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Passenger ship stability and fire safety

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PASSENGER SHIP STABILITY AND FIRE SAFETY

BY

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The contents of this paper reflect my own personal views and are not necessarily endorsed by the UNIVERSITY

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- Abstract -

When I started writing my project about Chapter I, II-i and II-2 of SOLAS 74 as amended, I was confused about what to mention and discuss in my thesis due to the extent and the difficulties of the chapters.
Finally I confined myself to the provisions concerning surveys to which passenger ships are subject.

The project describes the minimum knowledge which a surveyor should have in order to carry out the surveys specified in the international provisions and regulations.

This paper is an attempt to produce a booklet for surveyors. I have to remind the reader that this work is limited to Chapter I, II-1, II-2 with the hope that this booklet will be completed by the future MSA students of the World Maritime Univeristy.

CHAPTER I

Introduction

Any ships trading internationally should fulfill obligations related to international formalities. When this point is clearly fulfilled by the shipowner, certificates called "Statutory Certificates" are issued by the Administration whose flag the ship is entitled to fly or by a recognized class society or another country party to the convention if requested.

Those certificates are :

- *The Passenger Ship Safety Certificate*
- *The Cargo Ship Safety Construction Certificate*
- *The Cargo Ship Safety Equipment Certificate*
- *The Cargo Ship Safety Radio Telegraphy Certificate*
- *The Cargo Ship Safety Radiotelephony Certificate*
- *Load Line Certificate*
- *Marpol Certificate*
- *Tonnage Measurement Certificate*

The Passenger Ship Safety Certificate is issued for a period of one year for a passenger ship complying with the relevant conventions and provisions. This certificate covers the Safety Equipment Certificate, the Safety Construction Certificate, the Safety Radio Telephony Certificate and the Safety Radio Telegraphy Certificate.

The cargo ship safety construction certificate is issued to all cargo ships of 500 GRT and over after inspection of the hull, the machinery and their auxiliaries, the electronic equipment, the structural fire protection other than that relating to fire-extinguishing appliances and fire control plans. This certificate is issued for a period of validity of 5 years. For renewal the following points are inspected:

1) *The Hull*

The hull plating and sternframe, opening up of all sea valves and cocks including sanitary valves and upper valves, anchoring and mooring equipment, watertight doors in watertight bulkheads, weather deck, closing appliances etc.

2) *Machinery and electrical equipment*,

Propulsion system, auxiliary machinery, boiler, emergency escape routes etc. Electrical system: (The insulation resistance at the complete installation, main switchboard, generators, electrical motors for essential and important use etc.) Emergency source of power etc.

3) *The Cargo Ship Safety Equipment Certificate (SEC)*

The cargo ship safety equipment certificate (SEC) shall be issued after inspection to a cargo ship of 500 GRT and over, which complies with the requirements of Solas concerning:

3.1 *The life saving appliances* .

Life boats and their equipment, launching and embarkation arrangements, inflatable or rigid liferafts and their storage, davits and launching arrangement, stowage of lifebuoys, lifejackets and their stowage, muster list and emergency instructions, muster equipment and signals, lighting for decks, lifeboats, liferafts etc.

3.2 *The fire-fighting equipment*

Rockets and signals, fire pipes and hydrants, fire hoses and nozzles, international shore connection, portable fire extinguishers in accommodation and service spaces, means for stopping machinery and for shutting off oil fuel suction pipes, patrols and fire alarm, fire detection system etc.

3.3 The safety of navigation

Gyro compass, echo-sounding device, auto-pilot, steering gear, navigation lights (according to the revised COLREG, 1972), signalling apparatus: The SEC is valid for a period of 24 months. (Will be changed to 5 years on 1 February 1992 under the harmonized system survey.)

4) The cargo ship safety radiotelegraphy and/or radiotelephony certificates shall be issued after inspection to a cargo ship fitted with radiotelegraph installation and/or radiotelephone installation, which complies with the requirement of Chapter IV and any other relevant requirements of the present regulations. In the future the requirements of the GMDSS will be included.

4.1 Cargo ships of 1600 GRT must hold a cargo ship safety radiotelegraphy certificate.

4.2 Cargo ships of 300 gt and upwards but less than 1600 gt shall have a radiotelephony certificate unless provided with a radiotelegraphy certificate.

The radiotelephony certificate and the radiotelegraphy certificate are valid for a period of 12 months. (Will be changed to 5 years under the harmonized system on survey on 1 February 1992.)

Exemption certificate

When an exemption is granted to a ship a certificate called an exemption certificate shall be issued in addition to the "Statutory certificate listed above. The period of validity shall not exceed the normal validity of the corresponding certificate. The exemption certificates shall be issued either by the Administration or by any person or organization duly authorized by it. In every case the Administration assumes full responsibility for the certificate and must satisfy itself that adequate measures are taken to ensure the safety of the ship and its crew.

Remarks on duration and validity of certificates Reg.14 Chapter I

No extension of the five-year period of validity of the cargo ship safety construction certificate shall be permitted. This will be changed under the harmonized system on survey so that extension will be permitted. The Administration may extend the certificate, for the purpose of allowing the ship to complete its voyage to the state whose flag it is entitled to fly or where it is to be surveyed and only in the case that the ship can operate without any harm to the crew and for the ship itself. The period of such extension shall not exceed five months.

National rules

National rules are based on SOLAS regulations. Except in the cases where the standard in the IMO text is not detailed enough to be used for design and construction. In such cases the Administration has to produce the detailed standard, or if it is not possible to do so , to recognize the standard produced by a recognized classification society.

In any case, the Administration is totally responsible and should assume regarding the safety level that the standard in question covers all safety aspects. In this case a certificate or documents are used to verify that standards related to "design and construction" are met. The Administration can establish an extra set of rules when needed for instance:

- *module offshore drilling unit code*
- *rules for ships navigating to and from certain ports*

National rules can be with an international impact such as:

- *Suez and Panama canal rules*
- *St. Lawrence Seaway Regulations*
- *Various US Coast Guard Regulations*
- *Finnish-Swedish ice class rules*

These rules, even though national, should be respected and the foreign ships visiting such places should not only comply with SOLAS rules but also with the aforesaid national rules.

CHAPTER II

Introduction

Among the certificates I have just mentioned I have decided to write my project on "The passenger ship safety certificate". My project will be limited to chapter I, II-1 and II-2 of SOLAS 74 as amended. I will not treat chapters III-IV which deal with "Life saving appliances and arrangements", "Radiotelegraphy and radiotelephony" and chaptersV - VIII

The Passenger Ship Safety Certificate

1.1 The notation of "Passenger ship" is affixed to a ship which carries more than twelve passengers.

1.2 A passenger vessel is built according to the area in which she will trade (e.g. shallow water) in no case will there be any extention in navigation notation even if the strength of the hull is sufficient for a wider range of service. If so, this may be expressed in the certificate by adding the following note: "The strength of the hull structural elements complies with the navigation notation".

1.3 In addition to the Passenger ship safety certificate when the ship is employed in special trade, such as the pilgrim trade, a certificate called "a special trade passenger ship safety certificate" can be issued after satisfactory survey to a ship complying with the STP 1971 rules. The same applies for "The special trade ship space certificate", when the ship is complying with the space STP 1973 rules.

The two above-mentioned certificates shall be issued in addition to the "Passenger ship safety certificate" and "The exemption certificate".

Objectives:
The main objectives are to constitute common general rules applicable to the construction and life saving appliances of ships in the pilgrim trade, where such ships are exempted from certain requirements in SOLAS chapter II-1, II-2 and III.

2. *The rules concerning passenger ships are more strict than those for cargo ships as the former is supposed to carry passengers and it comes also from the fact that very important accidents in the beginning of this century occurred such as the Titanic disaster in 1912 (1430 loss of lives) and in 1914 the Empress of Ireland (1024 loss of lives). This obliged man to think more about the safety of life at sea and to improve its standards. Consequently international conferences of responsible government agencies and ship designers began to formulate rigourous international rules in order to have stronger and safer ships.*

3. *According to the historical point of view the first change in the building of "wooden ships" was to introduce the collision bulkhead. Even if it was not recognized that it was impossible to achieve absolute watertightness such bulkhead, however, proved itself to be a valuable safety feature.*

   Secondly, with the advent of iron and steam, the machinery and boilers were not so reliable. Then the isolation of the machinery spaces from the cargo spaces by means of bulkheads became not only a recommendation but an obvious choice.

   The last point was to achieve watertightness where the propeller shaft leaves the ship. Another bulkhead was then needed which explains the fourth bulkhead born out of necessity rather than regulations. However, the last bulkhead, nowadays called the Aft Peak bulkhead ,can be the aft machinery bulkhead when the machinery space is placed at the aft end of the ship.

The effort to increase the safety did not stop here. The first recommendations stipulated that all ships should be able to remain afloat with one compartment flooded and that passenger ships should be able to remain afloat with two adjacent compartments flooded. In 1882 LRS introduced a "class requirement" that all ships of 85 m in length and above should have an additional bulkhead every 21 m.

i.e. *85 m - 4 bulkheads*
106 m - 5 "
128 m - 6 "

A lot of propositions and recommendations from class society committees were established concerning cargo and passenger ships, but no direct action to follow these recommendations was taken until SOLAS 29 and 48 and later the SOLAS 60 of IMO.
Interest became international and the best solution to prevent a ship sinking and how to limit the flooding became the priority. It was a matter of great concern and the solution was a recommendation on the sub-division standard . After the tragedy of the Titanic , which was built as an unsinkable ship, it was proved that there was much to do and the sub-division standards were not sufficient.

After the report on the accident it was decided to limit the floodable length as defined (in Reg. II-1/4) as the length of the compartment whose mid-length is at the point under consideration which can be flooded up to the margin line which is situated at least 76 mm below the bulkhead deck and at which point the ship can stay afloat. See figure. 1

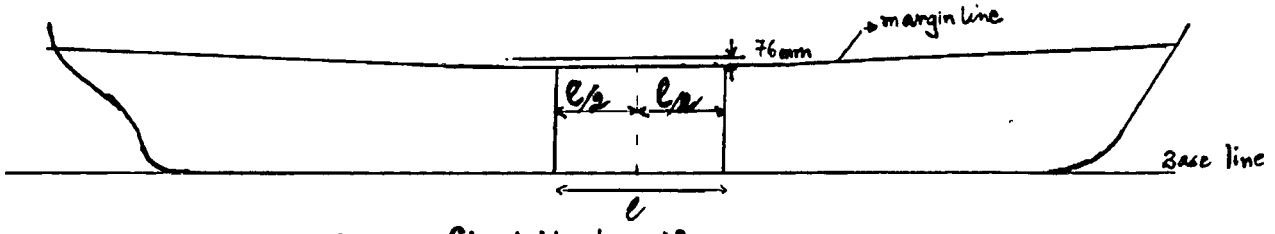
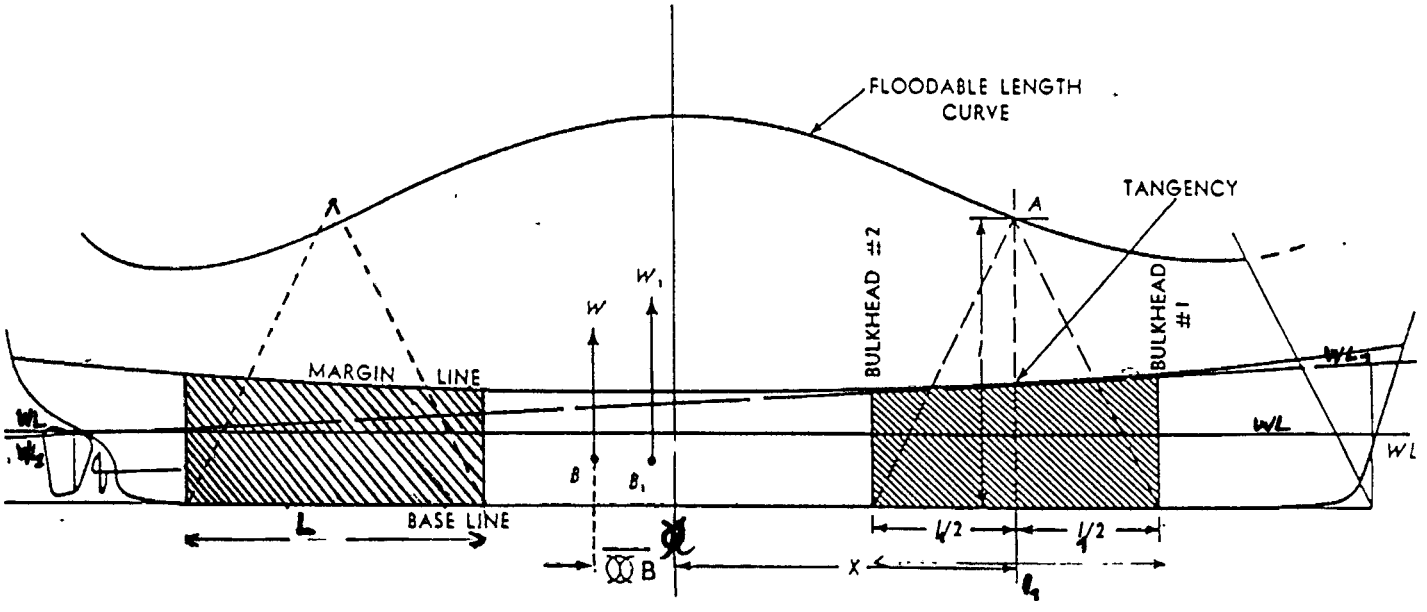


fig.1. Floodable length.

