ENGINEERING STANDARD

FOR

FIRE FIGHTING VESSELS

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0. INTRODUCTION

Tugs are vessels specially intended for towing oil tankers to jetties for berthing and unberthing.

As the tugs are equipped with fire fighting equipment, they are available to participate in fire fighting in addition to their normal duties when required.

To prevent spread of fire to neighboring tankers, tugs will unberth tankers and towing them to a safe location.

There are vessels in different classification built in compliance with the relevant requirements as follows:

a) Vessels specified for early stage of fire fighting and rescue operations.
b) Vessels specified for continuous fighting of large fires and cooling of the structures on fire.

Fire fighting systems are installed on these vessels in accordance with specified standard of classification.

1. SCOPE

This Engineering Standard specifies the minimum technical requirements for vessels assigned to specialized harbor services and are also equipped with fire-fighting devices to combat fires involved in oil tankers during loading operations at jetties or any other emergency cases. The type of vessels used for this purpose are:

- Tugs
- Vessels intended to operate for fighting fires only
- Vessels partially equipped with fire-fighting devices. The classification of fire equipment requirements and facility design are covered in this Standard.

2. DEFINITIONS AND TERMINOLOGY

Cargo

In this Standard refers to liquids having flash point below 60°C.

Deck Lights

A piece of heavy glass set in a ship's deck or hull to admit light.

Deck

A platform in a ship.

Deck House

A super structure (as a cabin) built on the upper deck of a ship but not extending to the sides.

Sea Chests

A casting connected to the side of a ship below the water line and to a valve for obtaining sea water.

Thrusters

The force that is exerted endwise through a propeller shaft due to reaction of the water on the revolving blades.

Vessel

A craft used as a means of transportation on water.

Vessels' Propulsion

The action of driving forward or ahead.

3. UNITS

This Standard is based on International System of Units (SI) except where otherwise specified.

4. GENERAL REQUIREMENTS

Vessel intended for towing/pushing off-shore support and other specialized off-shore and harbor services are normally equipped with water fog/foam making devices and give helping hand in fire-fighting operations. However, there are vessels originally designed as fire-fighters with classified equipment and can act independently in the operations.

Further details are given below:

4.1 Classification

4.1.1 The following matters are covered by the classification:

- The vessel's fire fighting capability.
- The vessels' stability and its ability to keep its position when the fire fighting water monitors are in operation.
- The vessel's ability of self-protection against external fires (class notation I only).

4.1.2 The requirements in this Section apply to vessels intended for fighting fires on offshore and onshore structures, as well as rescue operations in this relation.

4.1.3 Vessels built in compliance with relevant requirements specified in the following shall be given the class notation Fire Fighter I (or II or III).

4.1.4 The notation I implies that the vessel has been built for early stage fire fighting and rescue operations close to structure on fire.

4.1.5 The notation II or III implies that the vessel has been built for continuous fighting of large fires and for cooling of the structures on fire.

For the notation III, a larger water pumping capacity and a more comprehensive fire fighting equipment is required than for the notation II.

4.1.6 If a vessel fitted with fire fighting systems and equipment in accordance with the notation II or III, also has a system for self-protection in accordance with the notation I, the combined class notation Fire Fighter I and II or Fire Fighter I and III shall be given.

4.2 General

4.2.1 The classification of the vessel is based on the following:

- The operation of the vessel during fire fighting shall be in accordance with the approved operating manual.

- The vessel shall carry a sufficient quantity of fuel oil for continuous fire fighting operation with all fixed water monitors in use for a period not less than 24 hours for class notation I and 96 hours for class notation II or III.

- Foam-forming liquid for at least 30 minutes continuous foam production for the fixed foam monitors is stored on-board vessels with class notation III.

- Foam-forming liquid for at least 30 minutes continuous foam production by the mobile generator is stored in suitable containers on-board vessels with class notation II or III.

- The crew operating the fire fighting systems and equipment has been trained in such operations and in the use of air breathing apparatuses, and that the skill of the crew is maintained by exercises.

4.2.2 The above bases for the classification shall be stated in the "Appendix to Classification Certificates".

5. DESIGN OF FACILITIES

5.1 The following plans and particulars shall be prepared for approval:

- Manual for the operation of the fire fighting installation and the manoeuvering of the vessel during fire fighting.

- Arrangement and specification of adjustable floodlights for illumination when the vessel is operating in darkness.

- Location of the high pressure compressor for filling the cylinders of the air-breathing apparatuses.

- Location and arrangement of stations for fireman's outfit.

- Arrangement and location of the fire fighting pumps, their prime movers and the water monitors including, data for the monitors.

- Foundations for the fire fighting pumps, their prime movers and the water monitors.

- Arrangement and design of seawater inlets for the water monitor system.

- Fire fighting piping systems with specification of pump characteristics, water flow velocities and corrosion protection in the pipelines.

- System for remote control of the water monitors.

- Location of hose connections and hose stations for the mobile fire fighting equipment.

5.2 For Class Notation I Only

- Water-spraying piping system with location of the nozzles, pumps and valves etc., internal and external corrosion protection of the pipelines.

5.3 For Class Notation II or III

- Particulars of foam generator and containers for storing of foam-forming liquid.

5.4 For Class Notation III Only

- Arrangement of foam monitors incl. data for the monitors.
- Foundations for the foam monitors.
- Arrangement of foam concentrate tank, foam-mixing unit and piping to the monitors.
- System for remote control of the foam monitors.

5.5 The following calculations are to be prepared for approval:

- Calculation showing the point of balance between the reaction forces from the water monitors and the forces from the vessel's propulsion machinery and its side thrusters.

- Calculation proving satisfactory stability of the vessel when all monitors are in operation at full capacity in the most adverse direction for the stability.

- Report on inclining test determining the center of gravity and the light weight of the completed vessel.

6. CERTIFICATES

6.1 Certificates shall be required for the following components:

- Fire fighting pumps and their prime movers.

- Water monitors.

- Foam monitors.

- Compressor for filling the cylinders of the air-breathing apparatuses.

- Pipes and valves etc. for the fire fighting systems (material certificates as required for system covered by "main class").

- Spray nozzles for self-protection systems.

- Certificates shall be renewed annually after appropriate checking by concerned authorities.

7. SELF-PROTECTION OF THE VESSEL (CLASS NOTATION I)

7.1 Fixed Water-Spraying System

7.1.1 The vessel shall be protected by a permanently installed water-spraying system.

7.1.2 The fixed water-spraying system is to provide protection for all outside vertical areas of hull, superstructures and deck-houses including foundations for water monitors and other equipment.

7.1.3 The arrangement for the water-spraying system should be such that necessary visibility from the wheel-house and the control station for remote control of the fire fighting water monitors can be maintained during the water spraying.

7.1.4 The pipelines and nozzles shall be so arranged and protected that they will not be exposed to damage during the operations for which the vessel is intended.

7.1.5 The fixed water-spraying system should have a capacity not less than 10 liters per min. per m^2 of the areas to be protected. For areas internally insulated to class A-60, however, a capacity of 5 liters per min. per m^2 shall be accepted.

7.1.6 The pumping capacity for the fixed water-spraying system should be sufficient to deliver water at the required pressure for simultaneous operation of all nozzles in the total system. The pumps for the fire fighting water monitors shall also serve the spraying system, provided the pump capacity is increased by the capacity required for the water spraying system. A connection with shut-off valve is then to be fitted between the fire main for the monitors and the main pipeline for the water spraying system.

