	1.0064	1.0064	1.0064	1.0063	1.0063	1.0063	1.0062	1.0062	1.0062	10.25
10.50	1.0061	1.0061	1.0061	1.0060	1.0060	1.0060	1.0060	1.0059	1.0059	1.0059	1.0059	10.50
10.75	1.0058	1.0058	1.0057	1.0057	1.0057	1.0057	1.0056	1.0056	1.0056	1.0056	1.0055	10.75
11.00	1.0054	1.0054	1.0054	1.0054	1.0054	1.0053	1.0053	1.0053	1.0053	1.0052	1.0052	11.00
11.25	1.0051	1.0051	1.0051	1.0050	1.0050	1.0050	1.0050	1.0050	1.0049	1.0049	1.0049	11.25
11.50	1.0048	1.0047	1.0047	1.0047	1.0047	1.0047	1.0046	1.0046	1.0046	1.0046	1.0046	11.50
11.75	1.0044	1.0044	1.0044	1.0044	1.0043	1.0043	1.0043	1.0043	1.0043	1.0043	1.0042	11.75
12.00	1.0041	1.0041	1.0040	1.0040	1.0040	1.0040	1.0040	1.0040	1.0039	1.0039	1.0039	12.00
12.25	1.0037	1.0037	1.0037	1.0037	1.0037	1.0037	1.0036	1.0036	1.0036	1.0036	1.0036	12.25
12.50	1.0034	1.0034	1.0034	1.0034	1.0033	1.0033	1.0033	1.0033	1.0033	1.0033	1.0033	12.50
12.75	1.0031	1.0031	1.0030	1.0030	1.0030	1.0030	1.0030	1.0030	1.0030	1.0029	1.0029	12.75
13.00	1.0027	1.0027	1.0027	1.0027	1.0027	1.0027	1.0027	1.0026	1.0026	1.0026	1.0026	13.00
13.25	1.0024	1.0024	1.0024	1.0024	1.0023	1.0023	1.0023	1.0023	1.0023	1.0023	1.0023	13.25
13.50	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	1.0020	13.50
13.75	1.0017	1.0017	1.0017	1.0017	1.0017	1.0017	1.0017	1.0017	1.0016	1.0016	1.0016	13.75
14.00	1.0014	1.0014	1.0014	1.0013	1.0013	1.0013	1.0013	1.0013	1.0013	1.0013	1.0013	14.00
14.25	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	14.25
14.50	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	14.50
14.75	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	1.0003	14.75
15.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	15.00
15.25	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	15.25
15.50	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	15.50
15.75	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	15.75
16.00	0.9986	0.9986	[illegible]	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	16.00
16.25	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9984	0.9984	0.9984	16.25
16.50	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	0.9980	16.50
16.75	0.9976	0.9976	0.9976	0.9976	0.9977	0.9977	0.9977	0.9977	0.9977	0.9977	0.9977	16.75
17.00	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9973	0.9974	0.9974	0.9974	0.9974	17.00
17.25	0.9969	0.9969	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9970	0.9971	17.25
17.50	0.9966	0.9966	0.9966	0.9966	0.9966	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	17.50

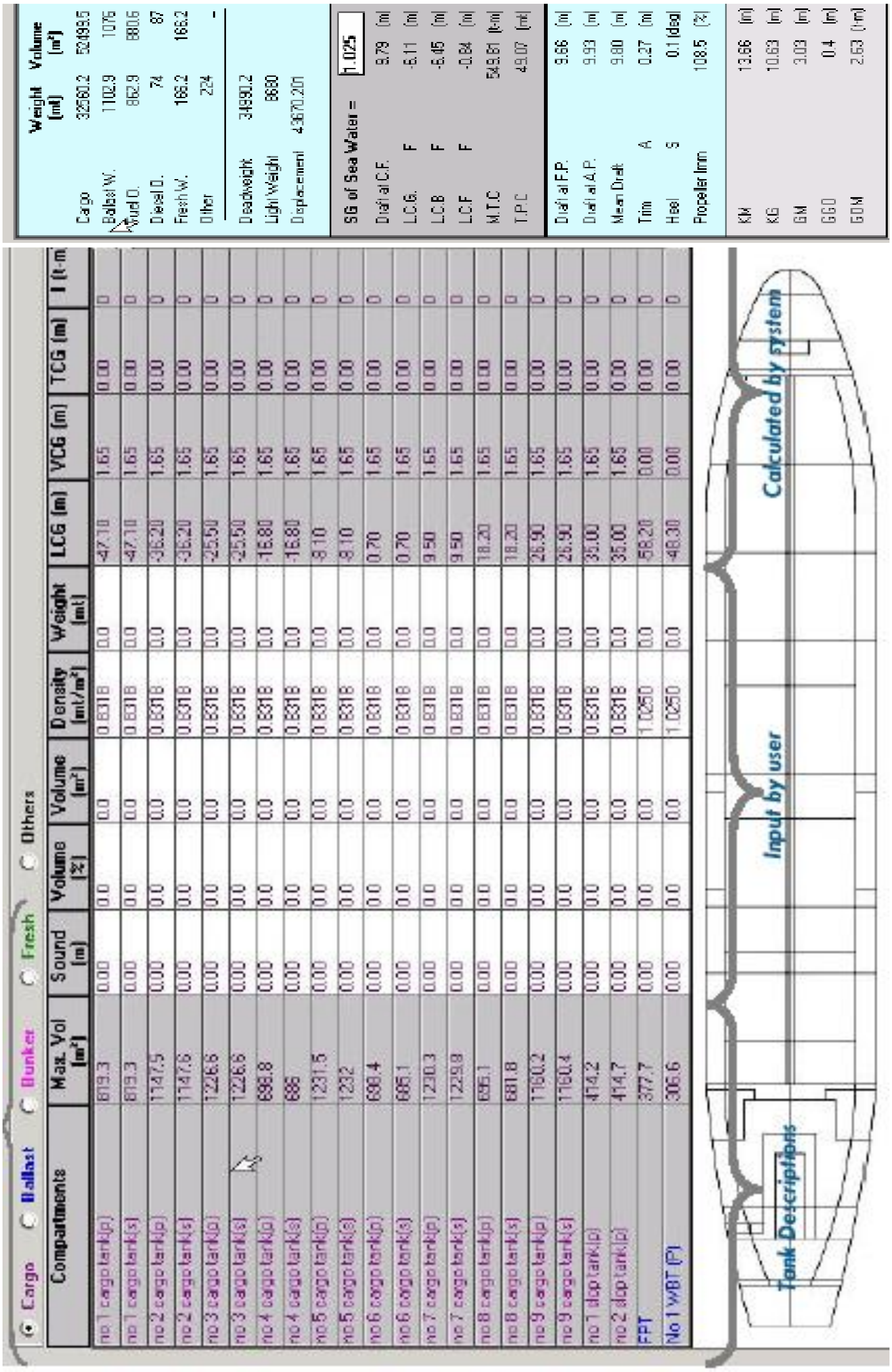
DENOTES EXTRAPOLATED VALUE

DENSITY = 690.0 TO 710.0

Figure 5.0 B ASTM Volume correction

Trim Aft	-3.00	0.00	3.00	6.00
Sound In Meters	Capacity			
	M³	M³	M³	M³
0.000	0.19	0.00	0.02	0.09
0.010	0.30	0.02	0.05	0.12
0.020	0.45	0.09	0.07	0.16
0.030	0.63	0.20	0.13	0.21
0.040	0.83	0.34	0.21	0.26
0.050	1.10	0.52	0.33	0.34
0.060	1.39	0.73	0.48	0.46
0.070	1.72	0.97	0.05	0.61
0.080	2.07	1.23	0.85	0.78
0.090	2.46	1.53	1.09	0.98
0.100	2.86	1.84	1.35	1.20
0.110	3.27	2.17	1.63	1.45
0.120	3.72	2.52	1.94	1.71
0.130	4.16	2.9	2.27	2.00
0.140	4.65	3.31	2.62	2.30
0.150	5.14	3.74	2.99	2.62
0.160	5.65	4.19	3.37	2.96
0.170	6.18	4.67	3.77	3.31
0.180	6.73	5.17	4.18	3.68
0.190	7.29	5.09	4.61	4.06
7.000	1234.04	1232.86	1231.16	1228.6
7.010	1234.15	1232.98	1231.32	1228.91
7.020	1234.26	1233.1	1231.48	1229.18
7.030	1234.36	1233.21	1231.62	1229.43
7.040	1234.47	1233.33	1231.77	1229.64
7.050	1234.57	1233.54	1231.92	1229.82
7.060	1234.68	1233.56	1231.07	1229.99
7.070	1234.78	1233.67	1232.22	1230.17
7.080	1234.88	1233.78	1232.36	1230.33
7.090	1234.97	1233.89	1232.50	123050
7.100	1235.97	1234.00	1232.65	1230.67
7.110	1233.16	1234.10	1232.79	1230.83
7.120	1235.24	1234.21	1232.92	1231.00
7.130	1235.35	1234.31	1233.06	1231.16
7.140	1235.4	1234.42	1233.19	1231.32
7.150	1235.48	1234.52	1233.32	1231.48
7.160	1235.55	1234.62	1233.44	1231.64
7.170	1235.61	1234.73	1233.56	1231.80
7.180	1235.67	1234.84	1233.68	1231.96
7.190	1235.73	1234.95	1233.80	1232.11
7.200	1235.79	1235.06	1233.97	1232.27
7.210	1235.85	1235.12	1233.00	1232.00

Fig. 5.0 C Trim tables relevant to cargo calculations



Compartments	Max. Vol (m³)	Sound (m)	Volume (%)	Volume (m³)	Density (mt/m³)	Weight (mt)	LCG (m)	VCG (m)	TCG (m)	I (t-m
no 1 cargo tank(p)	819.3	0.00	0.0	0.0	0.8318	0.0	-47.10	1.65	0.00	0
no 1 cargo tank(s)	819.3	0.00	0.0	0.0	0.8318	0.0	-47.10	1.65	0.00	0
no 2 cargo tank(p)	1147.5	0.00	0.0	0.0	0.8318	0.0	-36.20	1.65	0.00	0
no 2 cargo tank(s)	1147.6	0.00	0.0	0.0	0.8318	0.0	-36.20	1.65	0.00	0
no 3 cargo tank(p)	1226.6	0.00	0.0	0.0	0.8318	0.0	-25.50	1.65	0.00	0
no 3 cargo tank(s)	1226.6	0.00	0.0	0.0	0.8318	0.0	-25.50	1.65	0.00	0
no 4 cargo tank(p)	698.8	0.00	0.0	0.0	0.8318	0.0	-16.80	1.65	0.00	0
no 4 cargo tank(s)	686	0.00	0.0	0.0	0.8318	0.0	-16.80	1.65	0.00	0
no 5 cargo tank(p)	1231.5	0.00	0.0	0.0	0.8318	0.0	-8.10	1.65	0.00	0
no 5 cargo tank(s)	1232	0.00	0.0	0.0	0.8318	0.0	-8.10	1.65	0.00	0
no 6 cargo tank(p)	698.4	0.00	0.0	0.0	0.8318	0.0	0.70	1.65	0.00	0
no 6 cargo tank(s)	685.1	0.00	0.0	0.0	0.8318	0.0	0.70	1.65	0.00	0
no 7 cargo tank(p)	1230.3	0.00	0.0	0.0	0.8318	0.0	9.50	1.65	0.00	0
no 7 cargo tank(s)	1229.8	0.00	0.0	0.0	0.8318	0.0	9.50	1.65	0.00	0
no 8 cargo tank(p)	695.1	0.00	0.0	0.0	0.8318	0.0	18.20	1.65	0.00	0
no 8 cargo tank(s)	681.8	0.00	0.0	0.0	0.8318	0.0	18.20	1.65	0.00	0
no 9 cargo tank(p)	1160.2	0.00	0.0	0.0	0.8318	0.0	26.90	1.65	0.00	0
no 9 cargo tank(s)	1160.4	0.00	0.0	0.0	0.8318	0.0	26.90	1.65	0.00	0
no 1 slop tank(p)	414.2	0.00	0.0	0.0	0.8318	0.0	35.00	1.65	0.00	0
no 2 slop tank(p)	414.7	0.00	0.0	0.0	0.8318	0.0	35.00	1.65	0.00	0
FPT	377.7	0.00	0.0	0.0	1.0250	0.0	-58.20	0.00	0.00	0
No 1 WBT (P)	306.6	0.00	0.0	0.0	1.0250	0.0	-48.30	0.00	0.00	0

Chemical Simulator Fig 7.1A showing a Load indicator of a chemical tanker for stowage planning and cargo calculations

PARCEL	QTY	UN NO:	MFAG	MSDS	CHRIS	USCG	CHEM	IMO SHIP	COATING	SPECIAL	HEAT REQUIRE	Group Nos.	Incompatible
	M3		NO:	SHEET NO	CDE No:	GROUP	FAMILY	TYPE	PU | ZS	QUIREMEN	Y | N | F		Groups
ACT	400												
ACRYNOLITRILE	100												
PALM OIL	400												
BENZENE	400												
DI ETHYLMINE	400												
SOLVENT NAPHTA	400												
CAUSTIC SODA	400												
STYRENE	400												
H2SO4	400												
TD1	100												
CAPACITIES 98%													