Floodable length's curve: This is not more not less than a curve representing at selected points the specific value of the floodable length calculated along the ship's length.



l_1 - *The compartment's length is acceptable*

L - *The compartment is too long because the top triangle is over the floodable length curve.*

The permissible length (Reg. II-1/6)

The permissible length is obtained by multiplying the floodable length by a factor of subdivision which is dependent on the ship's length and function; if the required factor of subdivision is 0,5 or less the combined length of any two adjacent main compartments is not permitted to exceed the floodable length. fig 3.

A compartment may exceed the permissible length if the combined length of two adjacent compartments to which the compartment in question is common does not exceed the floodable length or twice the permissible length, whichever is the less. Where two adjacent compartments have different required factors of subdivision, then the combined length shall not exceed twice the proportionately adjusted permissible length.

Permeability (Reg. II-1/3.7)

This is expressed in percentage of the volume of a space which can be flooded with water. In practise it is a determinant factor of the floodable length because before the effects of flooding can be calculated definite values for the permeability of the space involved must be assumed.

It is assumed for passenger and crew spaces that 95% of its volume could be taken up by sea water allowing only 5% for the structure thickness and passenger furniture and for

- *Machinery spaces, it is assumed that 85% of the space might be flooded*
- *Cargo and store spaces 60 %;*
- *Tanks including double bottom tanks 0 or 95% **

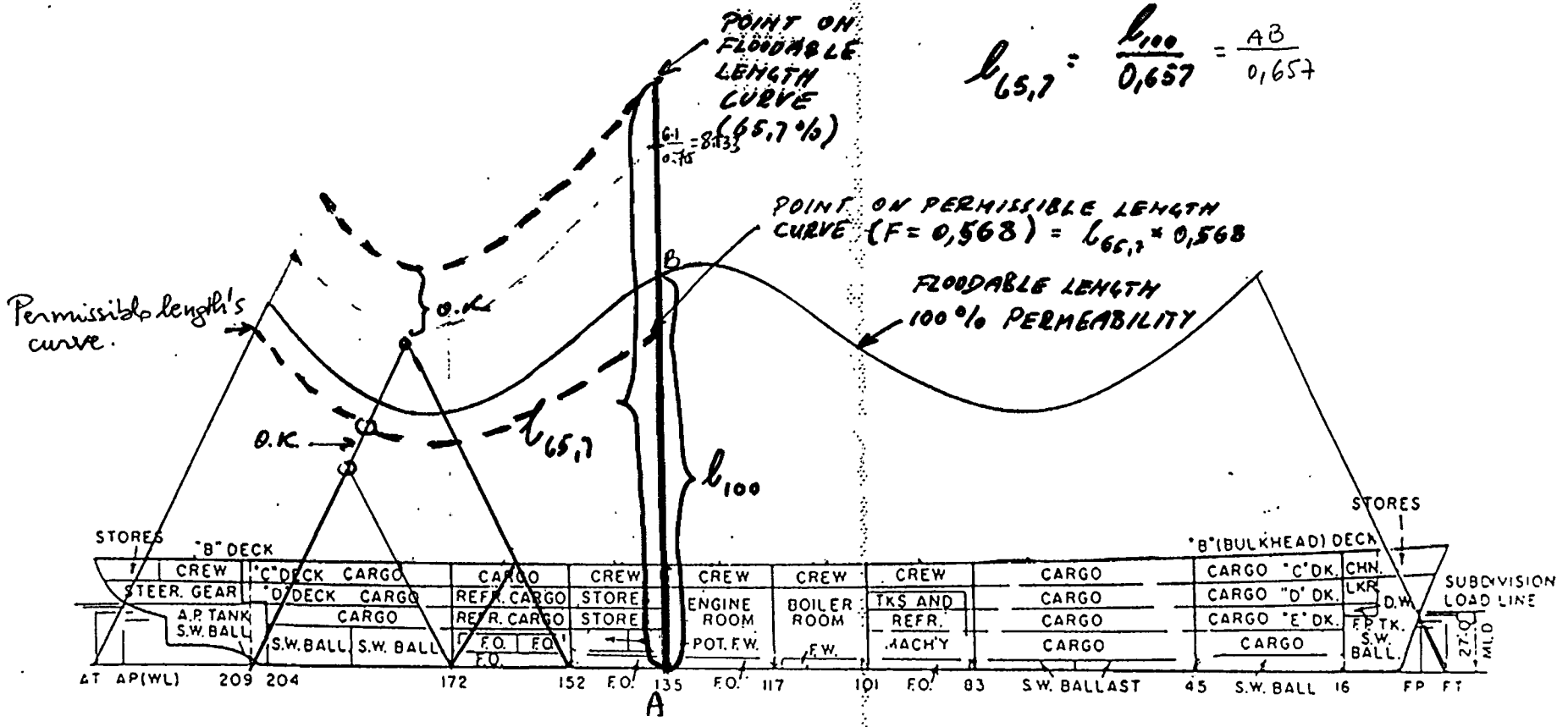


fig. 3 - Permissible length's Curve

* *Between those two values the value which result in more severe requirements is to be used, so approval should be made in each case.*

Criterion of service numeral CSN (Reg II-1/6.3)

In order to interpolate between the two extreme types of ships, passenger and cargo ships, it is required the determination of a criterion of service numeral which is a function of the volumes of the machinery spaces and passenger spaces below the bulkhead deck. Why do two points become so important in the determination of the CSN ? Firstly because cargo space was surrendered in order to provide more passenger space and secondly because as an economic necessity and attraction the machinery size was increased to raise the speed resulting in more space having to be made available to house the machines.

$$CSN = CS = K\,(M/V + P/V)$$

M = Machinery space volume + volume of any permanent oil fuel bunkers which may be situated above the inner bottom and forward of or abaft the machinery space.

V = Total ship volume measured below the margin line.

P = Total passenger volume space below the margin line.

To avoid a ship being designed with all passenger accommodation above the bulkhead deck in order to meet the minimum subdivision requirements below the bulkhead deck or to install them into restricted volumes below the margin line, it was agreed for an average volume allocated to a passenger taking into account the number of passengers carried and the space they occupy.

$P_1 = KN$ $K=0,056L$

L=length of the ship

N=number of passenger for which the ship is to be certified.

$P_1 = 0,056\ LN$

$P_1 = KN$ *is a standard volume for one passenger checked during the Plan Approval Process. (The larger the ship the greater the standard per passenger.) The higher value is to be used.*

This is only an approach. A further refinement to this approach is to allow P + actual passenger volume above the bulkhead deck to be used for P_1 *if this is less than 0,056 LN provided that the figure is never less than 2/3 0,056 LN = 0,04 LN.*

If P_1 *is greater than P: (Reg II-1/6.3.2)*

The $CSN=72\ (M+2P_1)/(V+P_1-P)$ *(k was selected to be 72)*

and in other cases: $C_S= 72\ (M/V+2\ P/V)$ *See figure. 4*

The relation between number of passengers carried and length of a ship related to the Cs when it is 23 or 123. In principle a CSN or CS of 23 correponds to a vessel engaged primarily in carrying cargo with accommodation for a small number of passengers while a numeral of 123 is intended to apply to a vessel engaged solely or very nearly so, in the carriage of passengers.

Factor of subdivision

Ships having a criterion numeral of 123 shall be governed by a factor of subdivision F=B given in the curve according to the length of the ships. Ships having a criterion of 23 are governed by a factor of subdivision F= A. See figure. 5

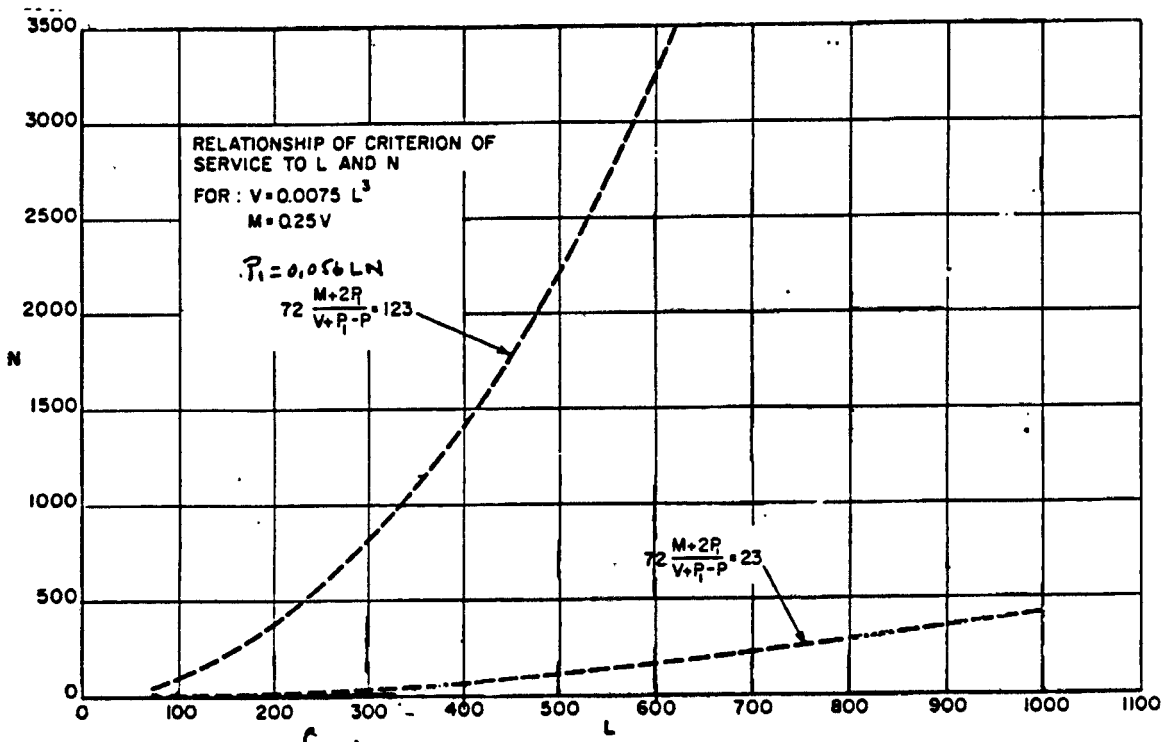


fig 4 - Criterion of service versus L and N

The curve B is obtained by the equation curve B;

$$F = B = (30,3/L-42) + 0,18\,m$$

The curve A by:

$$A = (58,2/L-60) + 0,18\,m$$

when CSN = C_S , the curve, is between 23 and 123 by : (Reg. II-1/4.1).