7.1.7 All pipes for the fixed water-spraying systems shall be protected against corrosion externally and internally by hot galvanizing or equivalent. Drainage plugs shall be fitted to avoid damages by freezing water.

7.1.8 The spray nozzles shall be able to give an effective and even distribution of water spray over the areas to be protected. The spray nozzles are subject to the I.P.I.'s approval for their purpose.

7.1.9 For safety and fire protection inside the vessels such as hydrants, hose stations, alarm systems, accommodation etc. see Appendix A.

7.2 Water Monitor System

7.2.1 Capacities

7.2.1.1 the requirements for the various class notations are given in Table 1.

TABLE 1 - WATER MONITOR SYSTEM CAPACITIES

GLASS NOTATION	I	II		III
No. OF MONITORS	2	3	4	4
CAP. OF EACH MONITOR IN m^3/h	1200	2400	1800	2400
No. OF PUMPS	1-2	2-4		2-4
TOTAL PUMP CAP. IN m^3/h	2400	7200		9600
LENGTH OF THROW IN m*	120	150		150
HEIGHT OF THROW IN m**	50	80		90
FUEL OIL CAPACITY IN HOURS ***	24	96		96

*** Measured horizontally from the mean impact area to the nearest part of the vessel when all monitors are in satisfactory operation simultaneously.**

**** Measured vertically from sea level to mean impact area at a horizontal distance at least 70 m from the nearest part of the vessel.**

***** Capacity for continuous operation of all monitors, to be included in the total capacity of the vessel's fuel oil tanks.**

7.2.1.2 For the class notation II and III an arrangement with less monitors than required in table 1 shall be considered as an equivalent solution. In such cases the total pump capacity shall be as required in Table 1, length of throw and height of throw are to be 180 m and 110 m, respectively.

7.3 Monitor Control

7.3.1 The activating and the manoeuvering of the monitors shall be remotely controllable. The remote control station should be arranged in a protected control room with a good general view.

The valve control is to be designed to avoid water hammer.

7.3.2 The control system should have redundancy type R2 as defined in Pt. 4, Ch. 1 of the DNV Regulations (lost function should be restored within 10 minutes).

7.3.3 Where an electrical control system is applied, each control unit should be provided with overload and short-circuit protection, giving selective disconnection of the circuit in case of failure.

Where a hydraulic or pneumatic control system is applied, the control power units shall be duplicated.

7.3.4 In addition to the remote control, local/manual control of each monitor should be arranged.

Guidance Note:

It is advisable that local/manual control devices to be automatically disconnected when remote operation is applied.

7.3.5 All shut-off and control equipment should be clearly marked.

7.4 Design and Support of Monitors

7.4.1 The monitors and their foundations shall be capable of withstanding the loads to which they are subjected on the open deck, dynamic loads resulting from the vessel's movement at sea, as well as the reaction forces from the water jet.

7.4.2 The monitors are to be able to give a solid water jet, so that the impact area will be concentrated and limited. The materials applied shall be selected with due regard to the corrosive properties of seawater and saline air.

8. FOAM SYSTEM

8.1 Foam Monitor System (Class Notation III)

- Arrangement of foam monitors including data for the monitors.
- Foundations for the foam monitors.
- Arrangement of foam concentrate tank, foam-mixing unit and piping to the monitors.
- System for remote control of the foam monitors.

8.1.1 Capacities

8.1.1.1 In addition to the water monitors, the vessel should be equipped with 2 foam monitors, each of a capacity not less than 5000 liters/min. with a foam expansion ratio of maximum 15 to 1.

8.1.1.2 The foam system, together with the arrangement and location of the monitors, should give a height of throw at least 50 m above sea level when both monitors are used simultaneously with maximum foam generation.

8.1.1.3 The foam concentrate tank should have capacity for at least 30 minutes of maximum foam generation from both foam monitors. When determining the necessary quantity of foam concentrate, the admixture is assumed to be 3%.

8.2 Foam Generating System

8.2.1 As far as applicable the requirements to appliances for fighting fires on open decks, given for the main class, shall be complied with.

8.2.2 The foam generating system shall be of a fixed type with separate foam concentrate tank, foam-mixing unit and pipelines to the monitors. The water supply to the system shall be taken from the main pumps for the water monitors. In such cases it may be necessary to reduce the main pump pressure to ensure correct water pressure for maximum foam generation.

8.3 Monitor Control

8.3.1 The foam monitors are to be remotely controllable. This also concerns the operation of the valves necessary for control of water and foam concentrate. The remote control of the foam monitors is to be arranged from the same control room as the control of the water monitors. Local/manual control of each monitor is also to be arranged.

8.3.2 All shut-off and remote control equipment shall be clearly marked.

8.4 Monitor Design

8.4.1 The foam monitors shall be of a design approved by the I.P.I.

9. PUMPS AND PIPING

9.1 General

9.1.1 The arrangement should be such that the water monitors will be able to deliver an even jet of water without pulsations of significance.

9.1.2 The requirements to pumping and piping systems given for systems covered by the main class, as well as the requirements to standard water extinguishing appliances and appliances for fire extinguishing on open decks given for the main class, shall be complied with as far as applicable to systems fighting fires outside the vessel.

9.2 Pumps

9.2.1 The pumps for the fire fighting system and the machinery driving the pumps shall be adequately protected, and shall be so located that they will be easily accessible during operation and maintenance.

9.2.2 The room where the driving units for the pumps are located is considered as a "machinery space", and should be protected against fire in accordance with the requirements for the main class.

9.3 Sea-water Inlets and Sea Chests

9.3.1 Sea-water suctions for fire fighting pumps shall not be arranged for other purposes. The sea-water suction valve, the pressure valve and the pump motor shall be operable from the same position. Valves with nominal diameter exceeding 450 mm shall be power actuated as well as manually operable.

9.3.2 Starting of fire fighting pumps when water inlet valves are closed should be prevented either by an interlock system or by an audible and visual alarm.

9.3.3 Sea-water inlets and sea chests shall be of a design ensuring an even and sufficient supply of water to the pumps. The location of the sea-water inlets and sea chests shall be such that the water supply is not impeded by the ship's motions or by the water flow to and from bow thrusters, side thrusters, azimuth thrusters or main propellers.

9.3.4 Strums shall be fitted to the sea chest openings in the shell plating. The total area of the strum holes shall be at least twice the total flow area in the sea-water inlet valves.

9.4 Piping Systems

9.4.1 The piping system from the pumps to the water monitors shall be separate from the piping system to the hose connections required for the mobile fire fighting equipment.

9.4.2 The piping systems should have arrangements to avoid over heating of the pumps at low delivery rates.

9.4.3 Suction lines shall be as short and straight as practicable. The maximum design of water velocity in the suction lines is normally not to exceed 2 m/s.

9.4.4 Piping between pumps and water monitors shall have a maximum design of water velocity normally not exceeding 4 m/s

9.4.5 The piping layout is to be in accordance with good marine practice with large radius bends, and is to be satisfactorily protected against damage.

10. MANOEUVERABILITY

10.1 The vessel shall be of sufficient size and should have side thrusters and propulsion machinery of sufficient power for adequate manoeuvrability during fire fighting operations.