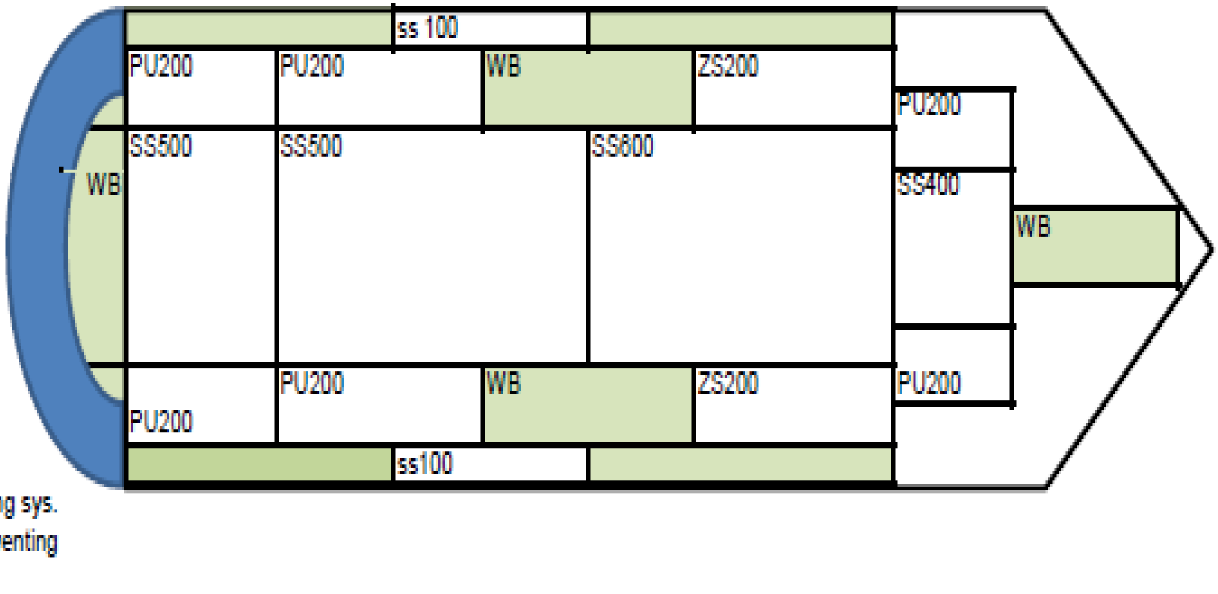
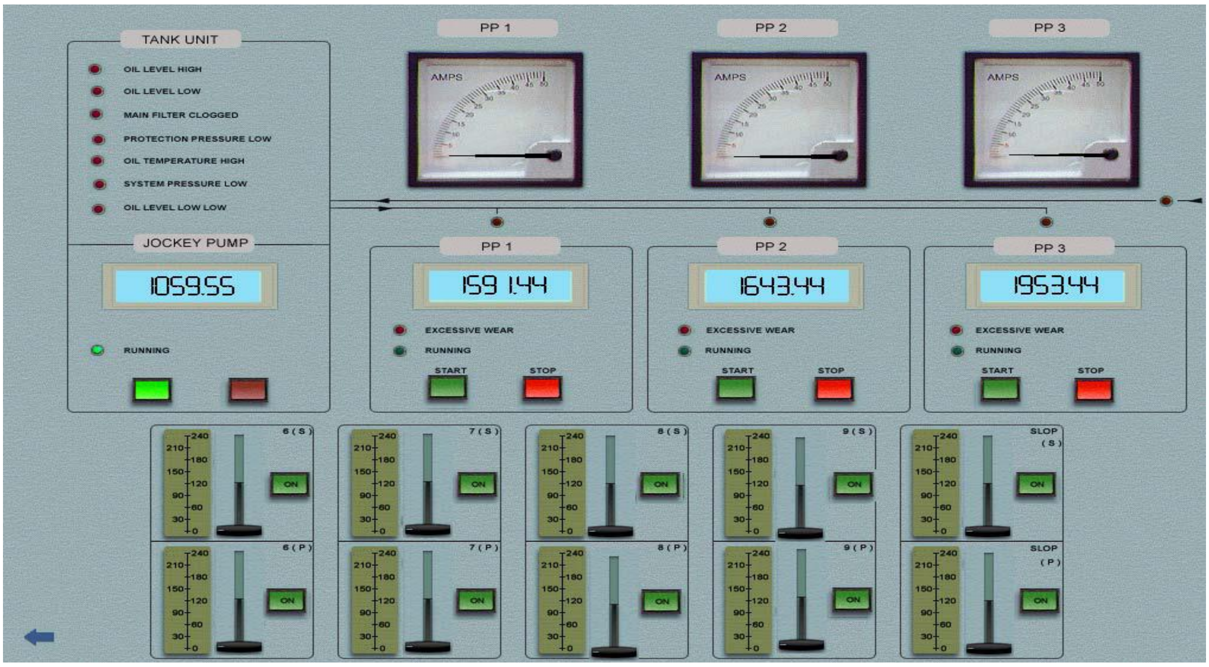


Fig 7.1B Use MSDS for Stowage planning Exercise

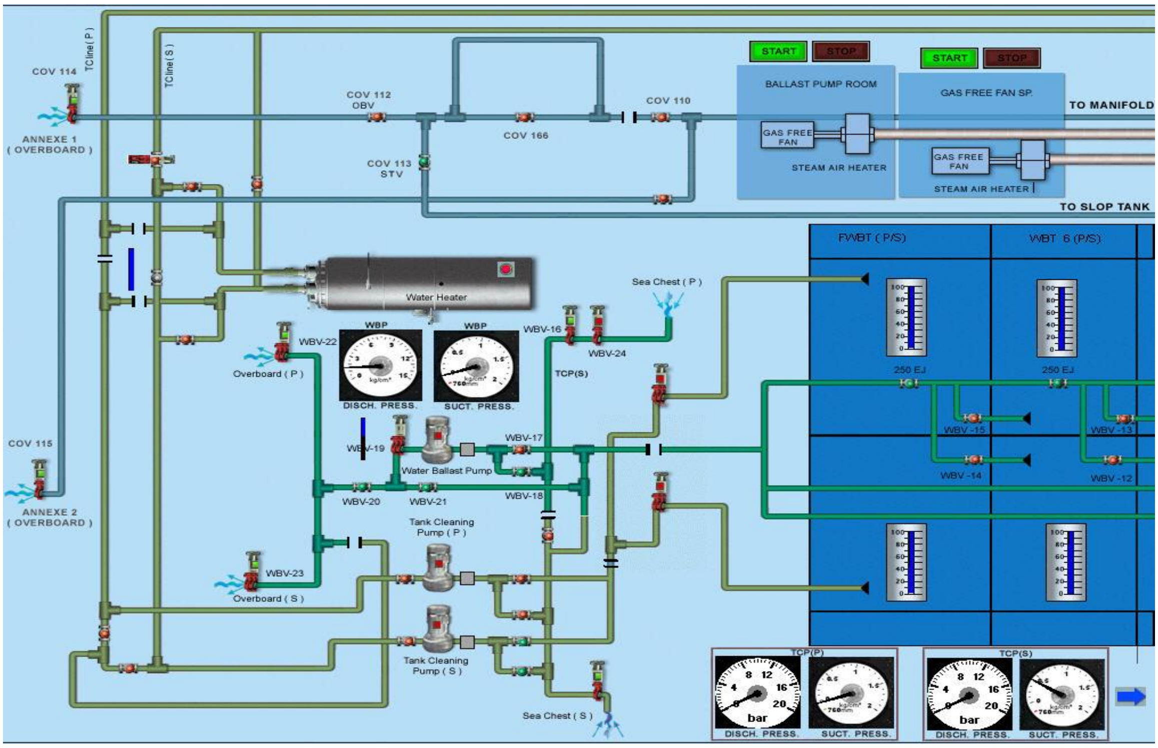
LCHS- CHEMICAL LOADING PLAN

CT	0 hrs			2 HRS			4HRS			6 HRS			8 HRS			completion		
	ULL	VOL	Wt.	ULL	VOL	Wt.	ULL	VOL	Wt.	ULL	VOL	Wt.	ULL	VOL	Wt.	ULL	VOL	Wt.
CT1(P)																		
CT1(S)																		
CT2(P)																		
CT2(S)																		
CT3(P)																		
CT3(S)																		
CT4(P)																		
CT4(S)																		
CT5(P)																		
CT5(S)																		
CT6(P)																		
CT6(S)																		
CT7(P)																		
CT7(S)																		
CT8(P)																		
CT8(S)																		
CT9(P)																		
CT9(S)																		
WBT																		
fpk																		
1P																		
1S																		
2P																		
2S																		
3P																		
3S																		
4P																		
4S																		
5P																		
5S																		
HEEL(P)																		
HEEL S																		
6P																		
6S																		
TCFWT P																		
TCFWT S																		
AFT.PEAK																		
Draft Fwd																		
Draft Aft																		
SF																		
BM																		
GM FL																		

Fig 7.1 Prepare a loading plan



Chemical Simulator Fig 7.1D: Power Pack and Hydraulic controls of a Cargo pumping system



Chemical Simulator Fig 7.2: Ballast Pump room on a Chemical Tanker

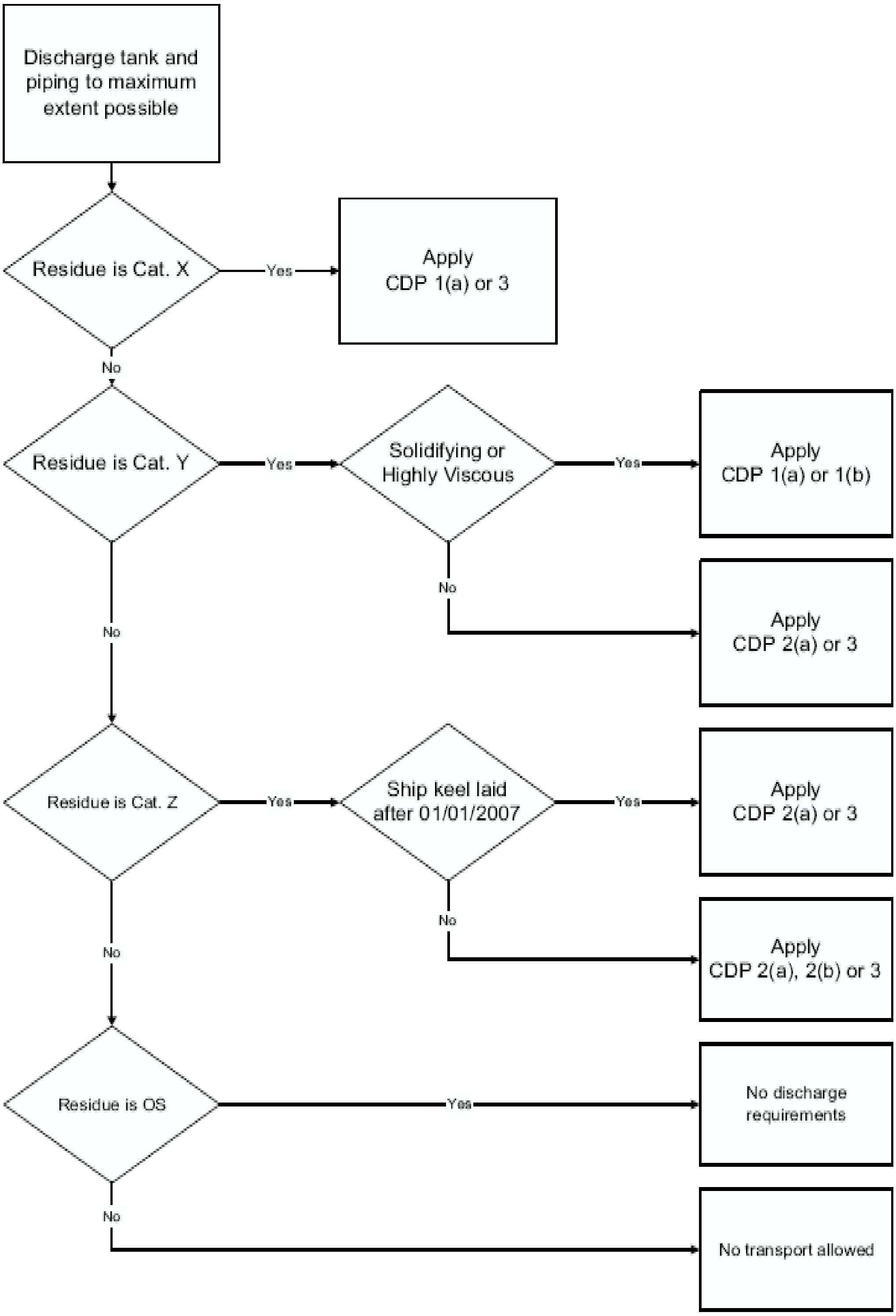


Fig.7.3 A Cleaning and disposal procedures

Cleaning and disposal procedures (CDP) (Start at the top of the column under the CDP number specified and complete each item procedure in the sequence where marked)						
No.	Operation	Procedure Number				
		1(a)	1(b)	2(a)	2(b)	3
1	Strip tank and piping to maximum extent, at least in compliance with the procedures in section 3 of this Manual	X	X	X	X	X
2	Apply prewash in accordance with Addendum B of this Manual and discharge residue to reception facility	X	X			
3	Apply subsequent wash, additional to the prewash, with: a complete cycle of the cleaning machine(s) *for ships built before 1 July 1994* a water quantity not less than calculated with "k"=1.0 *for ships built on or after 1 July 1994*		X			
4	Apply ventilation procedure in accordance with Addendum C of this Manual					X
5	Ballast tanks or wash tank to commercial standards	X		X	X	X
6	Ballast added to tank		X			
7	Conditions for discharge of ballast/residue/water mixtures other than prewash:					
	.1 distance from land > 12 nautical miles	X		X	X	
	.2 ship's speed > 7 knots	X		X	X	
	.3 water depth > 25 metres	X		X	X	
	.4 Using underwater discharge (not exceeding permissible discharge rate)	X		X		
8	Conditions for discharge of ballast:					
	.1 distance from land > 12 nautical miles		X			
	.2 water depth > 25 metres		X			
9	Any water subsequently introduced into a tank may be discharged into the sea without restrictions	X	X	X	X	X

Fig. 7.3B Tank cleaning and disposal procedure in MARPOL Annex II

Chemical Compatibility Chart

No.	Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Inorganic Acids	1																							
2	Organic acids	X	2																						
3	Caustics	X	X	3																					
4	Amines & Alkanolamines	X	X		4																				
5	Halogenated Compounds	X		X	X	5																			
6	Alcohols, Glycols & Glycol Ethers	X					6																		
7	Aldehydes	X	X	X	X		X	7																	
8	Ketone	X		X	X			X	8																
9	Saturated Hydrocarbons									9															
10	Aromatic Hydrocarbons	X									10														
11	Olefins	X				X						11													
12	Petrolum Oils												12												
13	Esters	X		X	X									13											
14	Monomers & Polymerizable Esters	X	X	X	X	X	X								14										
15	Phenols			X	X			X							X	15									
16	Alkylene Oxides	X	X	X	X		X	X							X	X	16								
17	Cyanohydrins	X	X	X	X	X		X									X	17							
18	Nitriles	X	X	X	X												X		18						
19	Ammonia	X	X					X	X					X	X	X	X	X		19					
20	Halogens			X			X	X	X	X	X	X	X	X	X	X				X	20				
21	Ethers	X													X						X	21			
22	Phosphorus, Elemental	X	X	X																	X		22		
23	Sulfur, Molten									X	X	X	X				X						X	23	
24	Acid Anhydrides	X		X	X		X	X							X		X	X	X	X					24