$F=A-(A-B)\ (C_S-23)/100$

See figure No.: 5

The factor of subdivision can also be calculated in accordance with formula relating to the type of the ship and length. (Reg. II-1/4.3.)

For passenger ships where CSN = Cs=123
when L=131 m and upwards F = B = (30,3/L-42) + 0,18

when $79 \leqslant L \leqslant 131$ *m*

$C_S = S = (3574-25L)/13 => F = 1$

when $S < Cs < 123$ *(Reg. 6.4.3) the factor F is obtained by linear interpolation between unity and factor B using the formula*

$$F = 1 - \frac{(1-B)\ Cs-S)}{123 - S}$$

For ships when the number of passengers is $12 < N < L^2/650$ *or 50*
=> F = 1 applies to ships of whatever length.

In the event that a passenger ship carries persons in excess of the lifeboat capacity she should comply with higher standard of subdivison (F is 0,50 or less). (Reg.6.5.)

L(m) => BB = (17,6/L-33) + 0,20

According to the aforesaid calculations the subdivision factor "F" varies from 1 to 0,33.(Reg.8)

If F = 1 => One compartment can be flooded and the ship remains afloat (one compartment ship).

F = 0,5 => Two compartments can be flooded (two compartments ship).

F = 0,33 => Three compartments can be flooded.

Now knowing the ship's length, the floodable length and the factor of subdivision we can easily draw our compartment with the appropriate dimensions without exceeding the measures allowed in the provisions.

WATERTIGHT SUBDIVISION AND STABILITY IN FLOODED CONDITION

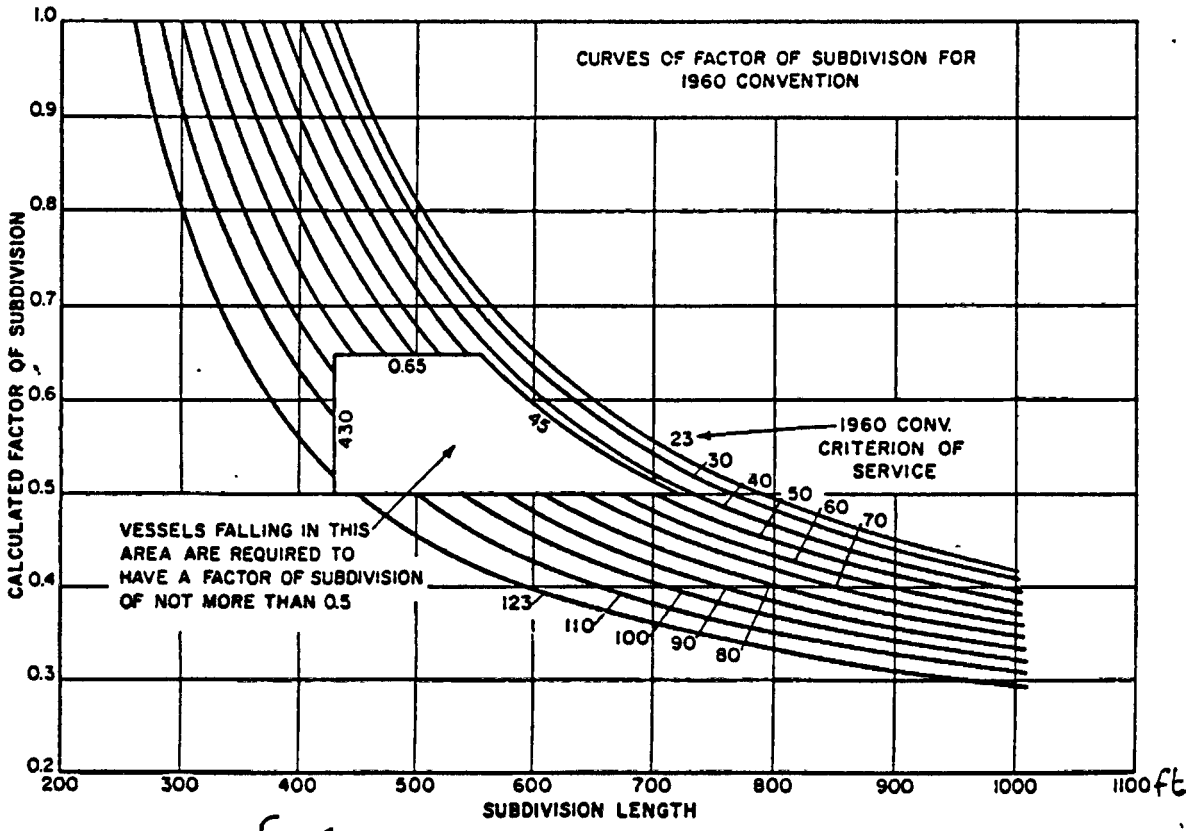


fig.5 Factor of subdivision, 1960 Convention

MARPOL 73/78

The ship should be built to an acceptable standard from the marine pollution prevention point of view. (Necessary separating and filtering equipment systems shall be installed. Carrying water ballast in oil tanks shall be avoided etc.) The flag state whose flag the ship is entitled to fly shall ensure that the structure equipment systems and the filtering arrangements are in all respects satisfactory and that the ship complies with the applicable requirements of Annex I of the Marpol Convention.

Double Bottoms (Reg. II-1/12)

In passenger ships a double bottom shall be fitted extending from the forepeak bulkhead to the after peak bulkhead as far as this is in accordance with the proper working and design of the ship. We can see three distinctions in fitting a double bottom according to the ship's length:

50 < L < 61 => A double bottom shall be fitted forward of the machinery space to the forepeak and additionally one abaft the machinery to the aft peak bulkhead space when the length is 61 < L < 76 m.

The last point when L > 76 m. The double bottom shall be fitted amidships and shall extend to the fore- and after peak bulkhead.

- *The double bottom height shall comply with the provisions of the Administration.*

- *The drainage wells' depth must not be deeper than the double height at centre line minus 460 mm. See figure. 6*

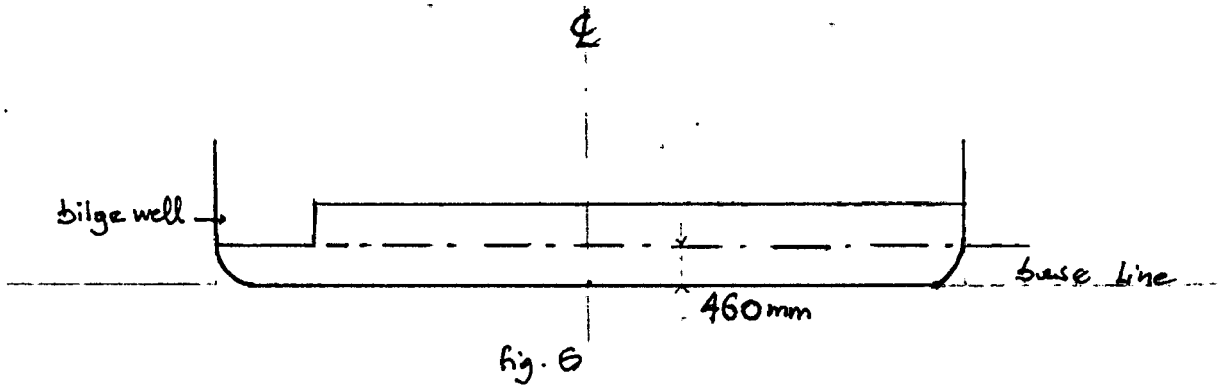


fig. 6

Forepeak or Collision bulkhead in passenger ships (Reg. II-1/10)

1) *The collision bulkhead shall be watertight up to the bulkhead deck and located at a distance from the forward perpendicular of at least 5% and not more than(3 m + 5% L)m.*

2) *The collision bulkhead shall be drawn up to the deck immediately above the bulkhead deck. The extension above the bulkhead deck does not need to be a direct continuation of the part of the bulkhead but it must not be located nearer to the forward perpendicutlar than 5% L_c.*
No door, manhole, ventilation duct or any other opening shall be in this bulkhead. In the event where pipes pierce the collision bulkhead the valve chest shall be secured at the bulkhead inside the fore peak. See figure.7

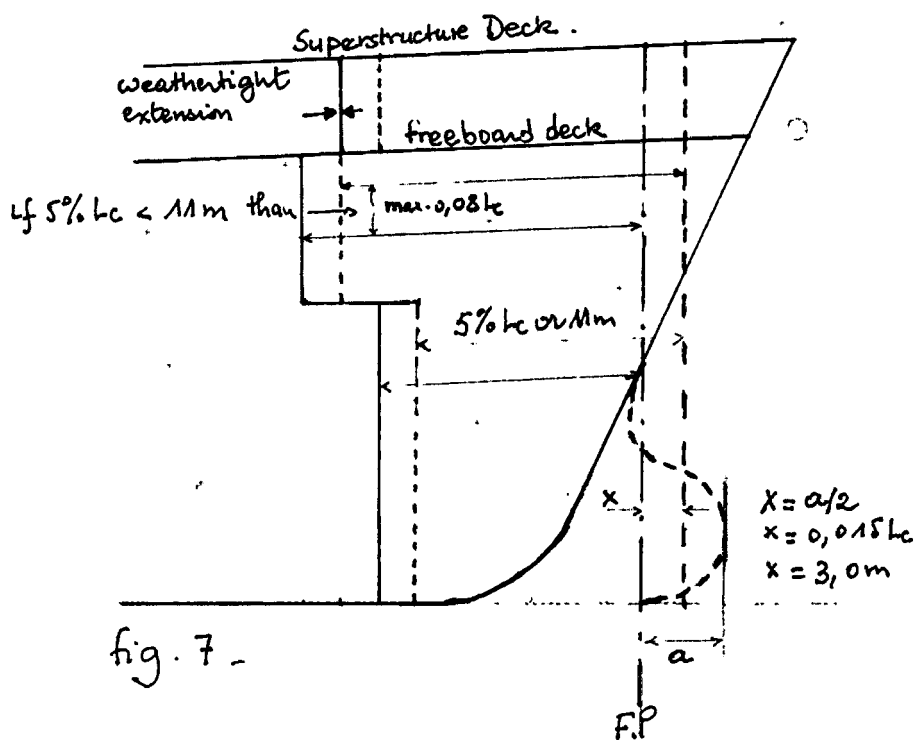


fig. 7

Assigning, marking and recording of subdivision load lines for passenger ships (Reg. 11-1/13)

The subdivision load lines corresponding to the approved subdivison draught shall be assigned and marked on the ship's sides and be recorded in the passenger ship safety certificate. (Principle passenger condition with the notation C1.)

Passenger ships used under alternative conditions may have additional marks, C.2, C.3, etc.

Watertight door requirements

First condition to observe:
The governing factor to regulate the method of operation of doors below the load line is whether there are passenger spaces below the bulkhead deck or not.