10.2 Side thruster (s) and main propeller(s) shall be able to keep the vessel at a standstill in calm waters at all combinations of capacity and direction of throw of the water monitors, and the most unfavorable combination should not require more than 80% of the available propulsion force in any direction.

10.3 If the system design is such that, in any operating combination, it will be possible to overload the power supply, a power management system shall be arranged. This system should include alarm at 80% of available power and automatic action at 100% available power.

10.4 The operation of the side thruster(s) and the main propeller(s) should be simple and limited to the adjustment of:

- Resultant thrust vector for the vessel,
- Possible adjustment of the turning moment,
- Possible adjustment of heading (gyro stabilized).

11. FLOODLIGHTS AND SEARCH LIGHTS (FOG LIGHTS)

11.1 As an aid for operations in darkness at least two adjustable floodlights are to be fitted on-board, in clear air capable to give sufficient illumination of areas at a distance of 250 meters. The floodlights are to be of high pressure sodium vapor type or equivalent and flame and waterproof types with minimum IP-66.

12. STABILITY AND WATERTIGHT INTEGRITY

12.1 General Requirements

12.1.1 The vessel's stability shall be assessed when the water monitor(s) is (are) in the most unfavorable direction with respect to stability.

The monitor heeling moment shall be calculated based on the assumption in 12.1.2. The criterion in 12.1.3 shall be complied with (see Appendix B).

12.1.2 Monitor heeling moment

The heeling force "F" from the water monitor(s) shall be assumed in the transverse direction, based on full capacity as given in Table 1.

The monitor heeling arm "a" shall be taken as the vertical distance between the center of side thruster (s) and the centerline of the monitor(s).

12.1.3 Criterion

The monitor heeling lever (h), calculated as:

$$\mathbf{h = \frac{F \times a}{displacement}}$$

Where:

F = Force (Weight in kg)
a = Meter (distance)
displacement = weight (kg).

The heeling lever should not exceed 0.5 times the maximum GZ corresponding to maximum allowable Vertical Center of Gravity (VCG).

If the maximum GZ occurs after 30 degrees, the GZ at 30 degrees shall be used instead of the maximum GZ (see Appendices C and D).

Documentation

- Additional information in the stability manual on the monitor capacity, position, heeling force and moment as well as plotting the monitors heeling lever on the GZ diagram of the most unfavorable loading conditions is given in Classification Note No. 20.1 "Stability documentation Ships" of DNV Standards.

13. FIREMAN'S OUTFIT

13.1 Number and Extent of the Outfits

13.1.1 Vessels with class notation I shall have at least 4 sets of fireman's outfit.

13.1.2 Vessels with class notation II or III shall have at least 8 sets of fireman's outfit.

13.1.3 The extent of the outfits should be as specified for the main class. Each breathing apparatus is, however, to have a total air capacity of at least 1800 liters.

Personal equipment should comprise:

a) Protective clothing of material to protect the skin from the heat radiating, fire and burns and scalding by steam. The outer surface should be water-resistant.

b) Boots and gloves of rubber or other electrically nonconducting material.

c) A rigid helmet providing effective protection against impact.

d) An electric safety lamp (hand lantern) of an approved type with a minimum burning period of three hours.

e) An axe.

For further information see Appendix (A).

13.2 Location of the Outfits

13.2.1 The fireman's outfits should be placed in a separate fire station with access from the open deck. The entrance to the fire station should be clearly marked. The room should be arranged for ventilation and heating.

13.2.2 The arrangement of the fire station should be such that all equipment will be easily accessible and ready for immediate use.

Fittings should be provided for hanging up protective clothing and other equipment which should be stored in suspended position.

13.3 Compressed Air Supply

13.3.1 A high pressure compressor with accessories suitable for filling the cylinders of the breathing apparatuses, is to be installed on-board in the safest possible location. The capacity of the compressor shall be at least 75 liters per min. The air intake for the compressor shall be equipped with a filter. The required pressure for filling the cylinders shall be in accordance with IPS-M-SF-302.

14. INTERNATIONAL SHORE CONNECTION

14.1 Ships of 1000 tons gross tonnage and over are to be provided with at least one international shore connection complying with the requirements stated in sections 42 and 43 of DNV. Facilities are to be available enabling such a connection to be used on either side of the ship.

14.2 The international shore connection should have, on one side, a flange with dimensions as shown in the Fig. 1 and, on the other side, a coupling that will fit the ship's hydrants and hoses.

14.3 The international shore connection should be suitable for a nominal service pressure of 10 kgf/cm^2. The connection should be kept aboard together with:

- A gasket suitable for a nominal service pressure of 10 kgf/cm^2;
- Four bolts, 16 millimeters in diameter and 50 millimeters in length, together with nuts;
- Eight washers.

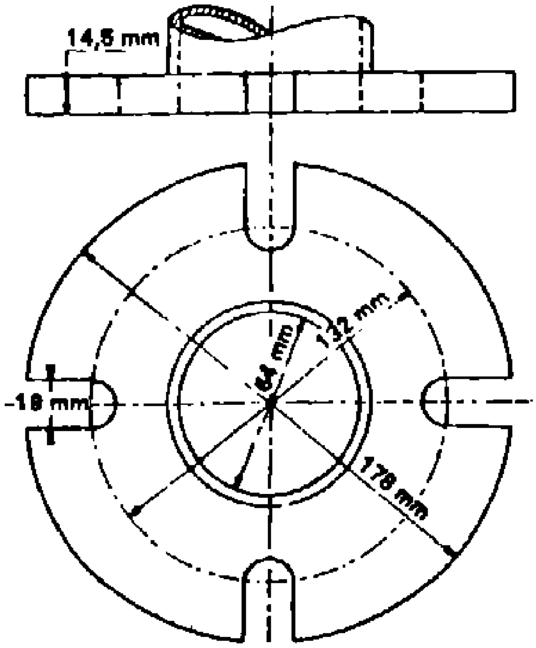


Fig. 1

15. SALVAGE SUCTION

Each vessel has its own by-pass connection from pump suction which should be used when an emergency case arise.

APPENDICES

APPENDIX A
HYDRANTS AND HOSE STATIONS

A.1 Arrangement

The outlets from the hydrants should have diameter of at least 50 mm.

Fire hoses should have lengths of not less than 10 m and should not exceed 15 m.

FIRE DETECTION AND ALARM SYSTEM

A.2 General

An approved automatic fire detection and alarm system should be installed for those parts of the interior of the vessel which are to comply with the requirements in this Appendix. The system should comply with the requirements given in Pt. 4 Ch. 6 Sec. 3 of DNV where applicable.

SIGNBOARDS

A.3 Signboards are Required as Follows:

- Emergency exit signs to be fitted.
- Shut-off and remote controlled manoeuvring equipment to be clearly marked.
- Precautions to be observed in case of fire, which should be posted in all cabins, public spaces and fire stations on-board.
- Marking of lockers and boxes for fire extinguishing systems on deck.
- Marking of boxes for dry chemical powder fire extinguishing system.

FIREMAN'S OUTFIT

A.4 General

A.4.1 Ships with the additional class notations F-A, F-M, F-C or FAMC should have at least 4 sets of fireman's outfit as specified in Pt. 4 Ch. 6 Sec. 2 of DNV.