X Represents Unsafe Combinations

Represents Safe Combinations

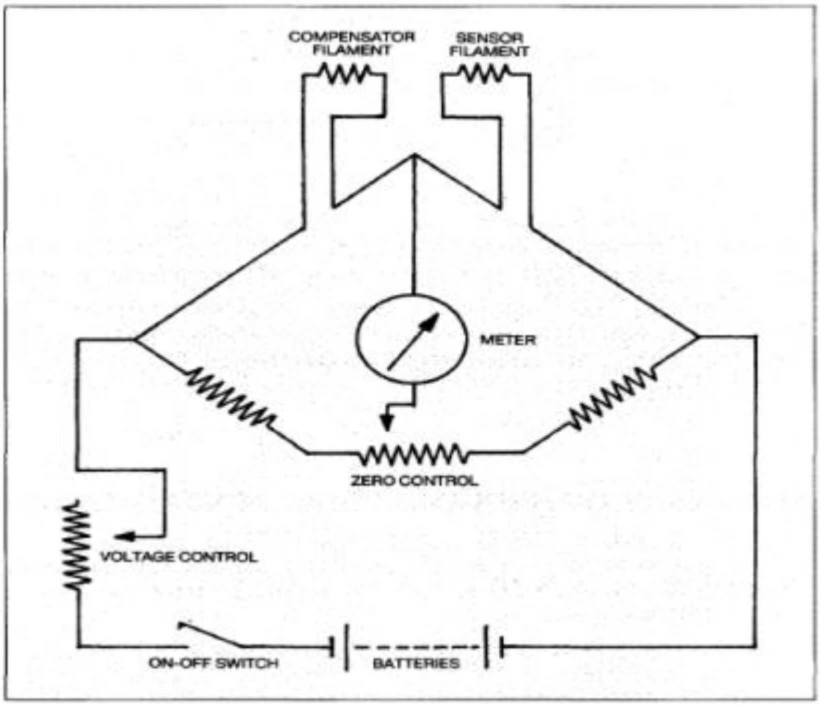


Fig. 9.0 A: A Circuit diagram of a Tankscope

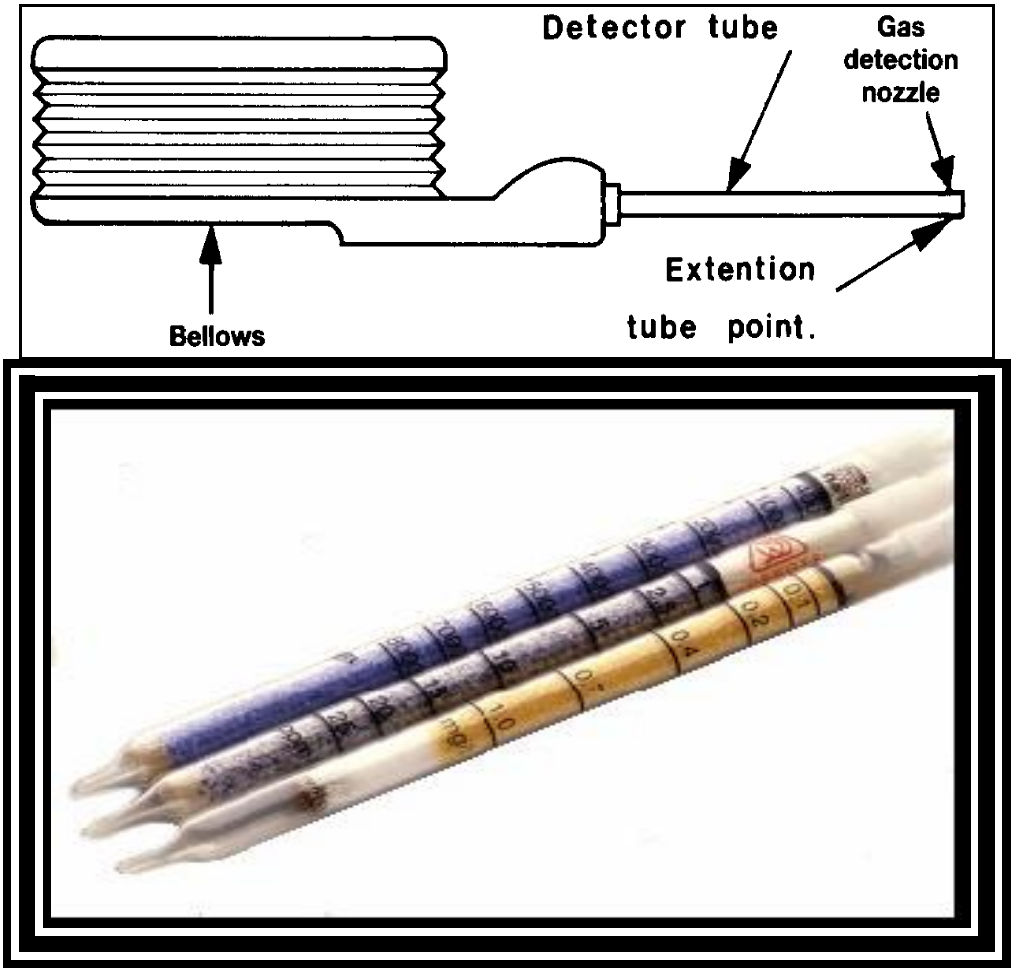


Fig 9.0 B: detection pump and tubes

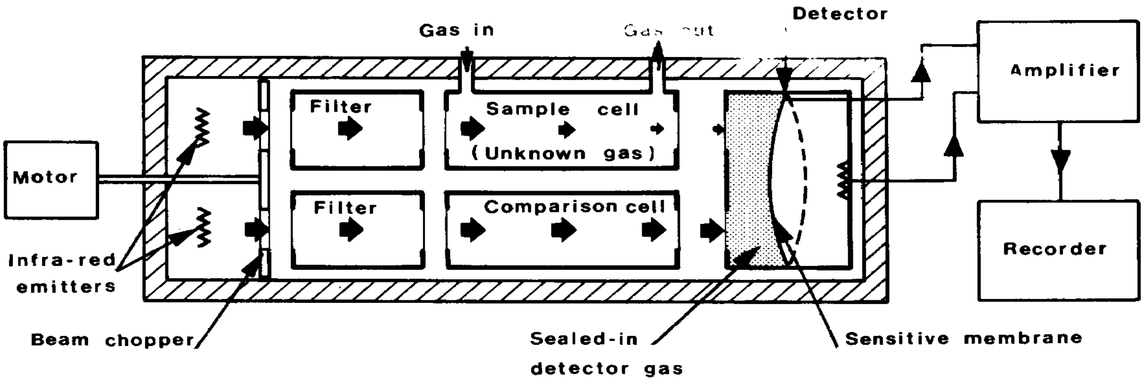
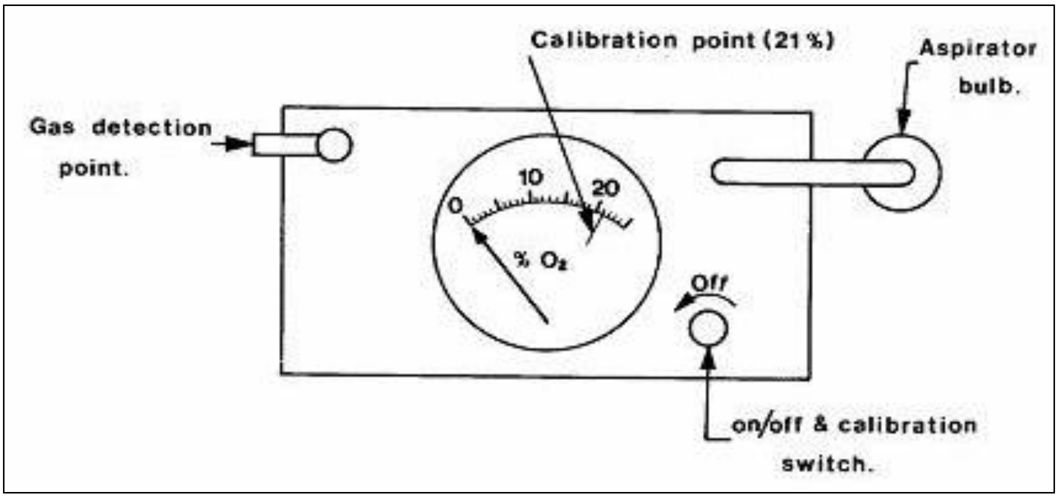


Fig: 9.0 C Gas detector



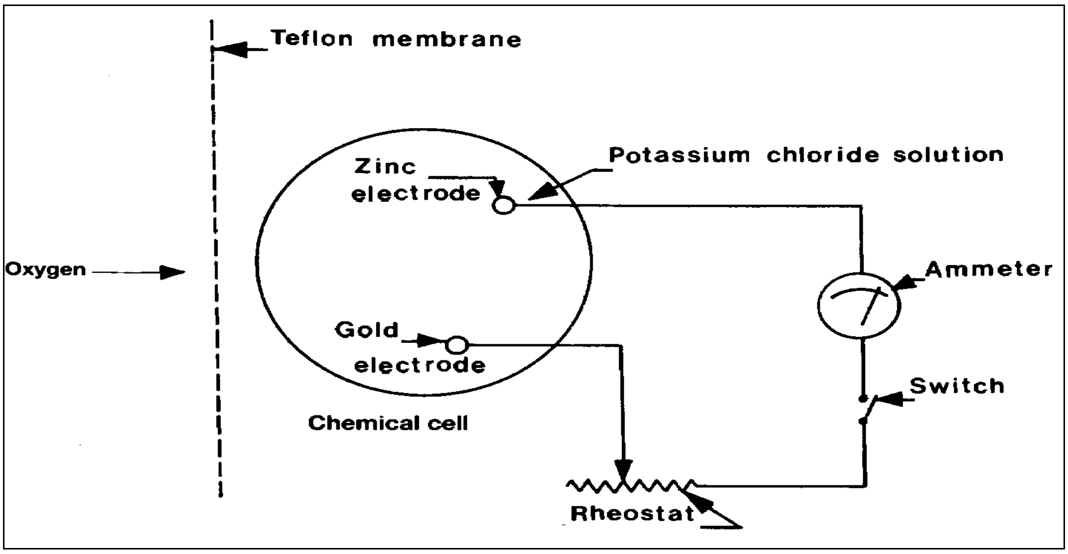


Fig: 9.D Portable Oxygen detector.