- *The watertight door must have at least two independent power sources called type 3 doors which are sliding doors power-operated as well as hand operated..*
- *The power sources must be capable of opening and closing all the doors under control, each of them capable of operating all the doors simultaneously. Central control of the power is required.*
- *In hydraulic systems each power source must consist of a pump capable of closing doors in not more than 60 seconds, and in addition, hydraulic accumulators must be provided of sufficient capacity to operate all the doors at least three times, e.g. closed-open-closed.*

- *Watertight doors shall be provided with indications at the bridge showing the position OPEN/CLOSED.*
- *The doors must be operated not only from a central operating place but also from a place above the bulkhead deck.*
- *An alarm shall be arranged in the case of remote operation.*
- *Watertight doors shall preferably be located inside the B/5 line.*

Openings in watertight bulkheads
(as amended final Res.MSC 11(55),12(56) and 13(57)

1) *Valves, cocks etc not being part of a piping systems must not be arranged in a watertight bulkhead.*
2) *The collision bulkhead or the forepeak bulkhead may have one pipe or may be pierced by two pipes in particular circumstances (with the Administration's agreement) provided that the pipes are fitted with suitable valves operating from above the bulkhead deck. The valve chest shall be secured at the bulkhead inside the forepeak.*
3) *Heat sensitive material must not be used in piping systems passing the watertight bulkheads.*
4) *Door openings and manholes are not permitted in collision bulkheads below the margin line or in watertight bulkheads between cargo holds (exemption in the latter case may be granted).*
5) *A watertight bulkhead within the machinery compartment must not have more than one opening and shall have a watertight sliding door.*

Opening in the shell plating of passenger ships below the margin line (Reg.II-1/17)

1) *Sidescuttles shall be of a non-operable type.*
2) *Sidescuttles shall be provided with hinged inside dead lights.*
3) *Shell openings shall be provided with check valves and closing arrangments which can be operated above the bulkhead deck where an indicator shall show whether the valve is open or closed.*

Watertightness of passenger ships above the margin line (Reg. II-1/20)

- *The bulkhead deck or a deck above it shall be weathertight (no entrance of water through it in rough weather at sea) (Reg.II-1/19)*
- *All watertight doors shall be tested as required in Reg.II-1/18.2)*
- *All openings in the exposed weather deck shall be sufficiently strong and provided with efficient means to close them weathertight. Reg. II-1/20-1 Res. MSC 12(56)*

Bilge pumping arrangements (Reg. II-1/21)

- *At least three (or if the criterion numeral is > 30), four) power bilge pumps located in different watertight compartments, if practicable, shall be provided.*
- *Each required pump shall have its section connected to the main bilge collector in order to draw water from any space required to be drain.*
- *The pumps may also be used for other purposes e.g. sanitary, ballast and washing purposes.*
- *One of the pumps shall be arranged as emergency drainage pump which can work below water. The power source shall be located above the bulkhead deck. Pumps and valves shall be capable of operating from a place above the bulkhead deck.*
- *In the machinery compartment a "quick drainage pump" shall be provided.*

- *The drainage system shall be given dimensions according to the formulas of Reg.II-1/21. (The diametre d=25+1,68 L(B+D)*

Stability information for passenger and cargo ships

Reg. II-1/22 as amended by Res. MSC 12/56

1) *All ships shall be subject to an inclining test.*
2) *Res. MSC 12(56) requires a new test at periodical intervals not exceeding 5 years.*
3) *Stability data for different loading conditions approved by the Administration shall be available on board.*

Damage control plans in passenger ships (Reg. II-1/23)

The documents for control of ship in case of damage shall include drawings and an up to date manual after any modification showing:

1) *The boundary limits of the watertight compartment.*

2) *The location of the openings and closing arrangements in the watertight bulkheads and the location of the operation devices for them such as the emergency shutting of watertight sliding doors and shell discharge valves remote starts of bilge pumps. The emergency operation of the watertight doors on each side of the bulkhead.*

3) *Arrangements for adjusting heels caused by flooding.*

4) *Arrangements for cross-flooding in accordance with Reg.II-1/8-5 and 8-7. All the aforesaid points must be studied before a casuality occurs so that every man concerned must intimately know what may be expected of him in an emergency.*

NB. (Reg. II-1/24 and 25 and the new Reg.II.1/23-2)

1) All watertight doors which are in use at sea shall be operated daily.

2) A surveyor, when carrying out a safety survey, shall not only check if fire fighting exercises and life saving exercises have been carried out accordingly, but should also check if the damaged plan exercise was carried out as well. Such information is normally and should be kept in the LOG -book. The other information,which is also recorded in the log.-book, is as follows:

1) Drills in operation of

a) Watertight doors

b) Sidescuttles in the shell

c) Valves and closing arrangements in the shell

d) Date and time for opening and closing of watertight doors and controls and drills including explicit record of any defects which may be discovered..

Stability

From the safety point of view stability is one of the most important points. Items concerning stability have to be handled carefully.
Two types of calculations are carried out:

When the ship is in intact conditions without any damage (e.g. opening in the hull) and only submitted to the weather conditions with the cargo load is what we call the "intact stability calculation".

When the ship is in damaged condition (e.g. with a part of her hull flooded) it is what we call by stability calculation in damaged condition.

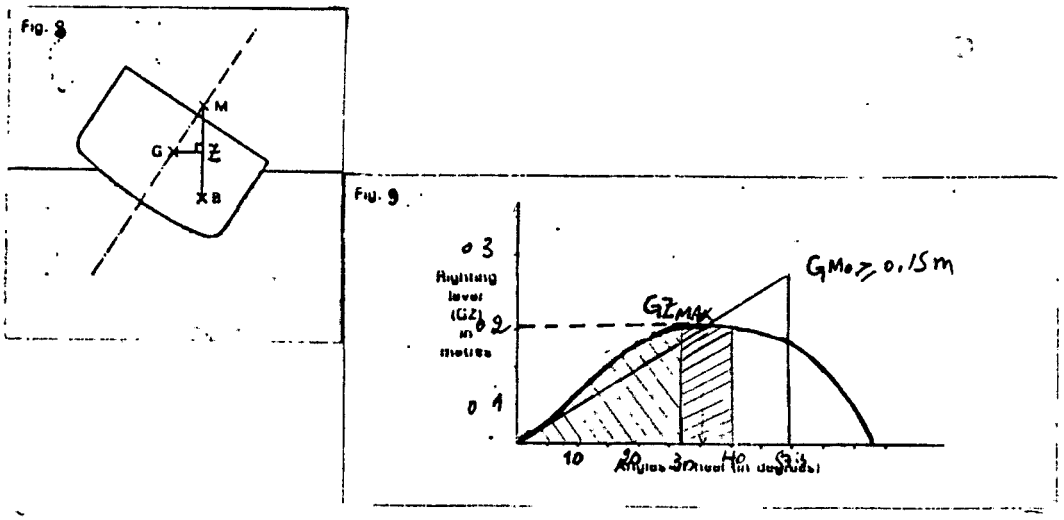
These calculations are run nowadays by a computer programme mostly supervised by a classification society and can also be performed by a shipyard. The Administration should approve the programme and if so it can limit it to spot-checks only. When the ship is ready and approved, a stability booklet is given to the master with all the loading condition information and data necessary to maintain sufficient intact stability in order that he fulfills the requirements such as after boarding and before departure. The master must determine the ship's trim and stability and also ascertain and record that the ship is in compliance with the stability criteria. This is a recommendation which is in the new amendment of regulation II-1/8 which is excepted to enter into force under the convention's "tacit acceptance" procedure on 29 April 1990.
There are other amendments to Regulation II-1/8 which I prefer to mention further or after a short introduction to stability.

1. *Like any object on land or at sea a ship is submitted to the physical principle of equality between the reaction of its proper weight and the reaction of the support which in this case, is water. A so-called "buoyancy force" counteracts upwards the total ship weight which is applied in the gravity centre. When the ship is in equilibrium the centre of buoyancy (B) is directly below the centre of gravity (G) in the same vertical.*

When a ship rotates slightly it returns by itself to its original position, it is then said that the ship is in positive stability.

If, when displaced slightly , the ship heels farther from its original position, the equilibrium is unstable, and the condition is called negative stability. What naturally happens when any slight rotation occurs is that the forces of weight and buoyancy generate a moment tending to move the ship back to its original positin of equilibrium. The lever of these two forces weight + buoyancy is usually shown by the projection of G which will intersect BM at Z. See figure. 8

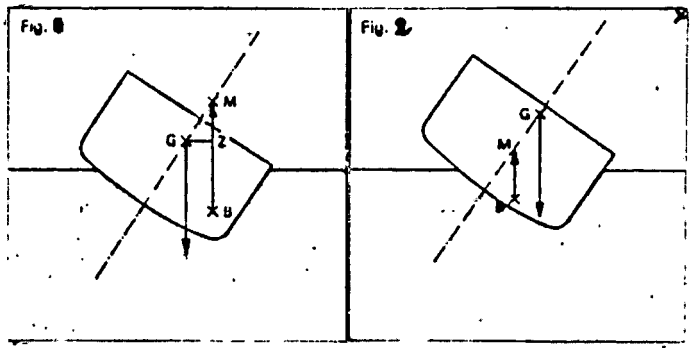
This distance, GZ is known as the righting arm or lever. This righting arm varies according to the angle of heel. This can be worked out and shows the stability curve of the ship in the intact condition. See figure. 9



2. *The drawn curve should fulfill the IMO recommendations which for passengers ships are as follows:*

- *The area e30 under the righting lever curve up to 30^{o} should be at least 0,055 m rad.*
- *e30-40 between 30^{o} to 40^{o} at least 0,03 m rad*
- *e40 up to 40^{o} at least 0,09 m rad*
- *GMO the inital metacentric height should not be less than 0,15 m*
- *GZ the righting lever should be at least 0,20 m at an angle of heel not less than 30^{o}.*
- *GZmax the maximum righting arm should occur at an angle of heel preferably exceeding 30 but not less than 25. See figure. 8*

- *Angle of heel on account of crowding of passengers to one side should not exceed 12.*
- *The angle of heel on account of turning should not exceed 10 .*



These two figures show the extreme position of the metacentric point "M". Where "M" is above "G" we have positive stability. In figure 2 where "M" is below "G" we have negative stabiltiy and the ship will be unstable and tend to capsize.

Thus the importance of the metacentric point "M" postition.
It is essential that "M" is above "G" for stability of vessel. However, the metacentric height must not be too great otherwise the righting arm GZ will also be accordingly great and the righting moment. Violent motion is then produced from side to side which can be extremely uncomfortable for those on board the ship and also risky for the cargo , the ship structure and so on. This is why particular attention is paid during the design of the ship so as to have a satisfactory metacentric height for all conditions of the ship.

In a damaged condition (e.g. opening in the hull)

To counteract the flooding by water the ships are divided below the waterline into a number of watertight compartments. The inrushing water weight added to the ship's weight will make the ship sink if the number of watertight compartments flooded is over the number of compartments corresponding to the properm factor of subdivision of the ship in consideration. On the other hand if the water remains in the limit of the number of compartment required in the provisions which can be flooded, it can also make the ship unstable if for example the water accumulates on one side of the ship more quickly than on the other. In such case recommendations are stipulated in Regulation II-1/8 to ensure that the ship will not capsize or heel beyond a certain angle. The damage extension assumption according to this regulation is as follows:

3.1) Longitudinal extention: (Reg.4)
The smaller of the following values (3,0 + 0,03 L) or 11,0 m if the required factor of subdivision is < 0,33 the assumed damage extension shall be increased to cover two watertight athwartship bulkheads.

3.1.2) Athwartship extension shall be 1/5 of the breath of the ship.

3.1.3) Vertical extension from the baseline upwards without any limitations.

II

3.2) Unsymmetrical flooding: (Reg.5)
This must be avoided. If necessary the correct transfer of water shall be made in less than 15 minutes and if the arrangements are automatic they shall be able to operate from a place above the bulkhead deck and be approved by the Administration. (More information in IMO Reg. A.266 (VIII) for the purpose of the use of such fittings.)

III

3.3) *Final conditon after damage: (Reg.6)*

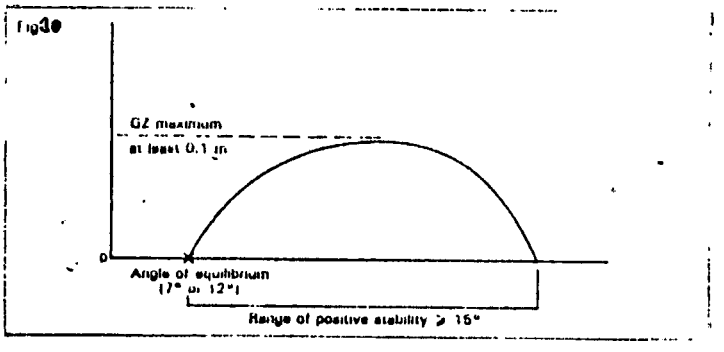
- *Remaining metacentric GM > 0,05 m at symmetric flooding.*
- *At unsymmetric flooding the angle of heel shall not exceed 7°*
- *The Administration may in special cases accept an angle of heel θ < 15°*
- *The margin line shall be above the water surface.*
- *The stability of the ship at the different loading conditions in undamaged condition shall be such than the values given above are not exceeded at damages according to the damage assumption.*

3.4) *The Master shall be given the necessary stability data so that he is able to ensure that this is the case to maintain sufficient stabiltiy. (Reg.7.)*
The Administration may not grant exemptions from the Damage Stability Requirements. (except as per 8.1.)