A.4.2 Each of the breathing apparatus should be provided with cylinders (active and spare) for a total of at least 120 minutes continuous use based on a consumption of 60 liters/min.

A.4.3 A high pressure compressor suitable for filling of the cylinders for the breathing apparatus should be installed. The compressor shall be driven by a separate diesel engine or from the emergency power plant and should be placed in an easily accessible and safe place on-board.

(to be continued)

APPENDIX A (continue)

Guidance Note:

When considering the compressor location it should be kept in mind that, when a fire has broken out on-board, the compressor must be operable and that the air to be compressed must be sufficiently clean for breathing purposes.

A.4.4 The firemen's outfits should be divided between two fire stations placed at a safe distance from each other. The fire stations should be clearly marked and shall have access from the open deck.

A.4.5 The arrangement of the fire stations is to be such that all the equipment is easily accessible and ready for immediate use, and such that the equipment has its own place. There should be arrangements for hanging up protective clothing and other equipment which should be stored in a suspended position. All the shot-off and the remote controlled manoeuvring equipment are to be clearly marked.

Guidance Note:

The fire stations should also be used as a centralized location of the shut-off and remote controlled manoeuvring equipment required as one part of the fire protection. Furthermore, the fire stations should be used for storing of the extinguishing equipment and other safety equipment onboard.

A.5 Fire Protection

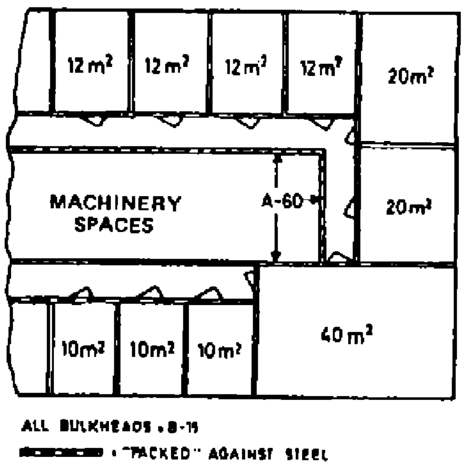
A.5.1 The purpose of the following requirements for fire technical sub-division of the accommodation is:

- To prevent a fire in any other part of the ship from spreading to the accommodation,

- To prevent a fire in the accommodation from spreading to other parts of the accommodation (within the time limits established for the concerned material's fire-technical class),

- To reduce the use of combustible material.

A.6 Fire Retarding



EXAMPLE OF FIRE RETARDING SUB-DIVISION
Fig. 2

(to be continued)

APPENDIX A (continue)

A.7 Ventilation

A.7.1 The ventilators for the accommodation should be arranged for automatic stop when the fire alarm is sounded Separate "test buttons" for testing of the alarm system without stopping the ventilators can be accepted.

A.7.2 Ventilation of the accommodation should be arranged so that a fire will not be supplied with air, and will not spread through the ventilation ducts.

A.8 Fire Extinguishing System

A.8.1 General

The accommodation is to be provided with a water extinguishing system consisting of fire hose reels permanently connected to a piping system under constant pressure, as specified in Pt. 4 Ch. 6 Sec. 4 of DNV.

Guidance Note:

The hose reels are to be the first means of fighting a fire which has broken out in the accommodation. When planning these systems it is important that the following conditions are considered:

- **That the hose reels are ready for immediate use without one having to start the fire pumps or carrying out other time consuming operations.**
- **That the hose reels are centrally located with regard to access, coverage area and effective fire fighting.**
- **That the hose reels are fitted so that the hoses will run out easily irrespective of the direction in which they are pulled.**

Heavy hose equipment will mainly be used to fight more extensive fires in the accommodation. When planning such systems it must be considered that the face of the fire should be fought from the outside. Hydrants and hose equipment should therefore be placed outside the doors leading into the accommodation.

A.9 Fireman's Outfit

The ship should be provided with fireman's outfit as described in A.4

A.10 Fire Detection and Alarm System

A.10.1 General

A.10.1.1 In all accommodation, service spaces and control stations there should be installed and approved automatic fire detection and alarm system in accordance with Pt. 4 Ch. 6 Sec. 3 of DNV.

In lieu of this an approved automatic sprinkler, fire detection and fire alarm system complying with Pt. 4 Ch. 6 D sec. 5 can be installed in the said spaces. In addition an approved smoke detection system should be provided in corridors, stairways and escape routes within accommodation spaces.

(to be continued)

APPENDIX A (continue)

A.10.1.2 Accommodation and service spaces which do not afford any substantial fire risk such as void spaces, sanitary spaces, etc. do not need to be fitted with a detection and alarm system.

A.11 Fire Instructions

A.11.1 Notice

Instructions regarding precautions to be observed in case of fire should be posted in all cabins, public spaces and fire stations on-board.

Guidance Note:

The instructions are supplied by the Marine Society.

A.12 Machinery Spaces

A.12.1 General

A.12.1.1 Access openings and skylights

All access openings for machinery space category A should be equipped with self-closing doors of steel. Windows in the casing are not permitted. Windows in boxes for valves, release handles etc. are not permitted, unless the box is completely enclosed in steel on the engine room side.

A.12.1.2 Emergency escape

Machinery spaces of category A are to have an enclosed emergency escape. The emergency escape is to provide a continuous fire shelter from the lower floor to the uppermost continuous deck. It should be insulated to class A-60 within machinery spaces and provided with a self-closing steel door at each level. The emergency escape should have a clear passage not less than 80 cm in diameter at all points.

The doors shall open outwards into the machinery space. A tunnel escape is considered to meet the requirements, provided the watertight door in the engine room bulkhead can be opened from the deck and from the tunnel and the machinery space sides.

Guidance Note:

The emergency escape is also intended to be a suitable access possibility in case of fire in the machinery space. The ladder in the emergency escape should be placed on a transverse bulkhead. Experience shows that smoke and heat is always heaviest in the upper part of the machinery space and that it is difficult to force a way through this part to gain access to and attack the fire source. The extinguishing systems, e.g. dry powder system, hand extinguishers as well as hose stations should therefore be placed close to the door leading into the machinery space.

(to be continued)

APPENDIX A (continue)

A.13 Fire Detection and Alarm System

A.13.1 General

The requirements in Pt. 6 Ch. 3 Sec. 6 B of DNV for ships with unattended machinery space are to be complied with.

The fire detection system is to be additional to the detection system required for the fire detection system.

Fire detectors of more than one type should be used. A suitable combination of smoke, flame or heat detectors to be arranged.

A.14 Electrical Equipment

A.14.1 Arrangement

The arrangement and location of any electrical equipment in machinery spaces should be such that the danger of fires (caused by an electrical fault or indirectly by an external non electrical fault) is reduced to minimum.

Electrical equipment is to be so designed and installed that the risk of fires caused by oil leakage is reduced to a minimum.

Any electrical equipment producing sparks in normal operation, and located closer than 3 m to fuel heated to above its flash point value, should be of certified safe type i.e. either flameproof (Ex."d"), intrinsically safe (Ex."i") or pressurized (Ex."p") according to IEC standard.

The maximum surface temperature should be 200°C. For electrical equipment not producing sparks in normal operation the maximum temperature of all external and internal parts to be 200°C.

For generators above 500 kVA rating and for all high voltage generators (>1000 V), protection should be provided against faults on the generator side of the circuitbreaker.