Fig: 9.0 E Various Gas detection instruments

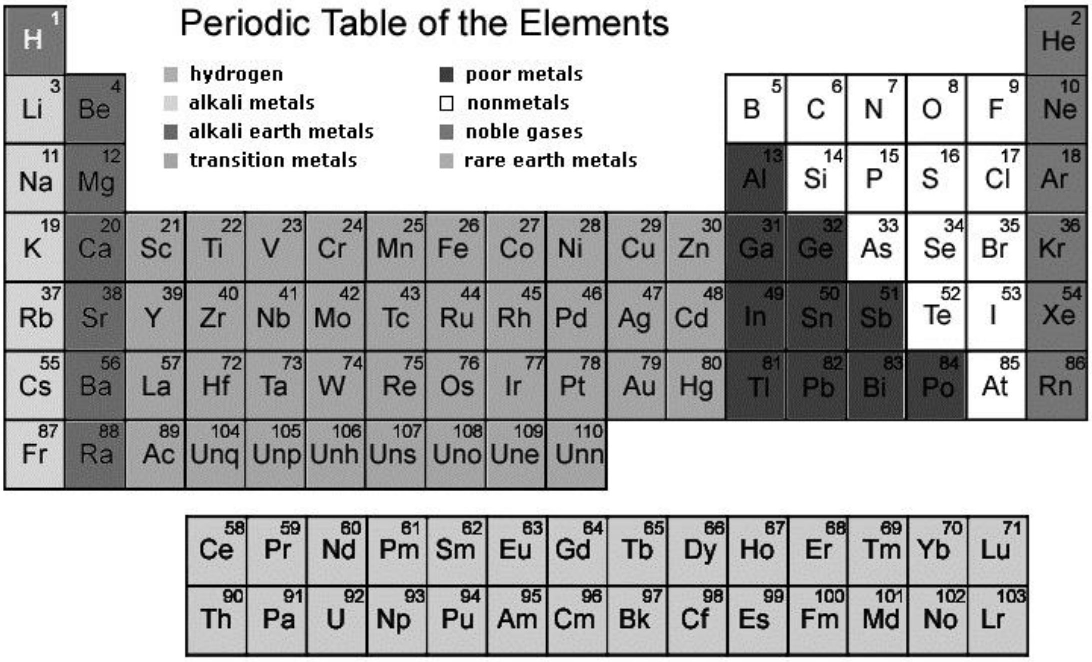


Fig. 11A: Periodic table

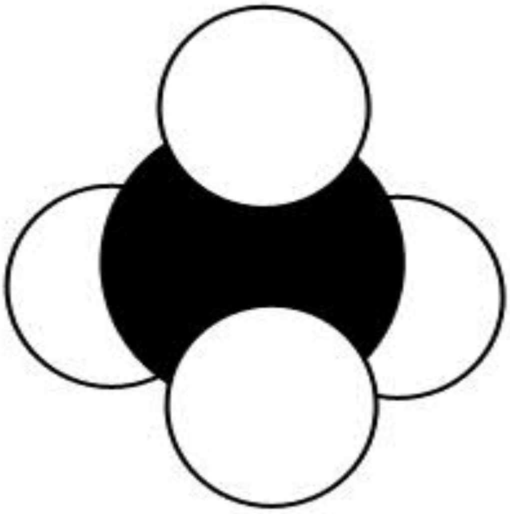


Fig 11B: Methane Molecule CH4

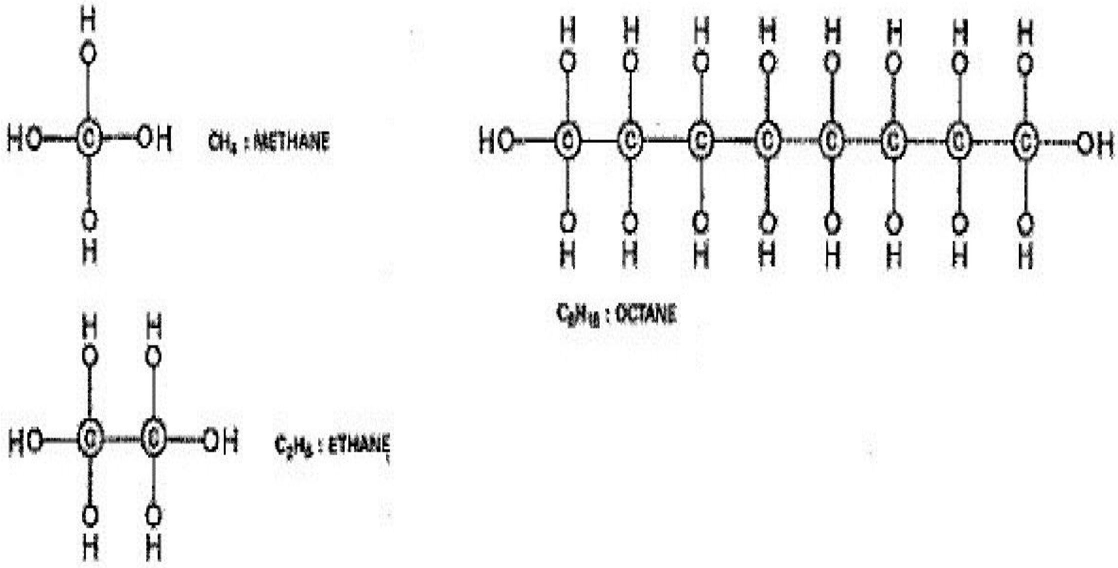


Fig.11C: Schematic representation of hydrocarbon molecules

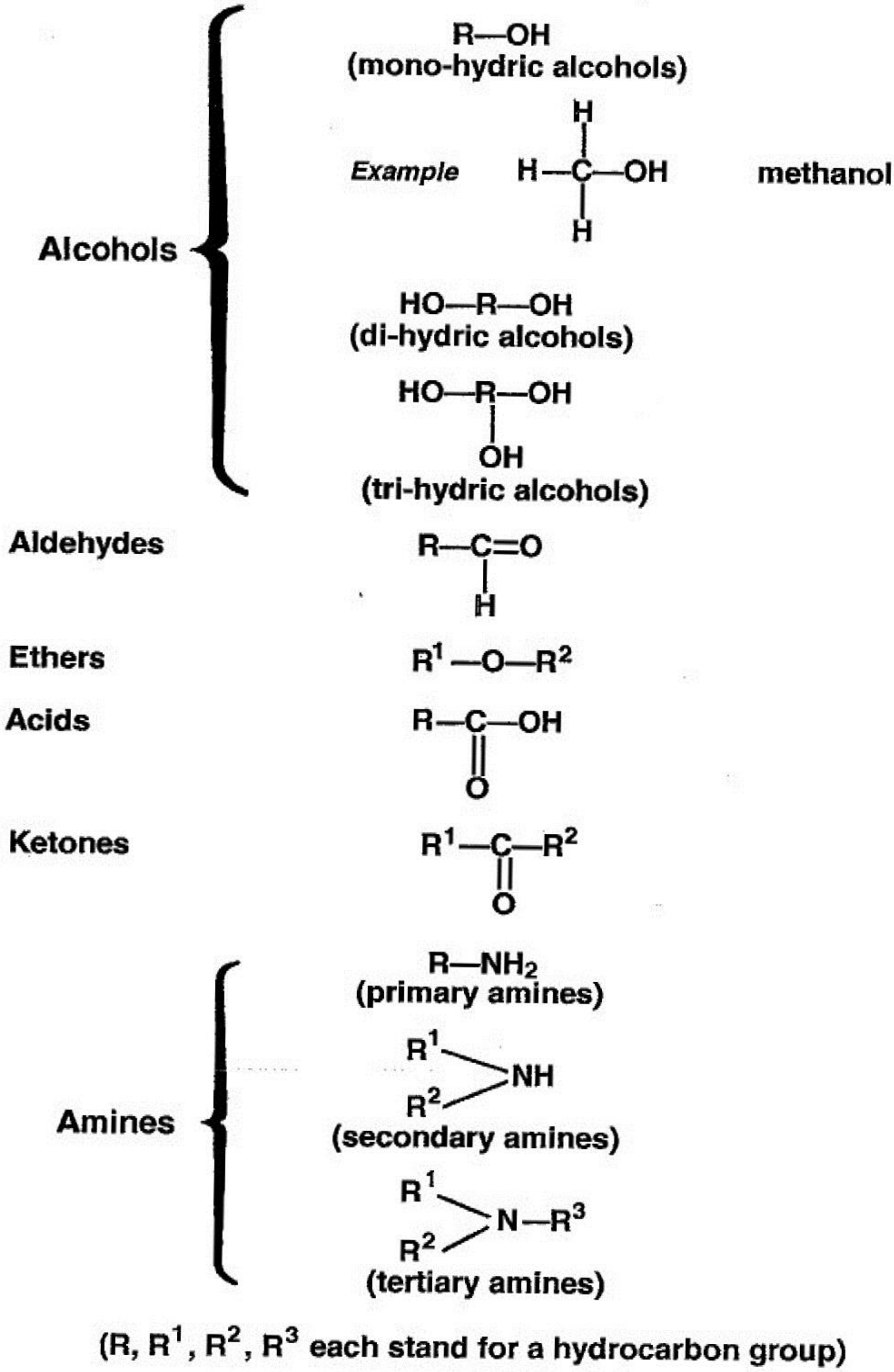


Figure 11 D: Molecular structure

Fig.12.0 A: MSDS placed on display for crew

SULFURIC ACID

SFA

CAUTIONARY RESPONSE INFORMATION

Common Synonyms	Oily liquid	Colorless	Odorless
Battery acid Chamber acid Fertilizer acid Oil of vitriol	Sinks and mixes violently with water. Irritating mist is produced.		

Keep people away. AVOID CONTACT WITH LIQUID.
Wear goggles, self-contained breathing apparatus, and rubber overclothing.
Notify local health and pollution control agencies.
Protect water intakes.

Fire	Not flammable. May cause fire on contact with combustibles. Flammable gas may be produced on contact with metals. POISONOUS GAS MAY BE PRODUCED IN FIRE. Wear goggles, self-contained breathing apparatus, and rubber overclothing. DO NOT USE WATER ON ADJACENT FIRES. Extinguish with dry chemical or carbon dioxide.
Exposure	CALL FOR MEDICAL AID. MIST Irritating to eyes, nose and throat. If inhaled, will cause coughing, difficult breathing, or loss of consciousness. Move to fresh air. IF IN EYES, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Dilute and disperse
Stop discharge
Chemical and Physical Treatment:
Neutralize

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 2; Sulfuric acid
2.2 Formula: H_2SO_4
2.3 IMO/UN Designation: 8.0/1830
2.4 DOT ID No.: 1830
2.5 CAS Registry No.: 7664-93-9
2.6 NAERG Guide No.: 137
2.7 Standard Industrial Trade Classification: 52232

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Safety shower; eyewash fountain; safety goggles; face shield; approved respirator (self-contained or air-line); rubber safety shoes; rubber apron.
3.2 Symptoms Following Exposure: Inhalation of vapor from hot, concentrated acid may injure lungs. Swallowing may cause severe injury or death. Contact with skin or eyes causes severe burns.
3.3 Treatment of Exposure: Call a doctor. INHALATION: Observe victim for delayed pulmonary reaction. INGESTION: Have victim drink water if possible; do NOT induce vomiting. EYES AND SKIN: Wash with large amounts of water for at least 15 min.; do not use oils or ointments in eyes; treat skin burns.
3.4 TLV-TWA: 1 mg/m^3
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: 3 mg/m^3 (mist)
3.7 Toxicity by Ingestion: No effects except those secondary to tissue damage.
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: None
3.10 Vapor (Gas) Irritant Characteristics: Vapors from hot acid (77-98%) cause moderate irritation of eyes and respiratory system. Effect is temporary.
3.11 Liquid or Solid Characteristics: 77-98% acid causes severe second- and third-degree burns of skin on short contact and is very injurious to the eyes.
3.12 Odor Threshold: Greater than 1 mg/m^3
3.13 IDLH Value: 15 mg/m^3
3.14 OSHA PEL-TWA: 1 mg/m^3
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: Not flammable
4.2 Flammable Limits in Air: Not flammable
4.3 Fire Extinguishing Agents: Not pertinent
4.4 Fire Extinguishing Agents Not to Be Used: Water used on adjacent fires should be carefully handled.
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Not flammable
4.7 Auto Ignition Temperature: Not flammable
4.8 Electrical Hazards: None
4.9 Burning Rate: Not flammable
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: Not pertinent.
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): Not pertinent.
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: Reacts violently with evolution of heat. Spattering occurs when water is added to the compound.
5.2 Reactivity with Common Materials: Extremely hazardous in contact with many materials, particularly metals and combustibles. Dilute acid reacts with most metals, releasing hydrogen which can form explosive mixtures with air in confined spaces.
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Dilute with water, then neutralize with lime, limestone, or soda ash.
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity:
24.5 ppm/24 hr/bluegill/lethal/fresh water
42.5 ppm/48 hr/prawn/LC₅₀/salt water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): None
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 2
Human Oral hazard: 3
Human Contact hazard: II
Reduction of amenities: XX

7. SHIPPING INFORMATION

7.1 Grades of Purity: CP; USP; Technical, at 33% to 98% (50° Be to 66° Be).
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: 3

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Corrosive material
8.2 49 CFR Class: 8
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)........	3
Flammability (Red).........	0
Instability (Yellow)........	2

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: Not listed
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 98.08
9.3 Boiling Point at 1 atm: 644°F = 340°C = 613°K
9.4 Freezing Point: Not pertinent
9.5 Critical Temperature: Not pertinent
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 1.84 at 20°C (liquid)
9.8 Liquid Surface Tension: Not pertinent
9.9 Liquid Water Interfacial Tension: Not pertinent
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
9.12 Latent Heat of Vaporization: Not pertinent
9.13 Heat of Combustion: Not pertinent
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: –418.0 Btu/lb = –232.2 cal/g = -9.715×10^5 J/kg
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Low *Physical properties apply to concentrated (98%) acid unless otherwise stated. More dilute acid is more water-like.