Recent amendments to regulation II-1/8 were adopted by the Maritime Safety Committee during its 56th session . These amendments will apply to new passenger ships, including RO-RO passenger ferries built after 25 April 1990. The regulation stated that sufficient stability be provided after the flooding of one, or two compartments depending on the degree of subdivision provided.
The main change made by the amendments is to introduce precise requirements for determining the parameters of stability after damage.
At present the regulation states in 2,2 "where the Administration considers the range of stability in the damaged conditions to be doubtful, it may require investigations thereof".
The amendment replaces this rather general requirement with three important provisions:

The first is that there should be a minimum range of positive stability of 15 degrees beyond the angle of equilibrium. The angle of equilibrium is the angle at which the ship remains after damage and is assumed to the 7° degrees in the case of flooding of one compartment and 12°degrees when two adjacent compartments are flooded. (These figures are taken from Res. A.265 (VIII) adopted by the IMO Assembly in 1971.)

*For the ship in damaged condition and heeling, the righting lever curve does not start from zero, as in the case of the intact ship but from the angle of equilibrium i.e. 7°or 12°degrees depending on the degrees of subdivision. See figure.*10



The righting lever shall be at least 0,10 m and is calculated using the formula GZ (in metres) = (heeling moment /displacement) + 0,04. This calcuation takes into account the effect of the crowding of passengers on to one side; the launching of all fully laden davit-launched survival craft on one side; and wind pressure.

The minimum area with positive range is required under the curve after damage thus enabling the ship to withstand the rolling caused by wave action. These provisions as stipulated in the new amendments taken together represent a set of measures which if implemented in a ship's design should guarantee proper and timely rescue operations as well as the normal functioning of the ship's machinery and other functions.

Other amendments concerning the safety of passenger ships, especially roll-on/roll-off ferries were adopted during the 56th session. The admendments which will apply to all passenger ships, are concerned with intact stability rather than damaged stability. The amendments expand the section of the Regulations II-1/8•7 by requiring that the information given to the master must show the influence of various trims, taking into account operational limits.

- *draught marked clearly at the bow and stern*
- *ships shall be fitted with a reliable draught indicating system*
- *use of an electronic loading and stability computer*
- *at regulation 20 a paragraph was added requiring that cargo loading doors shall be closed and locked before the ship departs and remains locked until the ship is at its next berth. The amendment makes provision for doors to be opened or closed while the ship is approaching or leaving the berth. This amendment is applicable to all passenger ships and not just RO-ROs.*

The third amendment to Regulation 22 was to check the original conformance of the light weight for passsenger ships and their longitudinal centre of gravity . Such a survey must be carried out at periodical intervals not exceeding five years. It should also be carried out whenever the comparison with the approved stability information, a deviation from the light ship displacement exceeding 2% or a deviation of the longitudinal C.G. exceeding 1% of L is found or anticipated. An inclining test is required at least every five years.

NB.

1) Reg. II-1/8-B is a regulation catergory II standard to replace this regulation some countries use the IMO Reg. A.265(VIII) which is based on what is called the concept of the probability of survival and is used as an equivalent to part B of Chapter II-1 of Solas 74.

Machinery and electrical installations

It is said in the rules that an emergency self-contained source of electrical power must be provided in a suitable location which must be above the uppermost continuous deck and outside the machinery casing. This installation must be able to function when the ship is listing at 22,5 deg and/or has a trim of 10 (Reg. II-1/42.6). The maximum practicable protection in the event of an outbreak of fire should be insured. The emergency source of power must be invulnerable, as practicable as possible, to a fire casuality in the machinery portion of the ship. Installations shall be such that the services essential for safety will be maintained under various emergency conditions, and the safety of passengers, crew and ship from electrical hazards will be assumed. (Periodical testing etc.).

CHAPTER II-1/E

Survey for passenger ships (Reg. I/7)

Each passenger ship shall be subject to the following survey:

(i) A survey before the ship is put in service (initial survey)

(ii) A periodical survey once every twelve months

(iii) Additional surveys as the occasions arise

(i) The Administration is not always in a position to carry out the entire initial survey all by itself due to lack of infrastructure and expertise in the Administration. Most Administrations do not have surveyors to inspect radio equipment on board and to carry out calculations for the tonnage measurements etc.

In such cases the Administration is using national organs or enterprises who deliver, after a survey, a report to the national Administration confirming that the items surveyed are in accordance with the standards required.

On the other hand in most cases the Administration delegates part of the initial survey to a classification society or the whole initial survey according to the policy of the country, as it will be cheaper to do so. An Administration may not be able to carry out the initial survey in a foreign country if its vessels are built abroad.

In the case where the Administration delegates a part of the initial survey to a class society it mostly concerns the scantling of the structure. Then the following items are to be considered when approving the scantling of the ship structure:

- The chemical composition and mechanical properties of steel
- The Plating thickness of decks, shell, bulkheads, inner bottom etc.
- Web frames and stiffeners dimensions etc
- Weld types and sizes
- Bending moments and shear forces

when the Administration is not delegating the scantling of the ship structure it uses class rules.

This initial survey is divided into distinct phases. Firstly, regarding the ship structure, the plans are examined and approved for compliance with the applicable parts of the rules. At this point it is important to know the following:

- How many copies are needed
- To which address should design documentation be submitted
- What response time can be expected from the certifying body which can be the Administration or the classification society, or both
- To which office should questions related to design documentation approval be addressed in order to save time.

The second thing is to control whether the ships are built according to the approved drawing or not. Then during the construction, from the start to the completion of the ship, surveyors from the Administration or from the classification society, when the task is delegated, follow the construction process which consits of:

1) *A complete inspection of:*

- *Arrangements, materials and scantlings of the structure*
- *Main and auxiliary machinery*
- *Boilers and other pressure vessels and their appartenances*
- *Electrical installations*
- *Radio installation including those used in life-saving appliances*
- *Fire protection and fire safety systems and appliances*
- *Life-saving appliances and arrangements*
- *Shipborne navigational equipment*
- *Nautical publications*
- *Means of embarkation for pilots*
- *Other equipment*
- *Workmanship*
- *Lights*
- *Shapes*
- *Means of making sound signals and distress signals*

2) *Carrying out all the required tests concerning the utilization and the running of all the equipment installed on board the ship and its safety utilisation according to the national and international relevant provisions for the safety of life at sea.*

Issuance of class or certificate

1) *Regarding the classification society, in order to recommend that on completion the ship should be classed, the class surveyors must make sure that:*

- *The ship is built in accordance with the rules and the approved plans*
- *The material of construction has been manufactured and tested as required by the rules*
- *The workmanship is of a satisfactory standard*
- *The agreed standards of alignment and fit-up have been complied with*

2) *Regarding the Administration:*

The passenger ship safety certificate is issued after a satisfactory completion survey.

NB.

a) In some countries, such as Sweden, there are two kinds of safety certificates for a passenger ship trading internationally.

b) The passenger certificate which is issued under the national regulations.

c). The passenger ship safety certificate which is isssued under international regulations. Included in this certificate are issued additional certificates such as:

- *The load line certificate for a period of five years with annual survey.*
- *The IOPP (International Oil Pollution Prevention) Certificate for a valid period of five years with annual survey.*

See appendix 1.

Annual survey

During an anuual survey it is required an inspection of:

- *structure*
- *machinery and equipment*
- *outside of the ship's bottom*

The renewal survey shall ensure that the ship, regarding the items listed, is in a satisfactory condition and fit for the service for which it is intended and that it complies with the convention regulations and the laws, decrees, orders and regulations promulgated by the Administration.

In the case of lights, shapes and signals it is reguired that they shall comply aslo with the international regulations for preventing collisions at sea.

iii) Additional surveys as the occasion arises

Unscheduled inspections are carried out during the period of validity of the certificate to ensure that a continued satisfactory condition of the ship is maintained. If not, corrective action shall be taken and the Administration shall be notified. If corrective action is not taken the certificate is withdrawn and the Administration, whose flag the ship is entitled to fly, shall be notified immediately.

Carriage of dangerous goods (Reg. II-2/41 and 54)

The carriage of dangerous goods in passenger ships is limited. If allowed some requirements shall be fulfilled such as:

- *The surroundings (staircases, elevator trunks, corridors etc) to cargo area where dangerous goods are loaded to have overpressure ventilation towards cargo hold area to prevent toxic and/or flammable vapours from entering the engine room and the accommodation area.*

- *The facilities shall be so arranged that spillage of dangerous goods can be kept onboard and dealt with in a proper way. (For instance closing devices for overboard from safe place etc.)*

  - *efficient alarm system*
  - *special fire fighting protective clothes*
  - *required fire fighting equipement*

* See IMDG code for the dangerous goods allowed to be carried on board passenger ships.

Appendix 1.

The issuance of certificates

There are special requirements concerning passenger ships of smaller size trading nationally. In Sweden the smaller passenger ships in national trade, are built according to national requirements only and are not subject to SOLAS' regulations.
In both cases (ships trading internationally and ships trading nationally) the Administration cannot force shipowners and shipyards to buy survey-work from a classification society but for all parties it is common and convenient to do so when dealing with passenger ships of large size.
For the smaller passenger vessels in national trade they are often surveyed only by the administration itself and it is done frequently.

The following certificates are issued:

- *Passenger Ship Certificate with two years validity. A survey is carried out every second year.*
- *National Load Line Certificate with five years validity. A survey is done every five years.*

CHAPTER II-2

Fire safety

There has been an important number of disastrous fires in large passenger ships at sea, in dry docks and repair yards all over the world. These cases of fires in ships in dock and under repair are of course fundamentally different in circumstance to fires in ships at sea, but to the public mind the difference is not so apparent, and they have undoubtedly influenced the general attitude to the question of fire danger, and have prepared the way for regulations relating to constructional and other precaution to be adopted in passenger ships in the same way for the Titanic disaster and the other important accidents. (See copy of major maritime fire disasters.)

Before IMO was established there was the 1929 convention where important additions were made in the regulations relating to fire protection in passenger ships. Another conference was held in 1948 and the second convention concerning SOLAS was adopted. After the creation of IMO, suggestions were proposed and then IMO recommendations and IMO resolutions were established. After the 1948 SOLAS-convention there were other SOLAS conventions under the auspices of IMO in 1960 and in 1974 as amended in 1981 and in 1983. Common to all the above mentioned conferences is the retention of the "basic principles of fire protection (Reg. II-2/2).