Guidance Note:

This may be accomplished by automatic de-excitation of generator, or automatic stop of the generator prime mover.

The fire resistancy of bunched electric cables installed in machinery spaces is to satisfy the following tests IEC Publ. 332-2 for Test on Electric Cables under Fire Conditions, Part 3:Test on bunched wires or cables.

A.15 Fire Pumps

A.15.1 Ordinary fire pumps

The fire pumps shall have a capacity as established in Pt. 4 Ch. 6 Sec. 4 . The arrangement should be such that the fire pumps throughout the fire main will be capable of maintaining a water pressure of 6 bar when two 19 mm nozzles are in action. The water pressure is not to exceed 8 bars, in order to facilitate efficient operation of each hose by one person.

(to be continued)

APPENDIX A (continue)

The total capacity of the fire pumps (excl. the emergency fire pump) need not exceed 300 m^3/hour. Fire pumps supplying water to a foam extinguishing system on deck are to comply with the requirements in Sec. 4 D.

One of the fire pumps in the engine room shall be used for fire purposes only.

A.15.2 Emergency fire pump

The emergency fire pump shall have a capacity as required in Pt. 4 Ch. 6 Sec. 4, but not less than 50 m^3/hour.

The emergency fire pump is to maintain a pressure of not less than 6 bar throughout the fire main with two 19 mm nozzles in action.

The power source for the emergency fire pump or the room in which this is located, should be arranged for heating.

Guidance Note:

The emergency fire pump is an alternative fire pump primarily to be used when a fire in the engine room prevents the use of the ordinary fire pumps. The emergency fire pump should be located outside the engine room and in a fire technical safe distance from it, normally in the forward part of the ship, but other locations may also be considered.

A.16 Main Extinguishing Systems

A.16.1 General

Machinery spaces of category A shall be protected by one of the following fixed extinguishing system:

- CO_2 total flooding system as described in A.16.2.

When the engine and boiler rooms are completely separated by steel bulkheads, the capacity of the main extinguishing system shall be based on the room with the largest volume.

Separate rooms in the machinery spaces should be included when calculating the capacity of the main extinguishing system and the system is to cover such rooms. The fixed main extinguishing system should be arranged so that it may be activated for each of these rooms separately without having to release the complete system.

A.16.2 CO_2 total flooding system

CO_2 total flooding system for the machinery spaces category A is to comply with Pt. 4 Ch. 6 Sec. 5.

The quantity of CO_2 gas should be sufficient for a minimum volume of 40% of the complete engine and boiler room, including casing.

Ships with CO_2 extinguishing system for both machinery spaces and cargo holds should have a total available quantity of CO_2 gas at least 50% greater than the quantity required for the largest of these rooms (see also Sec. 4).

(to be continued)

APPENDIX A (continue)

A.17 Hose Stations

A.17.1 General

The term hose station means a hydrant with hose complete with couplings as well as combined jet and water fog nozzle of approved type (see Pt. 4 Ch. 6 Sec. 4).

The hoses shall be of approved type and to be made completely of synthetic materials. The hoses shall be resistant to heat, oils and acids.

They should be wound on reels or placed on reels or in baskets in the immediate vicinity of the hydrants. The hose diameter shall be at least 50 mm.

Number and location

The hose stations in machinery spaces should be placed and arranged such that any part of these spaces can be reached simultaneously by spray from at least two combined jet and water fog nozzles, from one hose of not more than 15 m and another of not more than 30 m in length.

All boiler rooms should have at least two hose stations placed on the boiler room floor and as far from each other as possible.

In large engine rooms or engine rooms divided into sections, additional hose stations may be required.

A.18 Dry Powder Extinguishers

A.18.1 General

Dry powder extinguishers required in the following are subject to approval as specified in the Rules Pt. 4 Ch. 6 Sec. 6.

A.18.2 Number and location

At least the following number of approved dry powder extinguishers of 12 kg capacity should be placed in the engine room:

- 1 near each casing door
- 4 at the engine top floor
- 4 on the engine room bottom floor
- 1 near each auxiliary engine
- 1 near each boiler installation
- 1 in each separate workshop in the engine room.

Additionally there should be one approved portable dry powder extinguisher of at least 25 kg capacity. In vessels where the engine and boiler rooms are separated, at least one of the extinguishers should be placed in each compartment. The extinguisher should be fitted with an approved type of hose with a length of at least 15 m.

(to be continued)

APPENDIX A (continue)

Separate boiler rooms should be provided with at least 2 approved dry powder extinguishers for each boiler, each of minimum 12 kg capacity.

At least one spare charge of each extinguisher should be kept on-board.

Guidance Note :

The above-mentioned locations of the extinguishers is general, and efforts should be made to place these in the vicinity of the installations representing the greatest risk of fire. When installations are placed in separate rooms, the required extinguishers should be placed outside the doors leading into the rooms.

A.19 Fireman's Outfit

A.19.1 General

The ship should be provided with fireman's outfits as specified in A.4

APPENDIX B
FIRE FIGHTER "FI-FI I (or II or III)"

B.1 Additional Class Notation

Capability to fight fires by use of special fire fighting ships was recognized early as an important part of the total safety preparedness on offshore oil fields.

Apart from rough weather conditions, such ships will have to face large constructions of great heights consisting enclosed process modules, etc. Also the fire fighting itself with heavy water monitors causes visibility problems and the impact from the water jet may be harmful both to people and the platform construction.

The primary function for a fire fighter is to fight external fires, but the vessel will also be used for other purposes, like assisting during an evacuation of a platform. Therefore certain degree of self-protection is required as a fixed water spray system for the superstructure and deck houses.

There are special problems combined with the installation of the fire fighting equipment which must be taken into consideration. Great reaction forces from the monitors may give a conventional supply ship a speed of 5-8 knots. The need to keep the vessel in position (Fig. 2) consequently requires a positioning system.

The pumps feeding the water monitors and the dynamic positioning system are great power consuming units. Adequate attention must therefore be given by checking the power balance at different operational modes of the design of the power plant system. The efficiency of the monitors with respect to range and height (Fig. 3) must be sufficient for the actual platform, and the operator of the monitors must have good visibility.

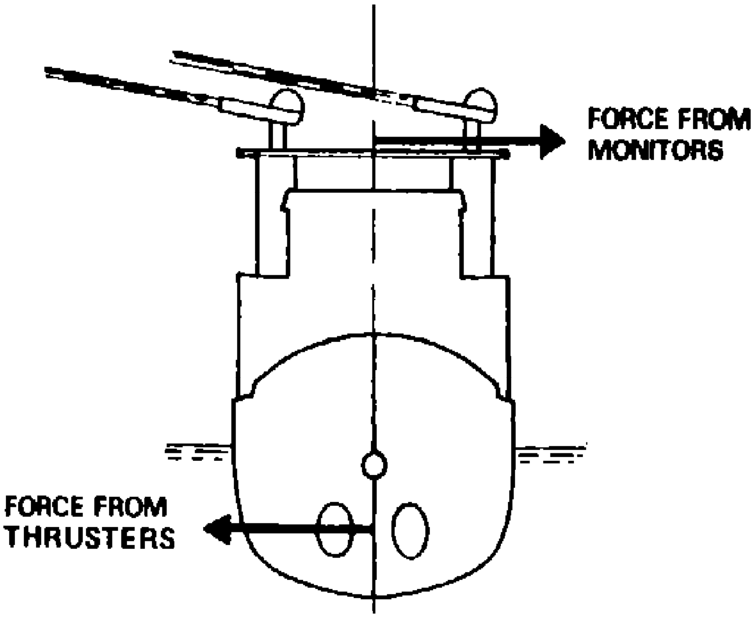
Det Norske Veritas has established a classification service based on a technical standard and rules for fire fighting vessels. The standard specifies requirements to the fire fighting equipment and the vessels itself.