NOTES

Fig.12B: MSDS for Sulphuric acid

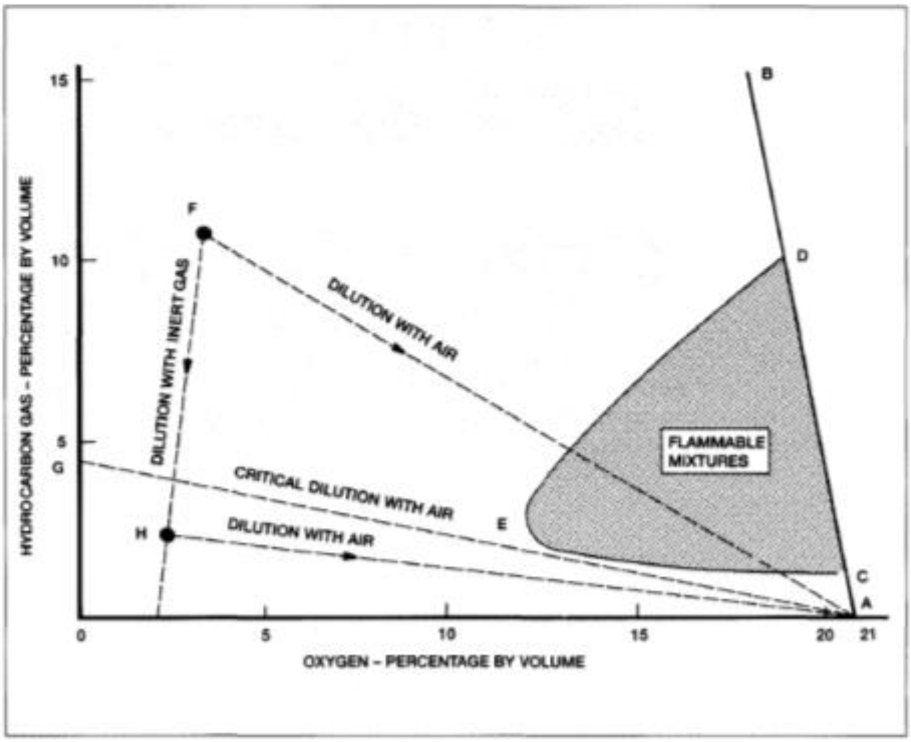


Fig. 13.1 A: Flammability diagram for flammable cargoes

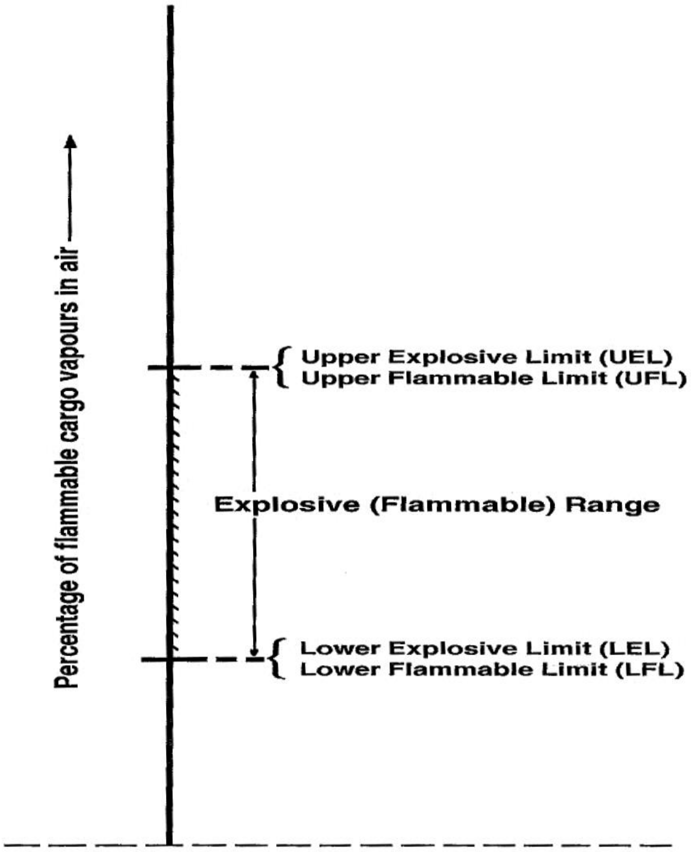


Fig 13.1 B: Flammable Range

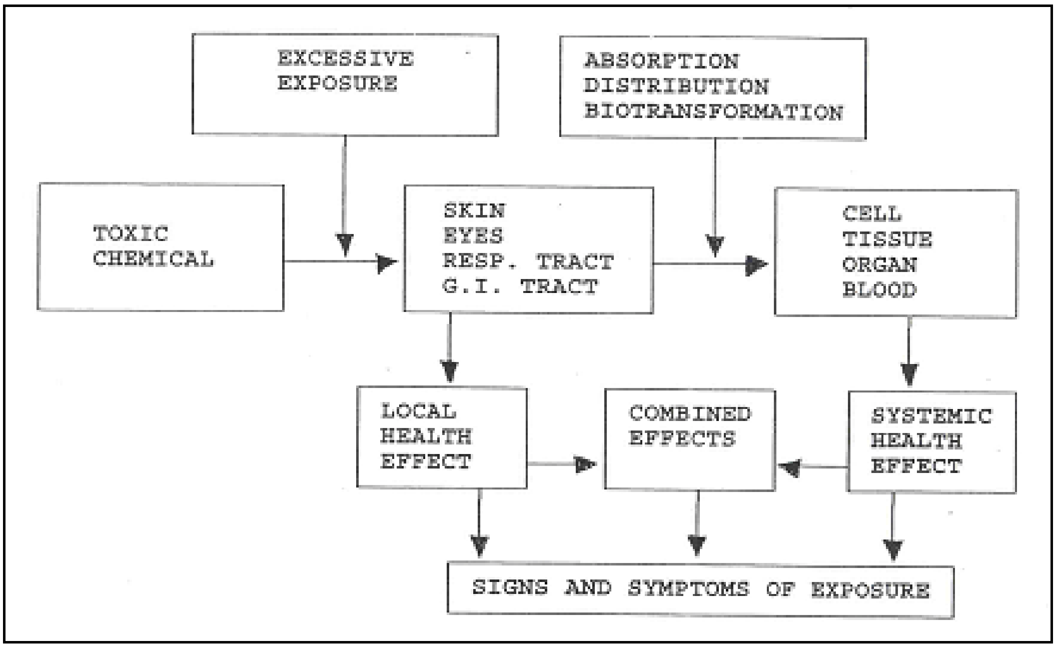


Fig. 13.3A: Health Hazards

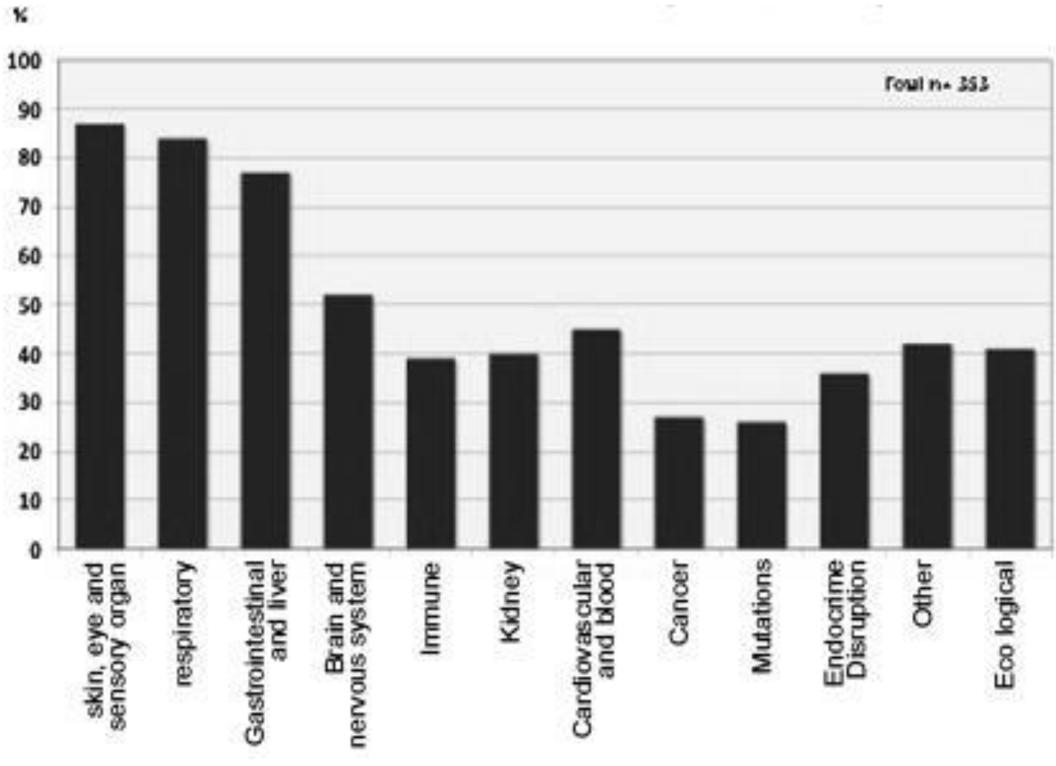


Fig.13.3B: Health Hazards in percentage of exposures to oil and Chemicals

Fig. 15.1 A: Entering enclosed space with SCBA

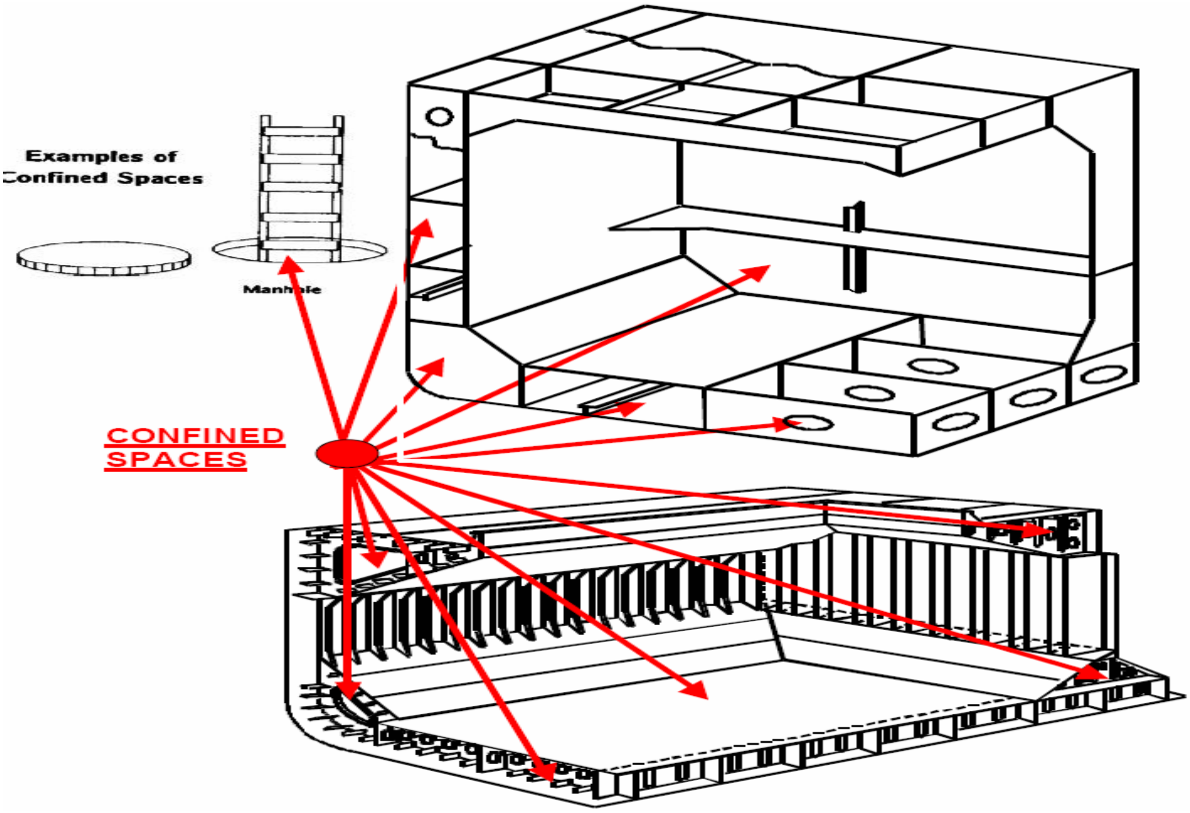


Fig.: 15.1B. Figure of enclosed / confined spaces

Fig. 15.5: Protective Clothing

Fig 16.4: Fire Safety - Fire drill on a ship

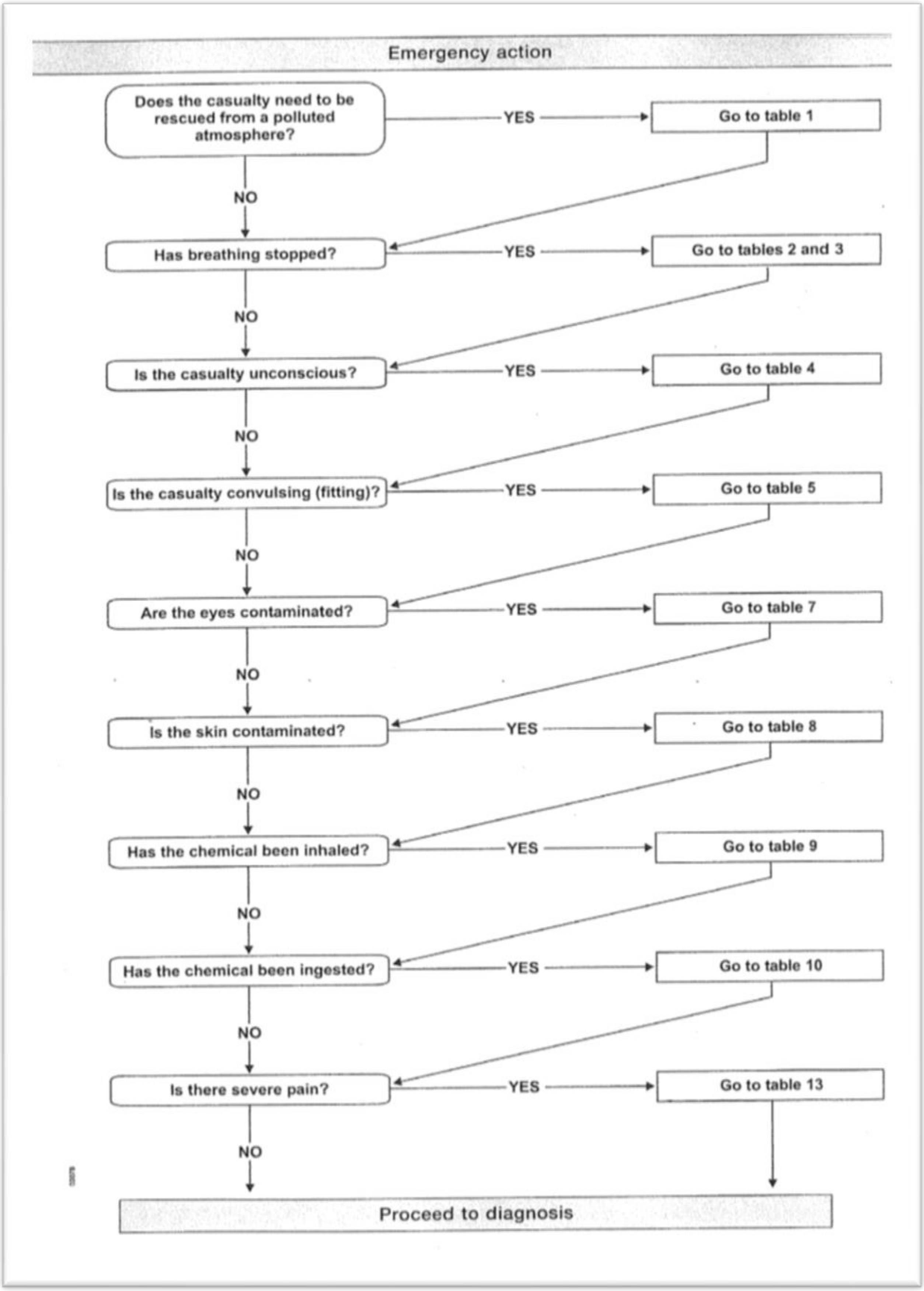


Fig. 18A: Use of MFAG chemical supplement- flow chart.

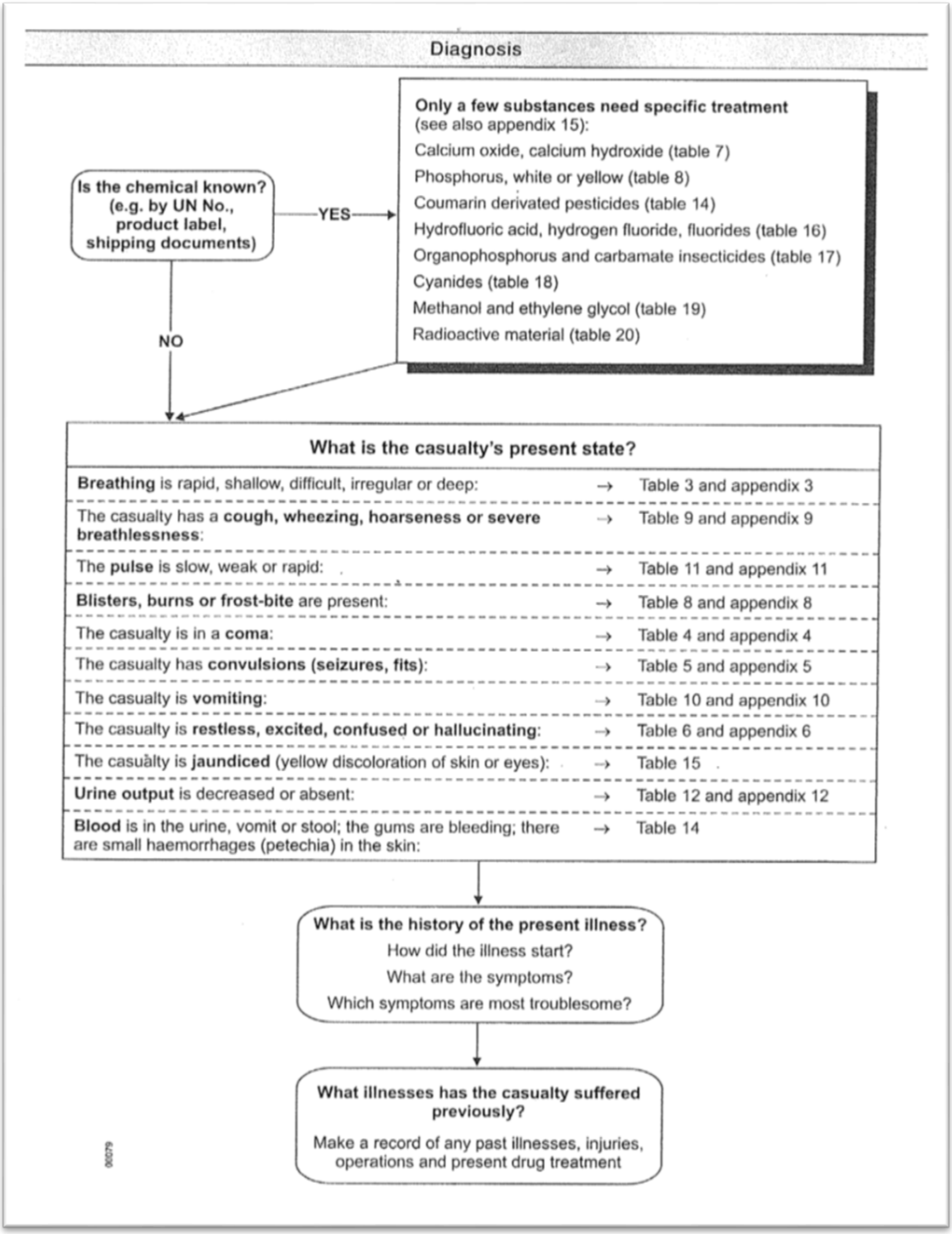


Fig. 18: Use of MFAG chemical supplement - Diagnosis

Ship details	Stripping requirements (in litres)		
	Category X	Category Y	Category Z
New Ships: keel laid after 01/01/2007	75	75	75
IBC ships until 01/01/2007	100 +50 tolerance	100 + 50 tolerance	300 + 50 tolerance
BCH ships	300 + 50 tolerance	300 + 50 tolerance	900 + 50 tolerance
Other ships: keel-laid before 01/01/2007	N/A	N/A	Empty to the most possible extent

Fig 20: Stripping requirements as per MARPOL Annex II

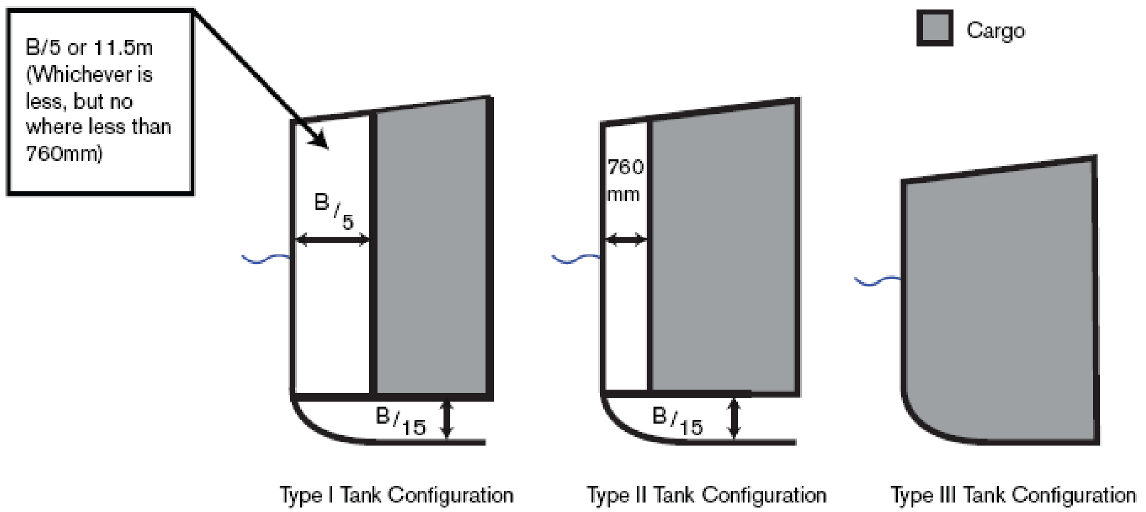


Fig 21.3: IBC Code, chemical tanker Location of tanks for ship type 1, 2 and 3.