MAJOR MARITIME FIRE DISASTERS

YEAR	*VESSEL*	*LOSS OF LIVES*	*CAUSE*
1807	*AJAX*	*250*	*FIRE, OFF TENEDOS*
1833	*HIBERNIA*	*150*	*BURNT, ATLANTIC*
1848	*OCEAN MONARCH*	*178*	*BURNT, RIVER MERSEY*
1848	*AUSTRIA*	*471*	*EMIGRANT SHIP, BURNT MID ATLANTIC*
1874	*COSPATRICK*	*470*	*EMIGRANT SHIP*
1900	*KAISLER WILH. DER GROSSE*	*300*	*LINER, BURNT HOKIKEN*
1904	*GENERAL SLOCUM*	*1.021*	*BURNT, EAST RIVER, NEW YORK*
1917	*MONT BLANC*	*2.000 +*	*COLLISION IN HALIFAX ONE OTHER VESSEL LOST*
1934	*MORRO CASTLE*	*137*	*BURNT, OFF U.S. EAST COAST*
1944	*FORT STIKENE*	*731 +*	*EXPLOSION, BOMBAY 12 OTHER VESSELS LOST*
1947	*GRANCAMP*	*500 +*	*EXPLOSION, TEXAS CITY TWO OTHER VESSELS LOST*
1962	*GRANCAMP*	*500 +*	*EXPLOSION, TEXAS TWO OTHER VESSELS LOST*
1961	*SAVE*	*259*	*EXPLOSION AND FIRE AFTER GROUNDING, MOUTH RIVER, LINDE*
1962	*DARA*	*263*	*EXPLOSION, PERSIAN GULF*
1963	*LAKONIA*	*128*	*FIRE, DUE WEST OF GIBRALTAR*
1965	*YARIMOUTH CASTLE*	*88*	*FIRE, OFF FLORIDA EAST COAST*
1976	*PATRA*	*100+*	*ENGINE-ROOM FIRE, RED SEA*
1980	*PRINSENDAM*	*-*	*ENGINE-ROOM FIRE, TOTAL LOSS*
1981	*"TAMPOMAS 11"*	*580*	*FIRE OFF JAVA*
1983	*RAMADAN 10*	*357*	*FIRE, NILE RIVER*
1987	*DONA PAZ*	*3.000+*	*COLLISION, SOUTHWEST OF MANILA, ONE OTHER VESSEL LOST*

1) *Division of ship into main vertical zones by thermal and structural boundaries.*
2) *Separation of accommodation spaces from the remainder of the ship by thermal and structural boundaries.*
3) *Restricted use of combustible materials.*
4) *Detection of any fire in the zone of origin.*
5) *Containment and extinction of any fire in the space of origin.*
6) *Protection of means of escape or access to fire fighting.*
7) *Ready availability of fire-extinguishing applicances.*
8) *Minimization of possibility of ignition of flammable cargo vapour.*

According to the aforesaid basic principles of fire protection the main objective is the main fire resisting bulkheads, apart above the bulkhead deck, which in association with the watertight bulkhead below the bulkhead deck, are intended to divide the ship from keel to the top of super structure into a number of fire containing sections. By this means the fire will be contained wholly within the space of origin for a period during which it would either burn itself out or give time for fire fighting parties to attack it whilst it was still of small proportions.

To realise such fire containing sections, a surveyor following up the building of a ship must ensure that:

1) *The fire resisting material used was tested. The non-combustible material shall have been tested in accordance with IMO resolution A.472 (XII). B class division (Reg. 3.4) shall have been tested in accordance with IMO resolution*
   A 513(13).
   For the material surface with low flame spread, shall take into account the provisions of the IMO resolution A166 (ES.IV).

2) *The fire resistance of the bulkheads was examined according to the requirement of the recommendation for fire test procedures IMO Res. A 517(13).*

3) *The length of main vertical zones shall not be generally over 40 m the mean length on any deck (Reg.3.9.) (This task is fulfilled during the paln approval process.)*

4) *The Administration may require a test of prototype bulkhead deck.*

5) *The bulkheads are different in type according to the degree of their fire resistance. We can distinguish three types:*
- *A class bulkhead or division*
- *B class division*
- *C class division*

5.1) *A-class divisions (fire resistant bulkhead. Reg.3.2).*
- *constructed of steel or other equivalent material*
- *capable of preventing the passage of smoke and flame to the end of one hour standard fire test.*
- *Insulated with approved non-combustible material such that temperature of unexposed side will not rise to more than 139° C and not at any point more than 180°C within*

A60 in 60 minutes

A30 in 30 minutes.

A15 in 15 minutes

A0 (a steel bulkhead without any insulation)

5.2 "B" class divisions (Fire retarding bulkhead)

a) Capable of preventing the passage of flame to the end of the first half and hour of the standard fire test.

b) Insulation value such that the average temperature will not rise more than 139°C nor at any point more than 225°C within B-15 (15 minutes), B.0 (0 minutes).

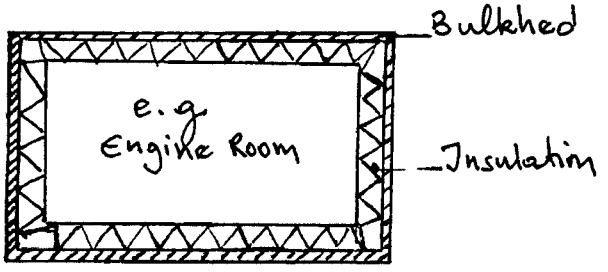
c) Constructed of approved non-combustible materials as defined in regulation 3.1 and tested according to IMO resolution A517(13) with exception of veneers unless complying with the relevant provisions of regulation 34.

5.3) "C" class divisions

Constructed of approved non-combustible materials, (tested in accordance with the IMO resolution A.472 (XII) except veneers unless complying with the relevant provisions of regulation 34.

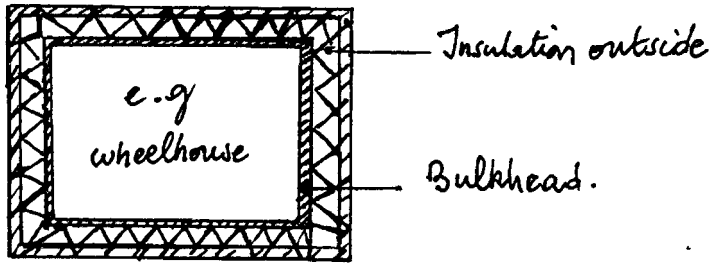
6) Fire insulation

6.1) On the side where the fire risk exists:



Note that the engine room's insulation is often fixed outside because it is difficult to arrange it inside due to the presence of the stiffeners on the bulkhead, pipes piercing the bulkheads and so on. In such case when a surveyor is carrying out a survey he should have to look whether some piece of insulation is cut or not.

6.2) Outside a protected space (i.e. a space which is important to the safety of a ship).



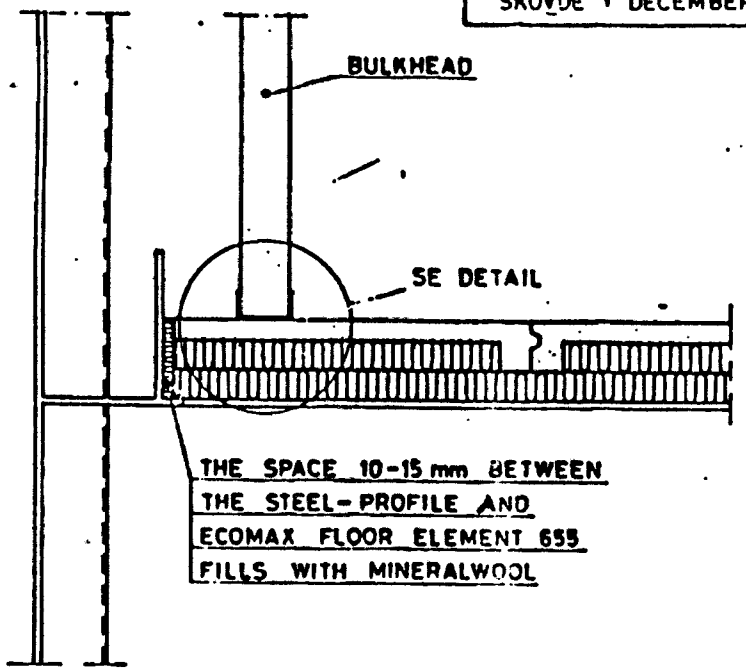
NB. If the insulation is fixed inside the bridge instead of outside, which is the way it should be, the thickness of insulation shall be increased from 50 mm (which is the standard thickness of rockwool) to 80 mm.

6.3) Insulation arrangements for bulkhead A60, A30, A15, A0. See figures.

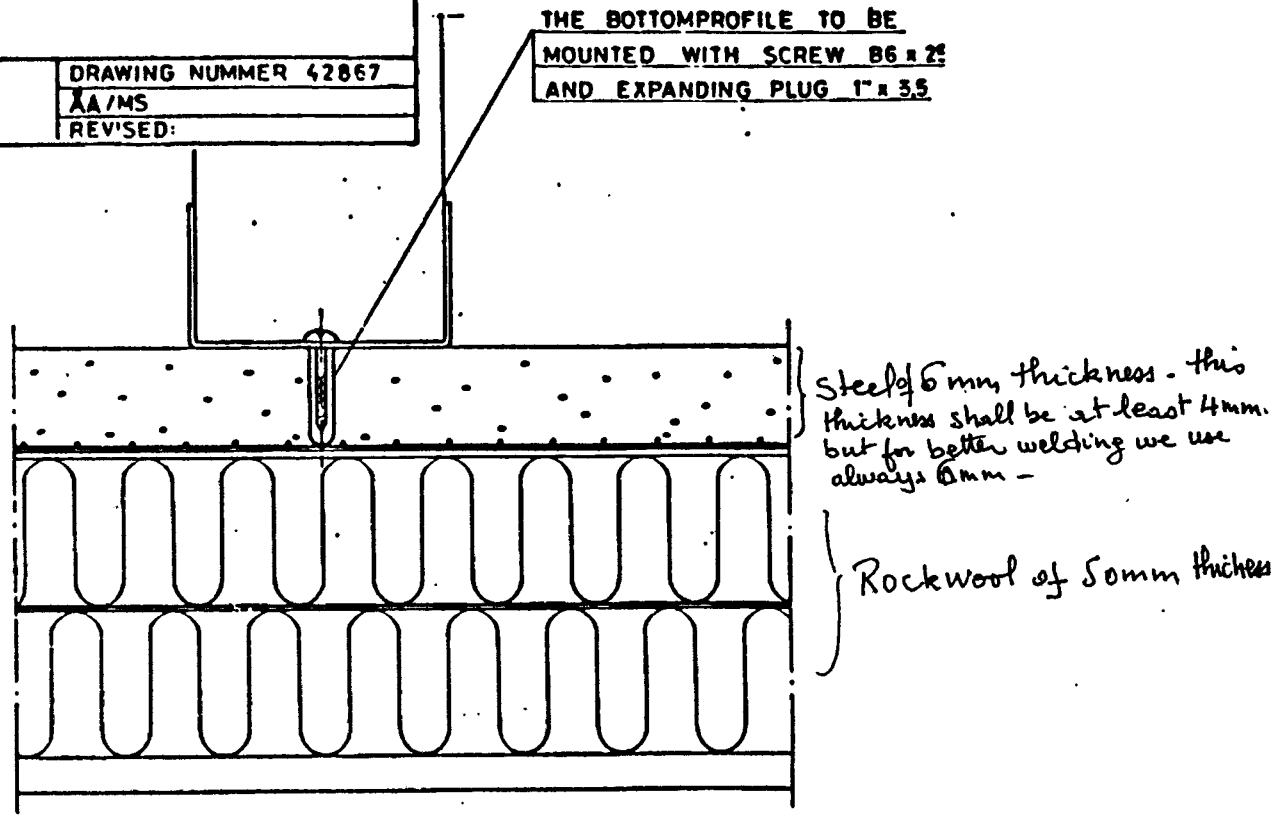
ECOMAX Floor Element 655
A-60 Class overdeck insulation

ROCKWOOL AB
SKÖVDE 1 DECEMBER 1977

DRAWING NUMMER 42867
AA/MS
REVISED:

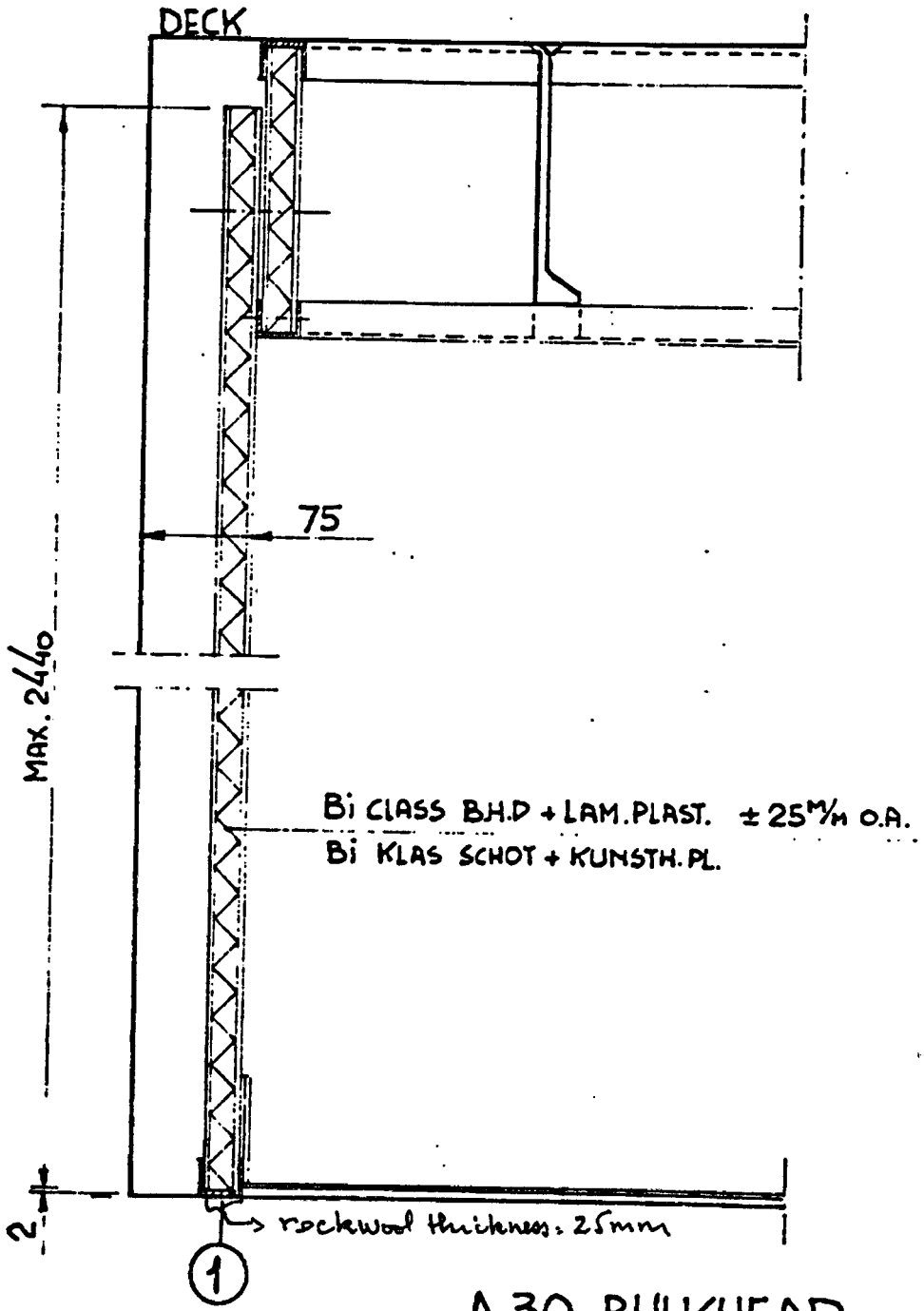


Typical section through a deck, ships side and bulkhead on top of the deck (1:5)



Detail showing connection between floor and bulkhead (1:1)

48.1



A.30 BULKHEAD

A_{15} ~~Class~~ division is in practice the same as the A30. In order to simplify the work when fixing the Rockwool layer we use the same thickness of rockwool in A_{30} ~~and~~ A_{15} =

WILTON-FIJENOORD N.V., SCHIEDAM		
BOUW NO 804-805 GROEP 640 TEK 202	DETAILS BULKHEADS, LININGS AND CEILINGS DETAILS SCHOTTEN, BESCHIETING EN PLAFONDS	REG.NO 654159 BLAD NO. 211

Nr | R | S | Orienteringsruta | Ändringen omfattar

Sjöfartsinspektionen
Malmö sjöfartsinspektionsdistrikt
Inkom den 75-06-10
Diarie nr

Ändr v | Sign/Godk | 70a

49.3

SJÖFARTSVERK
Sjöfartsinspektionen
11 FEB 1975
Ordnr 3

STEEL-DECK
WELDING
U-PROFILE TNF 63
0,7mm STEEL
TIGHTING. 50mm ROCKW.
700
CEILING OF 40mm ROCK-WOOL WITH GLASSFIBRE-TEXTURE ON THE VISIBLE SIDE. "ROCKFON"
HAT-PROFILE TNF 31
0,7mm STEEL
U-PROFILE
A
A
CORRIDOR BULKHEAD OF 50mm ROCKW. CORE + 0,7mm GALVANIZED STEEL WITH PVC-FOIL ON BOTH SIDES TYPE "TNF"
U-PROFILE TNF 27 0,7mm STEEL
DECK-COVERING OF 50mm ROCKWOOL + 25mm LITOSILO
CUT A-A
STEEL-DECK

14 JAN 1975

Pos	Antal	Vara-/detaljbenämning	Material	Vara-/detaljritn nr
-549				
-548				
-547				
-546				
510-557				
510-556				
510-552				
Kvr	Klass			

Ej toleranssatta mått enligt KMV standard 81/26/-

Corridor bulkhead in accommodation

Avd	Utförd av	Granskad	Godkänd
6252	Bsj	EH	

Rit vecka	Skala
3	1:2,5

KOCKUMS
Kockums Mekaniska Verkstads AB

Ritn nr 011/3571/1

How the division of the ship and the separation of accommodation spaces are arranged regarding the fire prevention and protection

1) *In order to divide the ship from keel to the top of the superstructure into a number of fire containing section the A class division shall be in line with the watertight subdivisions and shall extend from deck to deck and to shell or other boundaries. (Reg. 24.2 & 24.3.)*

2) *To determine the fire integrity and the insulation standard of bulkheads and decks, corresponding tables were established such as follws:*

2.1) For passenger ships carrrying more than 36 passengers "Regulation 26".

Table 26.1 for bulkheads
" 26 .2 - " -
" 26.3 for decks
" 26.4 - " -

2.2) For passenger ships carrying not more than 36 passengers "Regulation 27"

Table 27.1 bulkheads
" 27.2 decks

Remarks on the aforesaid table regarding the fire integrity:

Table 26.4

The fire integrity standard of a boundary between two spaces within a main vertical zone or horizontal zone which is not protected by an approved automatic sprinkler system according to reg 12, the higher of the two values given in the tables 26.2 & 26.3 shall apply.
In the case of the main vertical zone or horizontal zone being protected or both protected by an automatic sprinkler system, the lesser of the two values given in the tables 26.2 and 26.3 will apply.
If a sprinklered zone and a non sprinklered zone meet within accommodation and service spaces, the higher of the two values given in the tables 26.3 & 27.2 will appply to the division between the zone.

Details of construction (Reg. 35)

1) *In accommodations and service spaces, control stations, corridors and stairways; the construction of ceiling and bulkheading shall be in such way that:*
   - *The fire protection is not impaired.*
   - *The fire patrols can detect any smoke originating in concealed and inaccessible places, except that in the opinion of an Administration there is no risk of fire originating in such places.*

*Addition to Reg.25.1 (according to NASAN)**

Smoke doors in corridors

1) *Corridors in accommodation and service spaces shall be sub-divided with "B" class doors at least at every 14 metres (smoke doors) unless special reasons exist for another sub-division.*

2) *The smoke doors and all doors in stairway enclosures and to galleys and doors referred to in regulation 30.4 shall be of a self-closing type and provided with hooking arrangements which can be released from the wheelhouse and the fire control station, if any, and at the door.*

** NASAN: National Swedish Administration for Shipping and Navigation*

Interpretation:

The smoke doors are for the purpose of preventing the spreading of smoke from one area to another or from one deck to another. This will facilitate to evacuate the ship without inhalation of dangerous smoke from a fire. They can help to find the way out and to rescue people who are still in the ship.

<u>How is the fire detection and fire alarm organized?</u>

1) *Fire alarm*

The fire alarm shall be automatic in order to:

- *monitor permanently the space at risk of fire.*
- *give the signal in on the right time so that the fire will be attacked by the fire patrol whilst it is just at its initial phase.*
- *replace the watching by the fire patrol which in many cases cannot be everywhere at the same time.*

2) *The fire alarm system should be installed such that each section of the ship is covered by detectors to facilitate quick detection.*

3) Reg.13.14 (NASAN)

The alarm shall be audible: An audible alarm signal, without time delay allowed by the convention, shall be given automatically in all accommodation and service spaces, control stations and "machinery spaces of category "A", when a detector or a manually operated call point is activated.

4) Fire alarm system

The fire alarm cannot give any signal without the fitting of detectors which are fixed in all the risk zones. These detectors are different in type and use but the principle of functioning is the same when it comes to detect any indication of fire whether it is smoke, flame or gaz vapour. The different types of detectors used nowadays are the following:

4.1) Smoke detectors:

These are used in high risk areas such as the engine room, corridors and on car deck. They give a quick indication of smoke in case of fire.

4.2) Heat detectors:

They are different in type, usually mounted in cabins, restaurants, sauna, galleys and other public areas.

4.3) Flame detectors:

They are used in association with the smoke detectors above the main engines in the engine room and in front of the boilers.
Their basic principle of functioning is the reaction to ultraviolet or infrared radiation in the flames.

4.4) Push buttons:

They are manual call points mounted in escape ways and in places at great risk such as the bridge, engine control room and in the other control stations.

Please note that the above mentioned detectors and the push buttons shall be grouped into sections.

5) The location of the smoke and the heat detectors shall be in the right place in order to give an alarm on the right time. Positions near beam, ventilation duct or draughty areas where disturbance is created affecting the performance of the detectors shall be avoided. For smoke detectors it is stated in regulations 14-3 the necessity of performing realistic fire tests before the final positioning in machinery spaces.

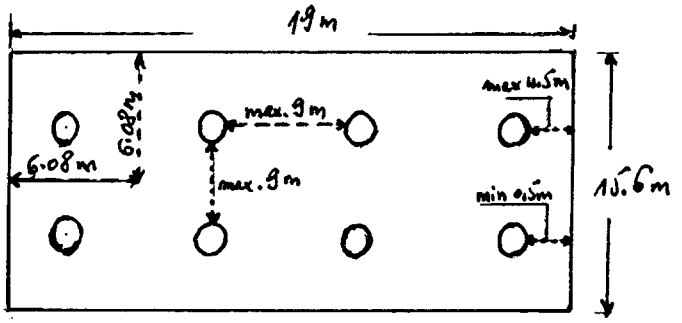
5.1) Reg. 13.2.5

The maximum spacing of detectors shall be in accordance with the table below.

Type of detector	*Maximum floor area per detector*	*Maximum distance apart between centres*	*Maximum distance away from bulkheads*
Heat	*37 m^2*	*9 m*	*4.5 m*
Smoke	*74 m^2*	*11 m*	*5.5 m*

The Administration may modify these spacings according to the realistic fire test result.

5.1.1) Heat detector:



The area covered per one detector is = 6.08 x 6.08 = 37 m^2. The required number of heat detectors for an area of:

19 x 15.6 = 296 m^2 is

296 = 37 = 8 heat detectors

Please note that the eighth heat detectorsshall be symetrically placed.

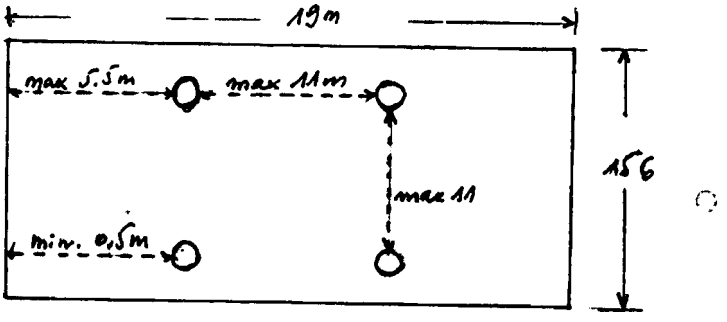
5.1.2) What will be the number of smoke detectors for the same area?

According to the above table there must be a minimum of one detector for each 74 m^2 (flat ceiling).

The required number will be:

296 ÷ 74 = 4 smoke detectors

The required distance between detectors shall not be more than 11 m.



6) Fire indications (Reg. 13.1.6)

A synoptical tableau is connected to the fire alarm central which is usually installed on the bridge. This indicating unit denote the section in which a detector or manually operated call point is in alarm. Thus the fire patrol can attack the fire with no unnecessary loss of time.