The rules are defining two main class notations. "Fire Fighter I" is primarily intended for stand-by ships. These ships have also a rescue function and need to be protected against radiation by an external water spraying system. Two monitors shall be installed with a total capacity of at least 2400 m^3/h, giving a horizontal and vertical throw of minimum 120 and 45 meters respectively.

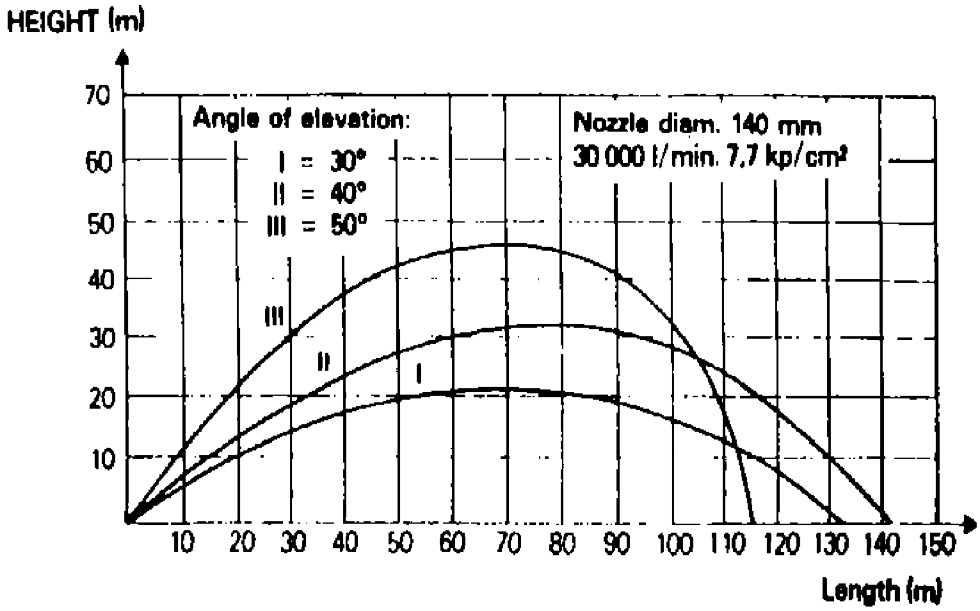
A "Fire Figher II"-ship should have 3 or 4 water monitors with a total capacity of at least 7200 m^3/h. The length of throw should be at least 150 meters, and the height 70 meters.

(to be continued)

APPENDIX B (continue)



FORCES ACTING ON A FIRE FIGHTING VESSEL
Fig. 2



LENGTH AND HEIGHT OF THROW OF TYPICAL MONITOR
Fig. 3

APPENDIX C
STABILITY AT LARGE ANGLES OF HEEL

This Appendix deals with the assessment of stability of large angles of heel, when the assumptions about the transverse metacenter used in Chapters 4 and 5 of DNV are no longer valid.

C.1 Objectives

a) To develop the form of the GZ curve as the vessel is heeled to any angle of heel.
b) To present the conditions of equilibrium as GZ curves.
c) To assess dynamical stability.
d) To assess the stability condition of a vessel with respect to Load Line Rules and Grain Rules.
e) To describe the effect of changes of form on the stability of a vessel.
f) To assess the effect of wind on the stability of container vessel.

C.2 Form of GZ Curves

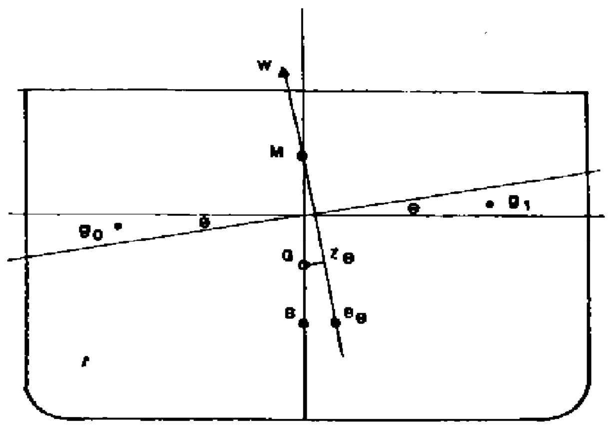
The stability condition of the vessel depended upon the sense of the couple formed by displacement acting through the center of gravity and buoyancy acting through the center of buoyancy.

Since the magnitude of the force of displacement is constant at all angles of heel, the size of the couple depends upon the arm of the couple, measured from the center of gravity G to a point Z on the vector through B. Therefore the measurement of the value of GZ at all angles of heel gives an indication of the stability of the vessel.

For a ship shape the values of GZ will have the following pattern for a stable vessel.

1. Fig. (4a)

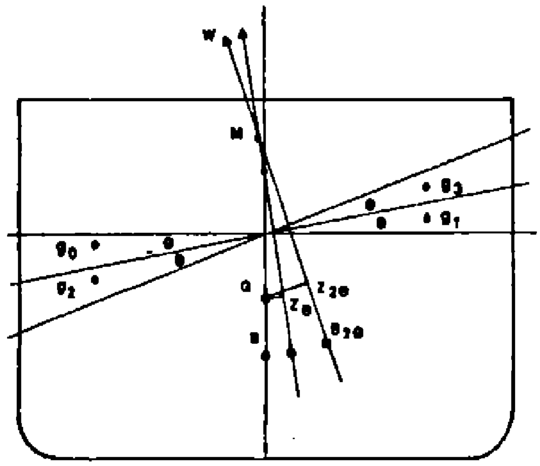
Suppose the vessel is heeled to some angle 1 then the center of buoyancy will move from Bo to Bθ as the result of shift of.



(a)

(to be continued)

APPENDIX C (continue)



(b)

INCREASE IN GZ UP TO ANGLE OF DECK EDGE IMMERSION
Fig. 4

buoyancy from go to g1. Now if the vessel is heeled through a further angle θ_2 (θ_1=θ_2) (Fig. 4b), then provided the deck edge is not immersed, or the bilge emersed, it can be seen that a larger volume of buoyancy will move from g_2 to g_3 and that $g_2g_3>g_og_1$. Hence the shift of the center of buoyancy $BB_\theta>B_\theta B_{2\theta}$. Hence the value of GZ will be increasing and increasing more rapidly as the vessel is heeled.

Note that if $BB_\theta>B_\theta B_{2\theta}$ then the meta-center M can no longer be a fixed point on the centerline.

The value of GZ will continue to increase until either the deck edge is immersed or the bilge is emersed.

2. Fig. 5

When the deck edge is immersed the condition will change.