Ship Type 1 each tank capacity not more than 1250 m^3;
Ship Type 2 each tank capacity not more than 3000 m^3;
Ship Type 3 each tank capacity not regulated.

SIMULATOR BASED EXERCISES

Incase a simulator is not available, the instructor is guided to show the Chemical simulator figures appended herein above and describe the operations as if operating the equipment as a table top exercise.

Exercise no 1. Chemical Tanker: Cargo handling simulator layout

Objectives: Understanding of the subsystems and their overall interactivity in the Chemical cargo handling simulator and the operations involved.

Familiarization with terminology and communications during liquid cargo operations.

Prerequisites: The theoretical aspects of the various kinds of liquid cargo transport should be known to the trainee Basic naval architecture related to chemical tanker would have been studied prior to simulator exercises. Basic stability and stress theory will have to be known by the trainees.

Training materials: Simulator or PowerPoint's of the mimic diagrams used in the CCR (Cargo Control Room) layout and general arrangements of the vessel in the liquid cargo simulator.

Simulator Condition: Familiarisation exercise enabling operations of all Chemical Tanker systems.

Briefing: Explanation of the ship type modeled.

Explanation of various subsystems and how they are interconnected.

Explanation of the Load Master, trim, draft heel indicators in simulator.

Student action: Attend lecture. Operate PC and Familiarize with Operational equipment

Repeat previous theory learned on cargo systems, stability and stress in case simulator unavailable, display the power-points and describe the operations

Instructor action: Apart from system mimics emphasize overall connection of the systems in the vessel.

Explain symbols used in mimics.

Explain Load Master and how it can be used in stowage planning.

Debriefing: Check if all systems understood and interconnection of systems in simulator.

Discuss if relationships with previous theory are properly understood.

Evaluation: By means of one or more diagrams have trainees show understanding of subsystems and symbols by describing system and / or indicating various symbols.

Exercise no 2. Inerting cargo tanks

Objectives: Understanding the principles, operations and safety precautions

involved with inerting of cargo tanks

Prerequisites: Introductory exercises will have been completed such as no.1. Theory of UEL, LEL and explosive mixtures will have been covered as well as explosion triangles.

Training materials: OHP sheets of the IGG system, the IG distribution lines from shore tank to vessel and inerting mimics of cargo tanks.

Simulator Condition: Cargo tanks empty, filled with air. Normal ballast condition.

Student action: After checking tank atmospheres, choices to be made for which tanks to start inerting and line up.

Continuous monitoring of IG flow and 0_2 content in the tanks.

Instructor action: Check choice of tanks, system used, and method chosen to tanks which are to be inerted. Check quality of IG supplied.

Debriefing: The instructor should ascertain that the tank atmospheres are at the required level of 02.

Check that students have understood the principles of inerting and explosion levels and limits.

Evaluation: By question and answer confirm that students have understood the principles of, and reasons for, inerting of cargo - tanks.

Based on the achieved levels of IG and 02 in the tanks the trainees' understanding and skills in inerting can be evaluated.

Exercise no 3. Loading full cargo of various chemicals

Objectives: By loading a full cargo into the vessel, appreciating efficient cargo planning, stability and stress criteria and maximum allowable draft and trim.

Prerequisites: The trainees will have performed familiarization exercises on the simulator and they will have knowledge of loading zones, stability, shear forces and bending moments. Use the stowage planning exercise sheet appended in fig. 7.1 Part D of this manual and execute the table top exercises to ensure compatibility of the cargo

Training materials: Mimic diagrams of cargo deck lines, manifold connections, loading/discharge and cargo tanks.

Displacement table and Loading plan.

Simulator Condition: Vessel cargo tanks empty with ballast on board

Shore connection for different grades and in different groups of tanks.

Briefing: Trainees should be told that all cargo tanks are empty and simultaneous deballasting required for this exercise.

Tanks to be filled up to 98% as per calculations from the IBC code.

Shear forces and bending moments to be kept within limits throughout the operation. Preliminary check to be done by off – line Load Master.

During loading cargo tanks, gas to be vented to shore (as applicable)

Student action: Trainees can perform preliminary stress and stability requirements with the Load Master.

Shore manifold connection to be made, manifold lines with jumper connection completed and commence loading. When loading tanks, levels to be monitored as well as tank atmosphere and shear forces and bending movements.

Instructor action: Check preliminary stress calculations.

Check tanks loaded in planned sequence in order to keep stresses within limits. Check tank levels after filing and topping off. If the exercise of filing all tanks takes too long in real time, a start can be made and then continued fast time until a further stage whereby topping off of tanks is again a useful learning experience.

Debriefing: Trainees should understand possibilities and limitations of a full cargo being loaded.

Stresses and stability has been monitored throughout the operation. Final draft, trim, tank ullages and atmosphere were monitored.

Evaluation: By means of observation of final condition assessing if trainees have reached required condition and that all values of levels, volumes, trim and list, shear force and bending moments are within the determined limits.

Exercise no 4. Unloading full cargo of various chemicals

Objectives: By unloading a full cargo from the vessel, appreciating efficient cargo planning, stability and stress criteria and maximum allowable draft and trim. Starting and Stopping Cargo whilst delivering smaller parcels into tank trucks, Barges and shore tanks

Prerequisites: The trainees will have performed familiarization exercises on the simulator and they will have knowledge of loading zones, stability, shear forces and bending moments.

Training materials: PPT/OHP sheets of mimic diagrams of cargo deck lines, manifold connections, unloading of cargo tanks.

Displacement table and Loading plan.

Simulator Condition: Vessel cargo tanks Full and no ballast on board.

Shore connection for multi grades and in different group of tanks.

Briefing: Trainees should be told that all tanks are Loaded and ballasting to be done during unloading for this exercise.

Tanks to be unloaded with pre planned sequential quantities and pump operations to be familiarized with.

Shear forces and bending moments to be kept within limits. Preliminary check can be done by ballast conditions with off – line Load Master.

When unloading tank stripping and draining shall be carried out using special techniques (if applicable)

Student action: Trainees can perform preliminary stress check with the Load Master.

Connection of shore manifold to be made, manifold lines with jumper connection completed and unloading to commence according to stress limitations. During unloading tanks, levels to be monitored as well as tank atmosphere and shear forces and bending moments to be frequently checked

Instructor action: Check preliminary stress calculations.

Check if tanks are unloaded in planned sequence in order to keep stresses within limits. Check tank residues after unloading are in compliance with regulations.

If the exercise of unloading all tanks takes too long in real time, it can be continued with a simulated fast time speed if available.

Debriefing: Trainees should understand limitations of a full/part cargo being unloaded.

Stresses and stability were monitored and final draft, trim, tank ullages, pressure, temperatures and atmosphere were continuously checked.

Evaluation: By means of observation of final ballast condition assessing if trainees have reached required condition of ballast water and empty tanks and that all levels, volumes, trim and list, shear force and bending moments were within the determined limits.

Exercise no 5 Chemical tanker: Purge and ventilate cargo tanks for entry

Objective: Preparing cargo tanks for man entry after unloading chemical cargo.

The trainee will learn how to purge cargo tanks with inert gas and air to safe level before man entry is permitted.

Prerequisites: Familiarization exercise no.1.

Inerting exercise no.2

Theory of explosion limits – LEL and UEL

Threshold Limit values (TLV)

Training material: Tank atmosphere diagrams.

Shore N2 line up.

Simulator Condition: Vessel ballasted to normal seagoing condition.

All cargo tanks empty.

Tank atmosphere: O_2: Nil N_2 – 99%

Briefing: The different status of the tanks to be explained to trainees.

Safe levels of Chemical Vapours and O2 to be pointed out.

Use of IG – System, P/V valves and venting system.

Objective to maintain proper tank atmosphere condition during whole operation.

Student action: Start purging selected cargo tanks with inert gas to safe vapour concentration before starting to ventilate with air. Make one or two tanks gas free for man entry.

Tank atmosphere to be constantly monitored.

Instructor action: Check that trainees observe tank atmosphere levels and that selected tanks are at safe levels before starting to ventilate with air.

Debriefing: Ensure trainees have understood correct use of tank atmosphere levels.

The importance of proper purging with IG to safe gas concentration before ventilating with air to be stressed upon.

Evaluation: By means of the tank atmosphere screens, the oxygen and gas contents in the vented tanks can be monitored.

Exercise 6 Chemical tanker. Tank cleaning with water/chemicals and also with steam

Objectives: By means of the exercise the relationship between the various subsystems is supposed to be demonstrated.

Understanding of Tank Cleaning to be demonstrated and realized.

Prerequisites: Familiarization exercise.

Unloading exercise.

IG usage exercise

Theoretical knowledge of trim and heel is required.

Making of a tank cleaning plan with Cleaning and discharge procedures (CDP) and use of the P and A manual.

Pollution prevention rules and procedures have been discussed.

Training materials: Mimic diagram of cargo tanks.

Cargo pump operation technique (FRAMO)

Shear force, bending moment.

IG system. Tank cleaning plan.

Simulator Condition: Cargo tanks empty with residues from multi grades of chemical parcels.

With full ballast condition.

Briefing: The trainees should be convinced of the complexity of the exercise, which should be built up step by step.

Requirements and precautions during Tank cleaning.

Following tank cleaning plans.

Student action: The trainees will start with preparing a Tank cleaning plan, which will keep trim and heel within the acceptable limits.

Chemical tank cleaning and stripping will take place simultaneously.

In this order operation will continue until all tanks empty.

Instructor action: The instructor should ascertain that the sequence of tank cleaning trim and heel into consideration.

During tank cleaning the tank atmosphere are monitored and inert gas supplied in accordance with the requirements of the IBC code.

Debriefing: Check which order tanks have been cleaned.

Check suitable draft, trim and heel were maintained.

Evaluation: By mean of question and answer determine understanding of multiple operations.

Time needed to complete operations will be a measure of efficient conduct of operations.

All cargo residues should be removed, tanks cleaned for the next cargo fulfilling all statutory and commercial requirements

CASE STUDIES

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Case Study 1

Over filling Palm oil cargo tank leading to spillage during unloading

Summary

On 03rd Sept 2014, the chemical tanker MT Lord Byron was discharging her cargo of Crude Palm oil at Billimar Docks in Drake, Moila. (Name and date changed)
Unloading operations had commenced at 2120 hrs on the 03rd under the supervision of the Chief Officer who was in charge of cargo operations on the ship.
Third officer who was on watch from 04th/0600 hrs in the morning was relieved by the 2nd officer at 1220 hrs.
At 1250 hrs, the Deck watch reported palm oil spilling onto the deck from one of the Cargo tanks and rushed to activate the Emergency shutdown system. By the time the pumps were tripped, palm oil had accumulated in the aft deck area up to the level of the fish plate and a small quantity had spilled over the side into the water.

Alarm was raised and Port control and local authorities were immediately informed about the incident. Spilt palm oil on deck was subsequently cleaned up and cargo operations resumed at 1700 hrs on 4th Sep 2014.

Narrative

The MT Lord Byron docked at Billimar docks at Drake in Moila on the 03rd of Sept at 1642 hrs.
Vessel was to discharge her entire balance cargo of Crude Palm oil, Palm Kernel oil and Palm Fatty acid distillate at this port.
Vessel has a total of 22 Cargo tanks ie. 11 Port & Stbd wing tanks

The stowage of cargo onboard was as follows:
Crude Palm Oil 1st parcel (CPO) 1st– 1S, 3P, 4S, 10P, 10S, 11S
Crude Palm Oil 2nd parcel (CPO) 2nd – 4P, 5S, 7P, 7S
Crude Palm Oil 3rd parcel (CPO) 3rd – 8P, 8S, 11P
Palm Kernel Oil (PKO) – 2P
Palm Fatty Acid Distillate (PFAD) – 1P

Sequence of Events:

03/1642 hrs – Vessel docked at Billimar docks (Port side to)
03/1705 hrs – Surveyor boarded
03/1715 hrs to 02/2010 hrs – Sampling and calculations completed
03/1845 hrs – Cargo hoses connected.
Common line on Port side connected for discharge of CPO 1st parcel
2Port manifold connected for discharge of PKO
4P & 5S manifolds connected through Y-piece on Port side for discharge of CPO 2nd Parcel
8P & 8S manifolds connected through Y-piece on Port side for discharge of CPO 3rd Parcel
03/2105 hrs – cargo hose connected to Barge on St.bd. side for discharge of PFAD

(Please see attached Manifold line up plan – Attachment 3)
03/2120 hrs – Commenced unloading CPO 1st parcel
03/2145 hrs – Commenced unloading PKO
03/2210 hrs – Commenced unloading PFAD to barge
04/0115 hrs – Completed unloading PFAD to barge
04/0300 hrs – Completed unloading PKO
04/0420 hrs – Commenced unloading CPO 2nd parcel
04/0720 hrs – Barge for PFAD cast off
04/0800 hrs – Stopped discharging from 5S at 8.00m ullage
04/0805 hrs – Commenced discharging from 7S
04/0815 hrs – Commenced discharging from 7P
04/1250 hrs – Oil spill from 5S / ESD activated at manifold by DTSM
04/1251 hrs – General alarm was sounded and cleaning up operations commenced.
Estimated palm oil spilt into water was 1.0 to 2.0 cub meters.
04/1300 hrs –Port control contacted and informed of spill. Vessel was advised to contact Brake Port control
04/1305 hrs – Vessel contacted Drake Port control and informed of spill
04/1315 hrs – DPA informed
04/1320 hrs – P&I club and Agent informed
04/1330 hrs – Spill contained
04/1340 hrs – Drake Water police boarded vessel
04/1613 hrs – Water police, Agent and P&I Surveyor disembarked.
04/1700 hrs – Resumed unloading operations

Observations:

1. All Officers on board had undergone relevant chemical tanker safety courses. The 3rd mate & 2nd mate had completed their Advanced chemical tanker safety course.
2. Rest hours for Chief Mate, 2nd Mate, 3rd Mate and Deck watches were checked and found to be in compliance.

Results of Investigation:
4th September 2014

Discharge of CPO 2nd parcel was commenced at 0420hrs on the 4thThere were 4 tanks on this group ie. 4P, 5S, 7P &7S. Initial discharge was started using 2 pumps from 4P & 5S

1. At 0800hrs on the 4th, the Chief mate instructed the 3rd mate who was on duty to stop discharge from 5S and commence discharge from 7S in order to stagger tanks for final stripping.

The 3rd mate stopped the 5S pump accordingly and asked the Deck watch to shut 5P manifold valve. However, the tank master valve on 5S was left open.

At 0805hrs, 7S pump was started and 5P and 5S manifold valves were opened.
At 0815hrs, 7P pump was also started.
Since 5S tank valve on the same group was left open, cargo started filling up slowly in this tank.

2. The hourly rate log showed that the ullage of 5S slowly rose from 8.173m at 0800hrs to 1.765m at 1200hrs. The decrease in ullage in 5P was being recorded each hour by the 3rd officer in the hourly rate log but still there was no realization of what was going wrong and no action was taken.

The Chief officer was also intermittently present in the CCR during this period but had not checked the tank ullages.

Also, a review of the hourly rate log shows that the ullages were not being effectively monitored. Discharge rate between 1000 hrs and 1200hrs is not consistent although discharge pressures and number of pumps in operation are the same.

3. Vessel is fitted with cargo tank High level and Cargo tank Overfill alarms. These alarms were found to have been accepted but not acted upon at the time of the incident.

GROUP DISCUSSION

1. Group Discussion: What could be the possible cause of the incident?
2. Discuss the lapses on part of the officers on watch.
3. What precautions would you have taken in case you were the responsible officer.

CAUSE OF DAMAGES

Basic Cause:

1. Inadequate Supervision:

Supervision of the 3rd officer's actions by the Chief Officer was found to be inadequate during tank changeover.

2. Inadequate use of safety barriers fitted:

Vessel is fitted with cargo tank High level and Cargo tank Overfill alarms. These alarms were found to have been silenced when the incident took place. As evident from interviews held, the alarms had been accepted but not acted upon.

Case Study 2

Over Pressure / Under pressurization of Tanks

There have been numerous cases of serious tank failure as a result of over / under pressure conditions created in cargo tanks due to blocked pressure / vacuum (PV) valves and vent lines leading to them.

A partly loaded vessel arrived and anchored while awaiting berthing pilot. She was loaded with High melting point cargo (Phenol). While anchored, the crew felt a sudden strong vibration and noticed deformation of deck plating and transverse frame above the cargo tank holding Phenol.

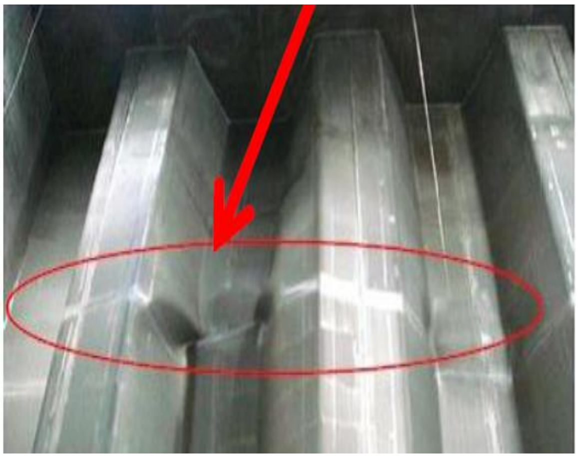
The cargo was later observed to have flowed into the adjacent empty cargo tank and into two other tanks below the Phenol cargo tank. There was no injury or pollution due to the incident and no breach of integrity to outer hull.

- Air temperature at the loading port was 10~11°C (50~52°F). During passage, air temperature dropped to as low as 1°C (34°F).
- In the first few days after loading the cargo temperature dropped from 57° to 53°C (135° to 127°F).

During the passage low heating maintained the cargo temperature at around 52.5°C (126.5°F).

- Due to cargo contraction pressure drop inside tank due to cooling was compensated by natural breathing through the pressure/vacuum (P/V) valve.
- The vessel experienced very rough sea, swell, cold climate, rolling and pitching.

With the cargo tank fully loaded, cargo sloshed into the mouth of the vent line. Due to the high melting point of Phenol and the low ambient temperature, Phenol solidified at the mouth of the vent line which gradually blocked the vent line completely.

Group Discussion:
1. What could be the possible reason for the incident?
2. What else should be done to prevent over/under pressurization

Lessons Learnt:

- Pressure/vacuum (P/V) valves and other relief devices should be well maintained and tested to ensure they function as designed for the cargo carried
- P/V valves and vent lines leading to them can become blocked by cargoes especially if they have high wax content, high melting points or are polymerizing cargoes. Even when the P/V valves appear to operate freely, flow through vent lines must be confirmed.

Monitor cargo tank pressures to avoid over / under pressurization of cargo tanks

ANNEXURE

ANNEX – 1: SAMPLE PARTICIPANTS HANDOUT

13 - HAZARDS ASSOCIATED WITH BULK CHEMICALS

TANK ATMOSPHERE EVALUATION

Tank atmosphere evaluation should be carried out:
- prior entry of personnel into a tank
- inerting, gas-freeing operations
- to establish a gas-free condition

The atmosphere in a cargo tank or enclosed space may be dangerous due to flammability, toxicity and / or lack of oxygen. No personnel should enter or work in a tank or an enclosed space unless safe working conditions are created. It is the responsibility of the master or officer on duty to ensure that safe working conditions are created.

Tank atmosphere evaluation is essential to safe working conditions. As a rule, a tank or enclosed space should not be entered prior gas freeing. Precautions for safe working conditions should be observed when entry is necessary.

Procedures for testing of tank atmosphere with regard to:
- Oxygen content
- Flammable vapours
- Toxic vapours

The following are the main hazards with regard to the handling and carriage of chemicals in bulk are:
i. Health hazards.
ii. Environmental hazards
iii. Reactivity hazards.
iv. Flammability & Explosion hazards.

HEALTH HAZARDS
The three main health hazards with regards to chemical cargoes are
1. Toxicity (due to poisonous substance),
2. Asphyxiation,
3. Corrosivity (due to corrosive substance)

TOXICITY
Substances, which, when absorbed into the human body, produce seriously harmful or fatal effects, are considered poisons.

Such substances may be absorbed into the human body by
1. Inhalation of vapours from toxic substance.
2. By skin absorption
3. By ingestion.

INHALATION
Among the above three, inhalation of air which is contaminated by toxic substances is the most likely route through which harmful substance may enter the body. The effect of

exposures to such harmful substances depends on factor such as the nature of the substance, the volatility of the substance, the degree of contamination, the period of exposures and health of victim. The effects may be acute/or chronic.

The acute effect is defined as the effect on man of a short duration to relatively high concentration of vapour.

The chronic effect is defined as the accumulative effect on the man of prolonged exposure to relatively low concentrations.

The vapours from some cargoes may have both an acute and chronic effect, while in the cast of some cargoes only one of the two effects predominates.

Threshold Limit Value (TLV) of a substance refer to the maximum concentration of the gases or vapours, mist or sprays to which it is believed that nearly all persons may be repeatedly exposed day after day without any adverse effects.

Three categories of TLVs (TLV TWA, TLV STEL and TLV C) have been identified with regards to such toxic substance. Degree of toxicity of such chemicals due to inhalation of vapours may be expressed in terms of their LC-50 values too.

1. TLV- TWA- (time weighted average) - Concentration which may be experienced for 8 hours a day or 40 hours a week without any adverse effects.

2. TLV – STEL - The max concentration of vapour allowable for a period of upto 15 mins provided that there are not more than 4 exposures per day with at least one hour gap in total span of 24 hours.

3. TLV-C- Concentration which should never be exceeded even for an instant.

SKIN CONTACT

Many chemical liquids and certain vapours are absorbed by the human body through the skin. Some of these substances are highly toxic and easily absorbed. These substances may enter the blood stream via the skin and be distributed to various parts of the body. In such cases the toxic effects are same as effects due to ingestion of this substance. The risk of absorption is greater if the skin is broken due to wounds, cuts or abrasions.

Fine sprays or must of toxic substances in air may easily enter the eyes. The effects of body contact may be local or systemic or both.

INGESTION

Ingestion (or introduction into the body via the digestive system) of toxic substance may be extremely harmful. Normally ingestion of such substance is not likely unless a person becomes unconscious, falls into the pool of that liquid and swallows some of the liquid. Splashed chemical liquids and chemical sprays may also enter the mouth. If swallowed all poisons are dangerous.

ASPHYXIATION

A deficiency of breathable oxygen results in asphyxiation. Incidents of asphyxiation in cargo tanks and other enclosed spaces are reported frequently. Such deficiency of oxygen may be due to inerting. Entering inerted spaces without breathing apparatus is highly dangerous.

Deficiency of oxygen should be suspected in unventilated spaces, which have been kept closed for a long time. This is due to the fact that during the rusting process oxygen in the space is consumed partly.

CORROSIVITY
Some cargoes are corrosive by nature and such cargoes may on contact with the body, totally or partly destroy human tissue. Acids are good examples of corrosive cargoes. Less corrosive liquids may only be irritating to the skin but may cause serious damage to eyes or to mucous membranes.

eg. Sulphuric acid, caustic soda

Acids can cause fires when it comes in contact with combustible materials. Therefore sawdust and cloth must never be used to collect nitric acid spill or other strong oxidizing agents. Sulphuric acid and chlorosulphonic acid react violently with water giving out large amounts of heat.

Acids are generally non-flammable but can react with metals to evolve hydrogen, which is highly flammable.
Chemicals may evolve toxic vapours if they are in contact with other cargoes or reactive agents. Toxic vapours may be generated from fire in certain chemicals. Inhibitors are added into polymerizing cargoes for their safe transport. The toxic nature of the inhibitors must be obtained from the data sheets. Toxic cargoes must not be stowed adjacent to tanks containing edible cargoes and should be as far as possible from accommodation and from machinery spaces.

ENVIRONMENTAL HAZARDS
Chemicals cargoes pose a severe environmental hazard if released to the sea or to the air.

Marine pollution may be caused by accidental and intentional discharge into the sea of cargo such as
- Collisions and stranding
- Lightening operations
- Tank washings and line flushing
- Deballasting
- Overflow from tanks
- Leaking hoses or loading arms
- Equipment failure

Water pollution hazard is defined by human toxicity, water solubility, volatility, odour or taste and relative density.

Air pollution hazard is defined by:
- Emergency exposure limit
- Vapour pressure
- solubility in water
- relative density of liquid
- vapour density

Marine pollution hazard is defined by
- bioaccumulation with attendant risk to aquatic life or human health or causing tainting to seafood
- damage to living resources
- hazard to human health

REACTIVITY HAZARDS
Chemical cargoes will react in a number of ways such as-

- Self
- Air
- Water
- Another cargo
- Other materials

SELF REACTION

Chemicals can react within themselves to form a different compound either by polymerisation or by decomposition.
Polymerisation reactions are exothermic reactions; the reaction speed is strongly influenced by catalyst (usually metals). Many polymerization reactions are started by heating and by liquid after the formation of peroxides. Most monomer polymerizes spontaneously (in the air), and in that case the reaction passes in an uncontrolled way.
In order to try to prevent the polymerization of monomers during transport and storage, so-called inhibitors are added in very low concentrations (sometimes 10-4-ppm). This is based on the fact that, unlike monomers these inhibitors prefer to react with oxygen, and in this way formation of peroxides is prevented. Consequently, these inhibitors do not live forever and during a long period of storage they will have to be replenished.

Strongly polymerizing substances which must be always be shipped with inhibitors, are

- Isoprene
- Styrene (vinyl benzenes)
- Vinyl toluene
- A-methyl styrene
- Acrolein
- vinyl acetate
- acrylates and methylacrylates
- vinylidene chloride

Where polymerisation causes the formation of heavy viscous substance decomposition generally causes the formation of a lighter more volatile substance. Catalysts and heat aid decomposition reactions. Catalysts for decomposition are acids, alkalis and metals. Appropriate quantities of stabilizers need to be added for the safe carriage of these cargoes.

Other substances which under certain circumstances (e.g. by adding acids) can undergo a slight polymerization,

- Olefins;
- Alyl alcohol;
- Aldehydes;
- Some unsaturated CI-hydrocarbons.

As such, these products are not considered dangerous.
Precautions:

- Obtain inhibition/ stabilizing certificate
- Note down temp for carriage, temp range of additive
- Do not load cargoes with a temp higher than the working temp of the inhibitor in the adjacent tank
- Do not inert tanks if the additive is oxygen dependent
- Blank off steam heating coils

REACTION WITH AIR

Some chemicals react with oxygen in the air to form peroxides. Organic peroxides once formed are thermally unstable and they are liable to exothermic self-accelerating decomposition. Vegetable, animal oil and greases are slowly oxidized in air by the action of bacteria. This process of decomposition is called putrefaction.

Oxidation is a chemical reaction whereby the substances itself produces the oxygen for oxidation. Oxidation reactions are started by oxygen from the air: this oxygen oxidizes some molecules of the substances (mostly peroxide), which molecule in their turn oxidizes other molecules, so that this sometimes lead to chain reaction with a great development of heat and even a chance of detonation.

Examples:

- Diethyl ether and other ethers;
- Epoxides;
- Benzyldehyde.

IBC code requires tanks carrying such substances to be suitably inerted with a low level of oxygen and maintained at a positive pressure during the voyage and while unloading.

REACTION WITH WATER

Some substances can combine with water or can be decomposed by water, as a result of which either a hazardous situation arises or the quality of the product strongly changes, or product develop which cause a corrosion of materials. In this case, contamination with water must be prevented.

Data sheets will indicate if any possible reaction with water exists. Tanks to be loaded with such cargo should be completely cleaned and dried. IBC code requires double segregation between such cargoes and water. The cargo should not be carried adjacent to water tanks, permanent ballast tanks, slop or cargo tanks containing water washings unless the tanks are empty and dry.