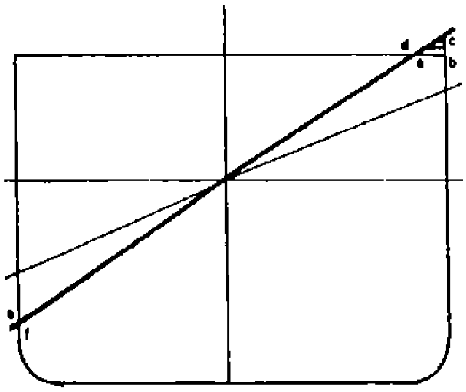
It is no longer possible to assume that the buoyancy is transferred equally from one side of the centerline to the other. The condition that underwater volume is constant must be maintained. Hence the emersed volume of buoyancy must equal the immersed volume of buoyancy.

Note if the waterlines are drawn so as to intersect at the centerline, then a volume represented by a.b.c must be replaced by the vessel 'sinking' until a layer of buoyancy a.d.e.f. is immersed. Clearly the centroid of this layer is on the emersed side of the centerline. Hence the shift of buoyancy is reduced. The rate of increase of GZ will be reduced.

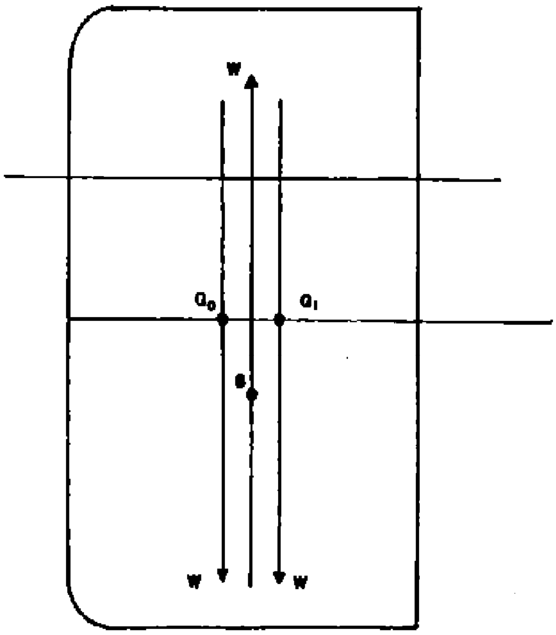
(to be continued)

APPENDIX C (continue)

After deck edge immersion it becomes difficult to describe the



EFFECT OF DECK EDGE IMMERSION
Fig. 5



STABILITY AT 90°
Fig. 6

behavior of GZ, particularly as the bilge emerges. However, if we consider the extreme case of the vessel at 90° heel then the sense of the theoretical couple depends upon the relative positions of G and B (assuming G has not moved), i.e. if in Fig. 6 the center of gravity is at G_0 the vessel is stable at 90° while if it is at G_1 the vessel is unstable.

If this pattern of movement of B relative to G is plotted as values of GZ against angle of heel a typical curve of statical stability (GZ curve) is obtained. (Figs. 7 and 8.)

(to be continued)

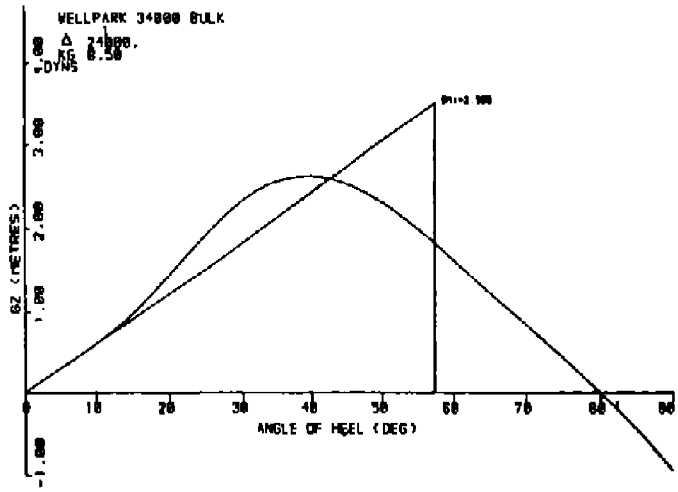
APPENDIX C (continue)

C.3 Features of GZ Curves

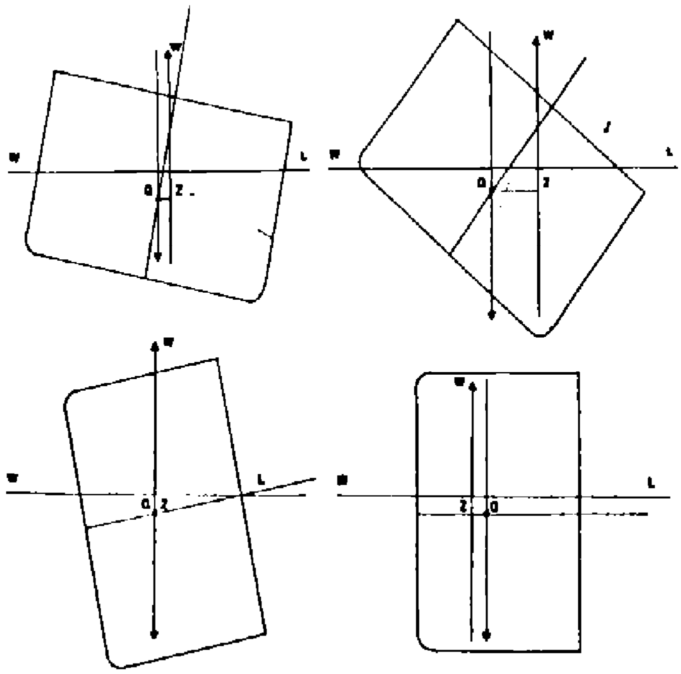
C.3.1 Initial slope and GM

A knowledge of the initial GM can be used to determine the slope of the origin of GZ curve.

In Fig. 9 AD is a line drawn as a tangent to the origin of the GZ curve. AD cuts an ordinate DE erected at 57.3° heel. BC is drawn close to the origin at angle θ.



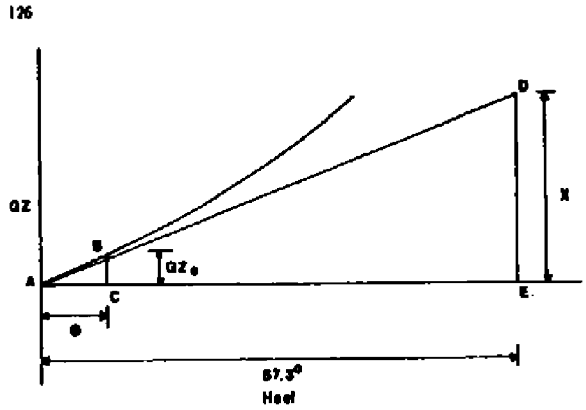
GZ CURVE OF A TYPICAL STABLE VESSEL
Fig. 7



CHANGE IN GZ WITH HEEL
Fig. 8

(to be continued)

APPENDIX C (continue)



RELATIONSHIP BETWEEN GM AND GZ CURVE
Fig. 9

Triangle ABC is similar to triangle ADE

$$\frac{DE}{AE} = \frac{BC}{AC}$$

$$\frac{DE}{57.3} = \frac{GZ\theta}{\theta}$$

Now if θ is small

$GZ = GM \sin\theta$

and $\sin\theta$ θ (θ measured in radians)

and 57.3° = 1 radian

$$\frac{DE}{1} = \frac{GM\theta_c}{\theta_c}$$

DE = GM

Thus if an ordinate equal to GM is erected at 57.3° and a line drawn to the origin then slope of this line indicates the initial slope of the GZ curve.