The shipper will normally provide information on tank cleaning methods. Toluene di-isocyanate reacts with water to form carbon dioxide. Other examples are Acetonitrile, Carbon tetra chloride, Dichloroethyl ether, Ethyl acrylate, Ethylene dichloride, Vinyl acetate.

REACTION WITH OTHER CARGO

Depending on their composition, chemical reactions can occur when two different substances are mixed with each other or come into contact with one another. If this happens, very hazardous situation may arise: a strong development of heat, the setting free of toxic vapours, fires and explosions. Therefore, this risk must be excluded by preventing that such substances (both in liquid state and as vapour!!) get into contact with each other.

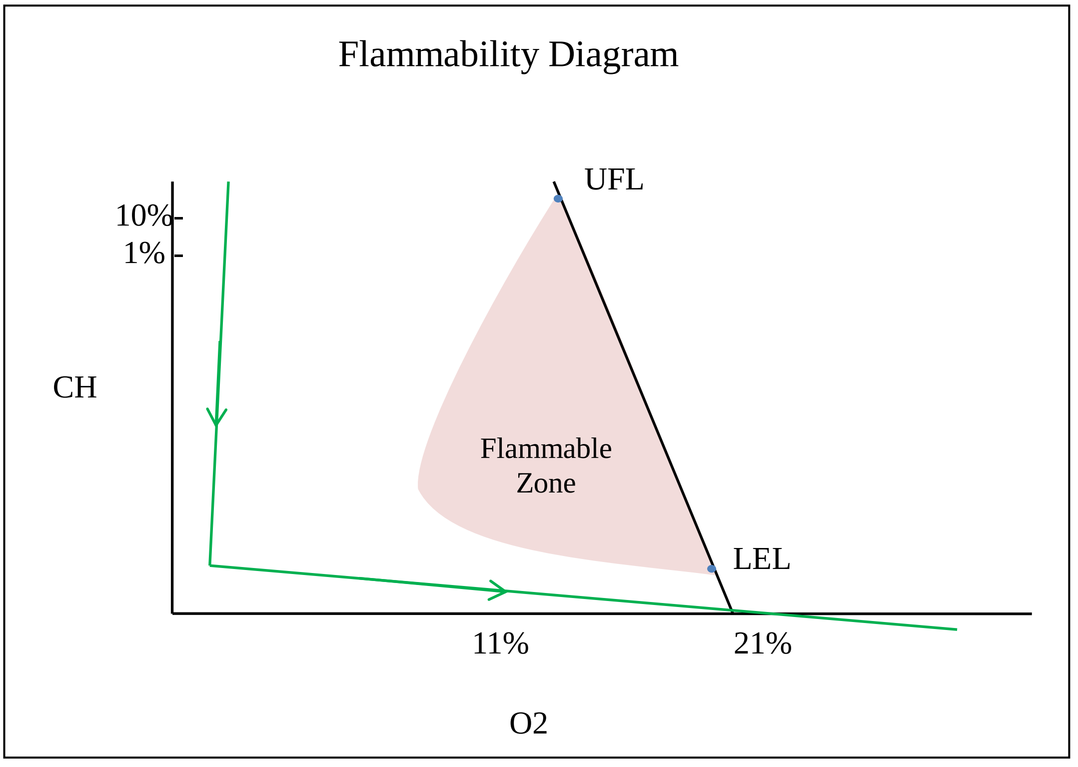
The classic case of incompatibility is between an acid and an alkali which neutralizes each other to form salt and water. The US coast guard has divided chemical cargoes into reactive and non-reactive groups. Sulphuric acid is generally incompatible with every other group. Nitric acid is generally compatible with other acids except sulphuric acid.
Whether cargoes within a pair of groups are indicated as incompatible in the table a careful study must be made of the exceptions as the USCG chemical data guide has numerous exceptions.

Chemical Compatibility Chart

1	Inorganic Acids	1																
2	Organic acids	X	2															
3	Caustics	X	X	3														
4	Amines & Alkanolamines	X	X		4													
5	Halogenated Compounds	X		X	X	5												
6	Alcohols, Glycols & Glycol Ethers	X					6											
7	Aldehydes	X	X	X	X		X	7										
8	Ketone	X		X	X			X	8									
9	Saturated Hydrocarbons									9								
10	Aromatic Hydrocarbons	X									10							
11	Olefins	X				X						11						
12	Petrolum Oils												12					
13	Esters	X		X	X									13				
14	Monomers & Polymerizable Esters	X	X	X	X	X	X								14			
15	Phenols			X	X			X							X	15		
16	Alkylene Oxides	X	X	X	X		X	X							X	X	16	
17	Cyanohydrins	X	X	X	X	X		X									X	17

FLAMMABILITY AND EXPLOSIVITY HAZARDS

Fire requires a combination of fuel, oxygen and a source of ignition. Most combustion of flammable substances, some only when heated, gives off gas which burn if ignited when mixed with appropriate quantity of oxygen as in air. In chemical fires the source of ignition may be heat from a reaction within the chemical itself or from a reaction after mixing chemicals. It is not the liquid cargo which burns but the vapours emitted from it.



FLAMMABLE (EXPLOSIVE) RANGE:
A range of combustible gas concentrations in air over, which the mixture is flammable. That is the range of concentrations between the LFL (Lower Flammable Limit) and the UFL (Upper Flammable Limit).

The lower limit of this range known as lower Flammable Limit (LFL) or the Lower explosive Limit (LEL) is that gas concentration below which there is insufficient gas to support and propagate combustion, the mixture is too lean.

The upper limit of the range known as the Upper Flammable Limit (UFL) or the Upper Explosive Limit (VEL) is that gas concentration above which there is insufficient air to support and propagate combustion, the mixture is too rich.

The term flammable range gives a measure of the proportions of flammable vapour necessary for combustion to be possible. A value of a flammable range is variable and depends upon particular vapour.

The flammable range of a particular vapour is broadened in the presence of oxygen if excess of that vapour is normally in air. The LFL is not much affected whereas UFL is considerably raised. All flammable vapours exhibit this property and as a result oxygen should not normally be introduced into an atmosphere where flammable vapours exist. The oxygen cylinders associated with oxy-acetylene burners and oxygen resuscitator should only be introduced into hazardous areas under strictly controlled conditions.

A cargo is flammable if it is capable of being ignited and of burning. Most chemical cargoes are flammable. It is not the liquid cargo that bums, but the vapours emitted. Generally flammable vapours can ignite and will bum when mixed with air in certain proportions. Certain cargo vapours can burn, if ignited, without being mixed with air. E.g. Ethylene Oxide and Propylene oxide.

FLASH POINT

Flash point is the temperature at which a product will give off enough flammable vapor to be ignited if an external source if heat is applied. Values given in the code are "Closed Cup Test" determined by an approved flashpoint apparatus. Acetone has a flash point around -18°Celsius so at ambient temperature the immediate vicinity of the liquid surface might be above the U.F.L. but there may be large volumes of flammable mixture in the vicinity. Styrene has a flash point of 28°Celsius, so in normal loading and carriage there might be flammable gas concentration at the surface.

AUTO-IGNITION TEMPERATURE

The lowest temperature to which a solid, liquid or gas re quires to 'be raised to cause self-sustained combustion without initiation by a spark, flame or other source of ignition. The auto ignition temperature is not related to the vapour pressure or to the flash point of the substance and, since most ignition sources in practice are external flanges or sparks, it is the flash point rather than the auto-ignition characteristics of a substance which is generally used for the flammability classification of hazardous material.

Some chemicals have properties which necessitate fire fighting techniques that differ from those used on simple oil fires. Some of these properties are-

- Some chemicals are soluble in water and at certain concentrations may be flammable.
- Chemicals which are soluble in water will generally destroy normal foam, so alcohol resistant or dual purpose foam is required.
- Some chemicals are heavier than and insoluble in water they can be smothered by blanket of water, provided application is gentle.
- Some chemicals react with water to produce heat and thus give off increased amounts of flammable gases.
- Some chemicals evolve large volumes of toxic vapours when heated.
- The comparatively low auto ignition temperatures of some chemicals increases the chance of auto ignition

The cargo data sheets for a chemical will draw attention to these unusual properties and indicate the correct fire fighting medium and special precautions for fire fighters.

Fire can be controlled and extinguished by the removal of heat, fuel or air. The main aim is to reduce the temperature or to remove the fuel or to exclude the supply of air with the greatest possible speed.

The fire hazard of a cargo covered by the bulk chemical codes is defined by its flashpoint, boiling point, flammability limits and auto-ignition temperature.

Part E: Evaluation

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

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

The purpose of evaluation/assessment is to:

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

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

Initial / Diagnostic assessment

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

Formative assessment

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

Purpose of formative assessment

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

Summative assessment

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

Purpose of summative assessment

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

Evaluation for Quality assurance

Evaluation can also be required for quality assurance purposes.

Purpose of assessment with respect to quality assurance

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

Assessment Planning

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

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

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

Validity

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

Reliability

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

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

If the Instructors are going to assess their own trainees, they need to know what they are to assess and then decide how to do this. The *what* will come from the standards/learning outcomes of the course/qualification they are delivering. The *how* may already be decided for them if it is an assignments, tests or examinations.

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

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

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

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

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

STCW Code 2010

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

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

Instructors should refer to this table when designing the assessment.

Instructors should also refer to the guidance as given in Part B-V/1-1 of STCW code, as given below;

Evaluation of competence

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

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

18. One or more of the first four methods listed should almost invariably be used to provide evidence of ability, in addition to appropriate questioning techniques to provide evidence of supporting knowledge and understanding.
Assessment is also covered in detail in another IMO Model Course, however to assist and aid the Instructors, some extracts from the Model course is used to explain in depth.

Multiple choice questions

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

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

Compiling tests

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

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

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

Quality of test items

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

Advantages and disadvantages of oral and practical tests

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

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

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

TEST PAPER – 1 (ANSWERS)

TOTAL MARKS	:	100
PASSING MARKS	:	50%
DURATION	:	30 Min

(All questions carry 4 marks each)

All questions are to be answered. Indicate your choice by encircling the alphabet. All Multiple Choice questions carry one mark each. Minimum requirement for passing is 50% marks.

1. Types of Chemical Tankers are
   a) Ship types I,II,III
   b) Pollution Categories X,Y Z that they carry.
   c) Parcel, Bulk, small chemical Tankers
   d) All of the above

2. The requirements for tank cleaning on a chemical tanker are given in:
   a) Marpol Annex II
   b) Marpol Annex VI
   c) SOLAS 74
   d) STCW 95

3. Cargoes carried on chemical tankers are called:
   a) IBC
   b) IMO
   c) ISM
   d) NLS

4. The temperature at which a substance which is in the solid state begins to convert to the liquid state is called:
   a) Boiling point
   b) Flash point
   c) Ignition point
   d) Melting point

5. The range of concentration of a gas in a gas-air mixture over which the mixture is capable of being ignited, expressed as percentage of the volume of the gas to the volume of the gas-air mixture.
   a) Auto ignition range
   b) Flammable range
   c) Lower explosive range
   d) Upper explosive range

6. Metal reinforcement in a tank cleaning hose running from one coupling to the other provides a continuous path for electrical continuity, this is called:
   a) Static electricity
   b) Wiring
   c) Bonding
   d) Strengthening

7. To minimize sparking due to static electricity hazards, it is recommended to wait for ______ minutes before taking a manual sounding after tank cleaning.
   a) 15 mins
   b) 30 mins
   c) 45 mins
   d) 60 mins

8. Cargoes that are the most pollutant to the environment are categorized as:
   a) CAT-X
   b) CAT-Y
   c) CAT-Z
   d) OS

9. All operations to be carried out on board a chemical tanker involving cargo and ballast will be clearly described in the following manual and should be done in accordance with this manual.
   a) SOPEP
   b) P&A
   c) ISM
   d) SMPEP

10. The cargo record book must be completed after the following operations:
    a) Ballasting
    b) De-ballasting
    c) Loading
    d) All of the above

11. Which chemical tankers can carry the most dangerous cargoes?
    a) Type 1
    b) Type 3
    c) Type 2
    d) None of the above

12. Chemical Tankers Tank cleaning and pumping out residues is to be carried out in accordance to
    a) P&A manual
    b) Tank cleaning guide
    c) Annex II
    d) All of the above

13. In case of an emergency the vessel will be immediately pulled away from the jetty by the following:
    a) Emergency head line
    b) Emergency stern line
    c) Emergency fire wire
    d) Emergency towing arrangements

14. The following warning sign must be placed over the ships onshore side.
    a) No smoking
    b) No naked lights
    c) No visitors
    d) All of the above

15. Which of the following is not required as a PPE for working with chemicals?
    a) Chemical resistant gloves
    b) Chemical suit
    c) Welding gloves
    d) Safety boots

16. On a chemical tanker you must have the following drills:
    a) Grounding
    b) Oil spill
    c) Chemical spill
    d) All of the above

17. State the percentage of affluent achieved before stopping discharge of tank washings of category "X" cargo?
    a) 0.1% by weight
    b) 1% by weight
    c) 0.01% by weight
    d) No requirement

18. Information about cargoes to be handled is essential to the safety of the vessel and her crew. Where can such information be found?
    a) MSDS
    b) SOLAS 74
    c) Marpol 73/78
    d) IBC Code

19. A man can work in a tank for 8 hours per day for 5 days a week if the gas in the tank is below the following value.
    a) STEL
    b) LEL
    c) UFL
    d) TLV

20. State the current categorization of chemical cargoes
    a) A, B, C, D and Appendix III
    b) X, Y, Z, and OS
    c) 1, 2, 3, 4
    d) a,b,c,d

21. The chemical cargoes could be carried in adjacent tanks could be found from
    a) Marpol Annex II
    b) Compatibility chart
    c) SOLAS 74
    d) STCW 95

22. How much cargo residues may be retained on ships built on or after 1st January 2007?
    a) 75 litres
    a) 100 litres
    b) 300 litres
    c) 900 litres

23. There are only _________ substances under O.S.
    a) 8
    b) 6
    c) 4
    d) 2

24. The purpose of EEBD is to
    a) Work in tanks
    b) Escape from dangerous gas / smoke
    c) Work on manifold
    d) Work in enclosed space

25. Vegetable oils can be carried on chemical tankers
    a) Under "O.S."
    b) Cannot be carried
    c) No Restrictions
    d) Under category 'Y'

SIMULATOR ASSESSMENT

Sr. No	HUMAN FACTORS	Name Rank Company Cert no:		Name Rank Company Cert no:	
1.	Leadership				
2.	Team Work				
3.	Communication Skills				
	OPERATIONAL SKILLS				
4.	Ability to recognize faults				
5.	Ability to take remedial actions				
Self Appraisals	EXERCISES				
6.	Exercise 1				
7.	Exercise 2				
8.	Exercise 3				
9.	Written Test Marks				
10.	Overall Grading				
REMARKS:					

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