Deck edge immersion is indicated by the point of flexure of the curve, although the exact point of flexure will depend upon sheer and position of superstructure.

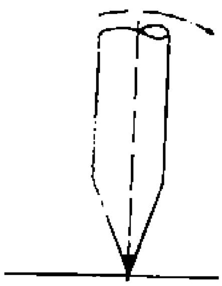
Maximum GZ and the angle at which it occurs can be found by inspection. The range of stability can also be found by inspection.

It must be emphasized that only the early part of the curve up to say 40° heel can be regarded as giving a reasonable representation of the actual GZ value.

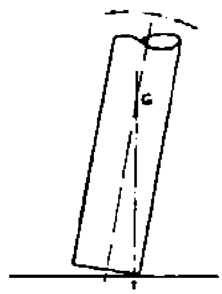
APPENDIX D
STABILITY OF SHIPS

Statical stability is a measure of the tendency of a ship to return to the upright if inclined by an external force.

In theory it is possible to balance a pencil on its point on a flat surface. The pencil will be balanced if its center of gravity is vertically above its point. In practice this is found to be impossible to achieve. It is, however, possible to balance the pencil on its flat end, since, if the pencil is very slightly inclined, the center of gravity may still lie within the limits of the base and the pencil will tend to return to the upright. Fig. 10 is exaggerated to show this.



UNSTABLE

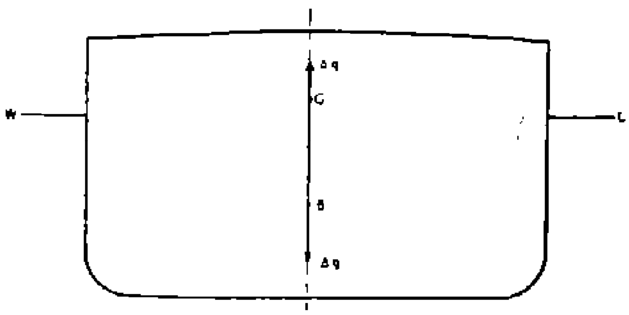


STABLE

Fig. 10

The only times a ship may be assumed to be stationary and upright are before launching and when in dry dock. Thus it is essential to consider practical conditions and to assume that a ship is always moving. If the vessel is stated to be upright it should be regarded as rolling slightly about the upright position.

In the upright position (Fig. 11) the weight of the ship acts vertically down through the center of gravity G, while the upthrust acts through the center of buoyancy B. Since the weight is equal to the upthrust, and the center of gravity and the center of buoyancy are in the same vertical line, the ship is in equilibrium.



EQUILIBRIUM
Fig. 11

When the ship is inclined by an external force to an angle θ, the center of gravity remains in the same position but the center of buoyancy moves from B to B_1 (Fig. 12).

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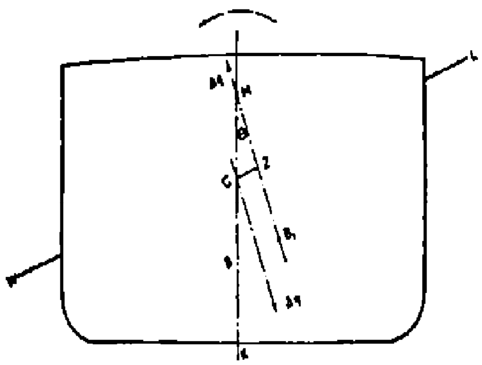
APPENDIX D (continue)



STABLE
Fig. 12

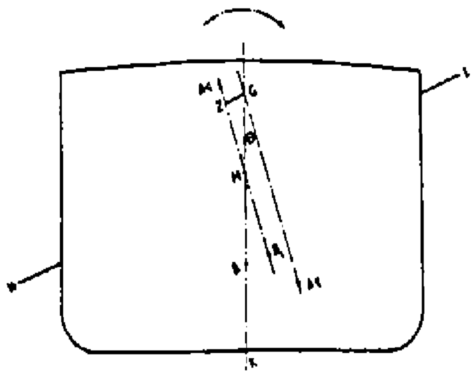
The buoyancy, therefore, acts up through B_1 while the weight still acts down through G, creating a moment of $g \times GZ$ which tends to return the ship to the upright. $g \times GZ$ is known as the righting moment and GZ the righting lever. Since this moment tends to right the ship the vessel is said to be stable.

For small angles of heel, up to about 10°, the vertical through the new center of buoyancy B_1 intersects the centerline at M the transverse metacenter. It may be seen from Fig. 12 that:

$$GZ = GM \sin\theta$$

Thus for small angles of heel GZ is a function of GM, and since GM is independent of θ, While GZ depends upon θ, it is useful to express the initial stability of a ship in terms of GM, the metacentric height. GM is said to be positive when G lies below M and the vessel is stable. A ship with a small metacentric height will have a small righting lever at any angle and will roll easily. The ship is then said to be tender. A ship with a large meta-centric height will have a large righting lever at any angle and will have a considerable resistance to rolling. The ship is then said to be stiff. A stiff ship will be very uncomfortable, having a very small rolling period and in extreme cases may result in structural damage.

If the center of gravity lies above the transverse metacenter (Fig. 13), the moment acts in the opposite direction, increasing the angle of heel. The vessel is then unstable and will not return to the upright, the meta-centric height being regarded as negative.

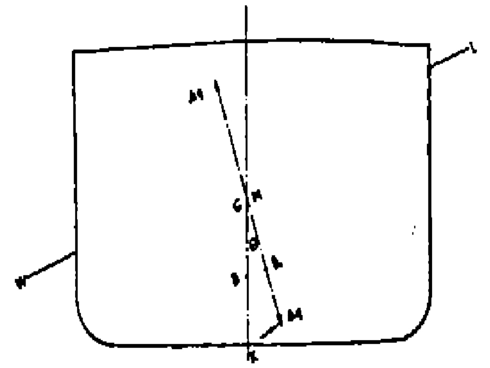


UNSTABLE
Fig. 13

(to be continued)

APPENDIX D (continue)

When the center of gravity and transverse metacentric coincide (Fig. 14), there is no moment acting on the ship which will therefore remain inclined to angle θ. The vessel is then said to be in neutral equilibrium.



NEUTRAL EQUILIBRIUM
Fig. 14

Since any reduction in the height of G will make the ship stable, and any rise in G will make the ship unstable, this condition is regarded as the point at which a ship becomes either stable or unstable.

To find the position of M

The distance of the transverse metacenter above the keel (KM) is given by KM = KB+BM.

KB is the distance of the center of buoyancy above the keel and may be found by one of the methods shown previously.

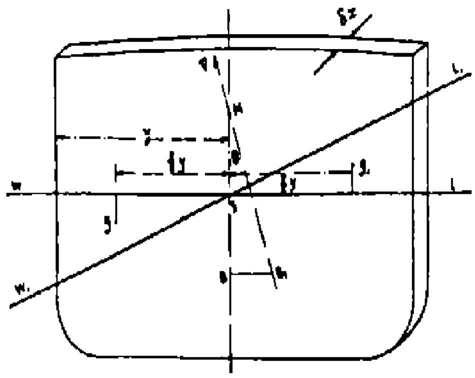


Fig. 15