NB:

1) The functioning of heat, smoke, flame detectors shall be periodically tested to the satisfaction of the Administration (Reg. 13.1.10)

2) At a fire alarm, in case of fire, we should be able to stop from the control stations (bridge, control fire station, engine room) the following:

In the engine room:

- ventilation fans

- ventilation openings

- funnel annular spaces

- tunnel doors

- oil fuel pumps and purifiers

- oil fuel transfer pumps

- quick closing suction valves of the daily and settling thank for fuel and diesel oil supplying the main engine, generator engine, boiler. .and suction valve for bunker.

Accommodation and other spaces:

- ventilation fans

- electrical energy source

- skylights

- doorways

- all the switches of the aforesaid elements shall have remote control positions

- means of stopping and shutting off shall be located in some places outside the spaces concerned. local operation shall also be possible.

Fire fighting appliances

1) The extinguishing media is classified according to its suitability to extinguish a certain type of fire.

1.1) Classification of fire (SFS 3062)

A for fires in solid materials, commonly of organic nature

B for fires in liquids and gases

C for electrical fires (High voltage)

D for fires in metals

See corresponding figures.

1.2) Fire extinguishing media

- portable extinguishers (Res. A.602(15) Guidelines for marine portable fire extinguishers)

- Fixed fire extinguishing system

1.2.1) Portable extinguishers (water, powder, gas, foam) should be inspected once a year by a firm of persons approved by the national Administration.

1.2.2) During the inspection the following items shall be checked:

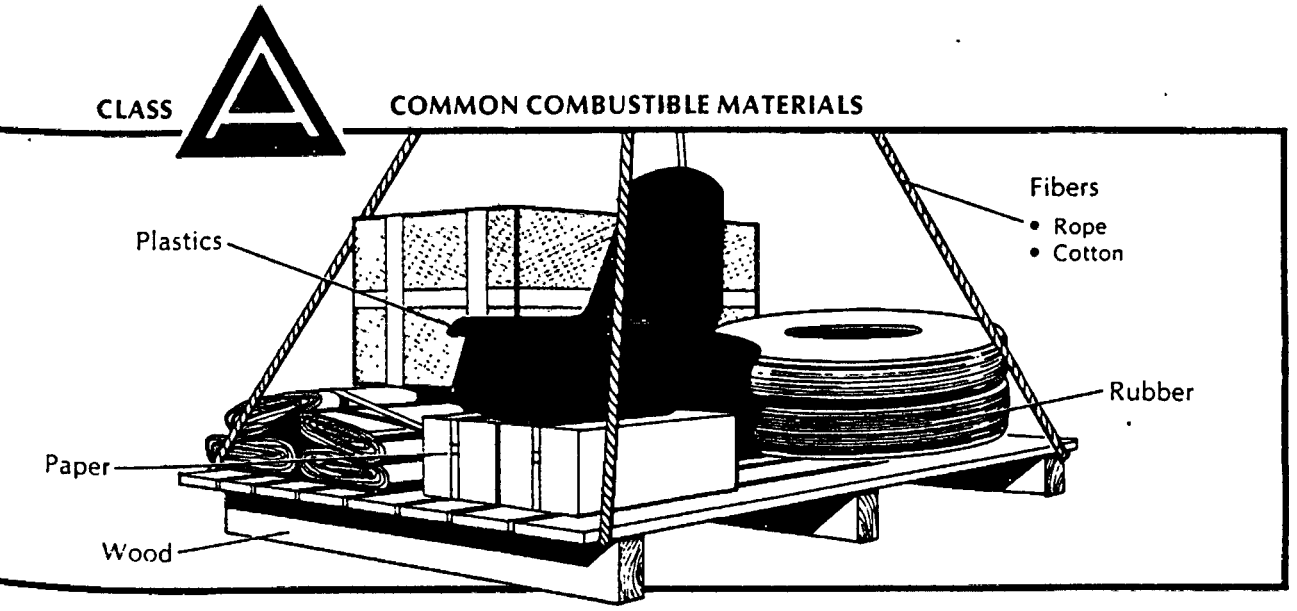
a) Condition of the bottle and propellant bottle

b) " " the release mechanism

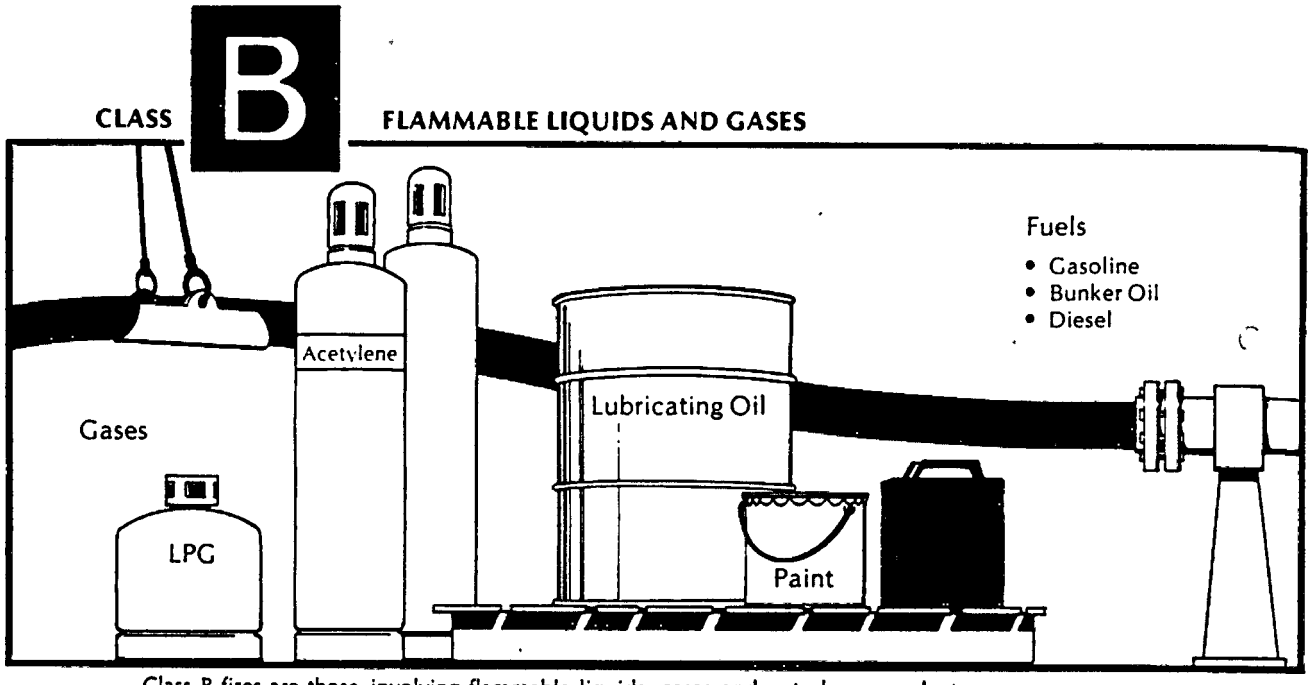
c) " " the hose and handle

d) " " the extinguishing medium

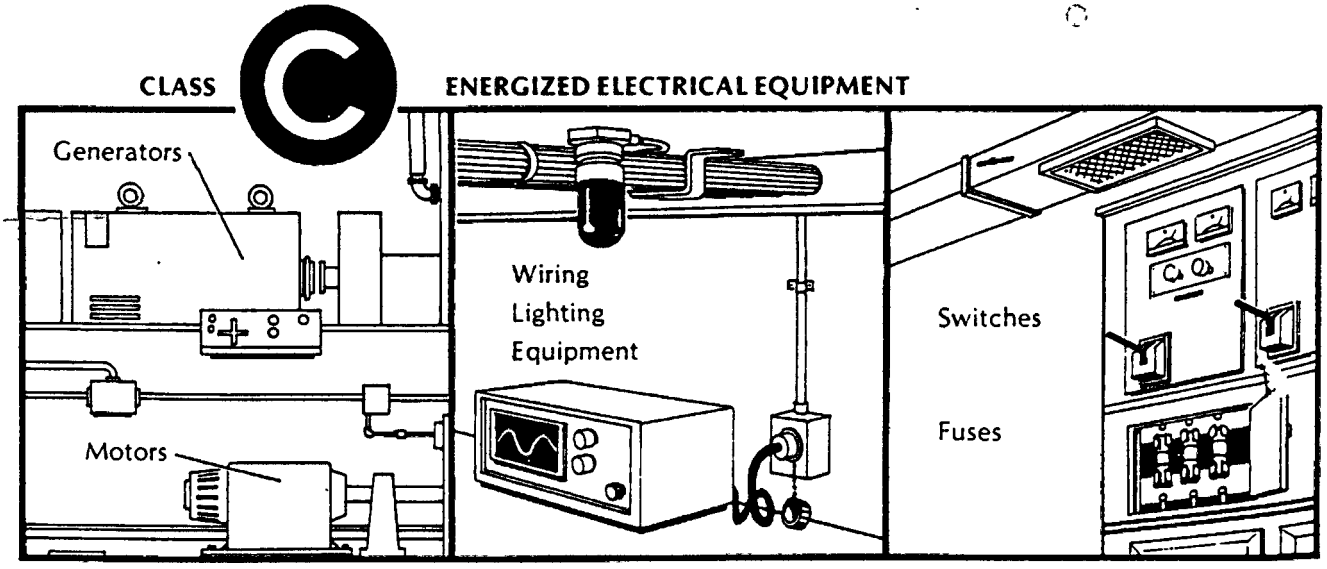
After inspection an inspection mark shall be fitted or stamped on the extinguisher.



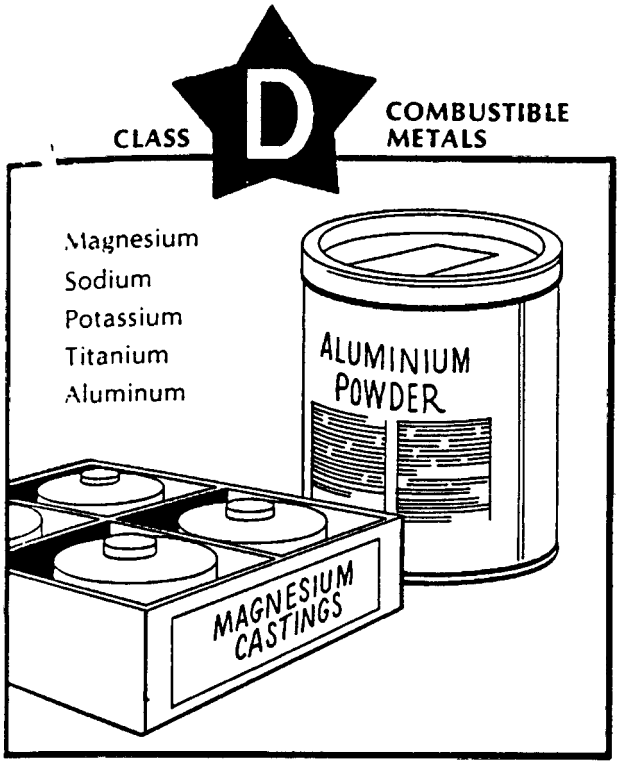
Class A fires are those involving common combustible materials.



Class B fires are those involving flammable liquids, gases and petroleum products.



Class C fires are those involving energized electrical equipment and wiring.



Class D fires are those involving combustible metals.

The surveyor shall check the information (date) in the inspection mark.

Additionally he has to check:

- the location according to the suitability of the extinguisher

- the size

- the name of the controller

- fixing and marking

- the spare changes

The portable extinguishers shall be stowed at the entrance of the space it is intended to be used in.

The different spaces at risk shall be provided with the required number and with the appropriate type of extinguisher to the satisfaction of the Administration.

1.2.3) Fireman's outfit, consisting of:

a) protective clothing

b) gloves

c) boots of electrically non-conducting material (e.g. rubber)

d) helmet

e) electric safety lamp (hand lantern, 3 hours of capacity of use)

f) axe

g) breathing apparatus of compressed air type with spare changes. (The smoke mask type with hose and air pump is allowed, but not recommended.)

h) fire proof lifeline

See annex to the NASAN notice "1975:A43" concerning personal protection equipment.

1.2.4) The minimum number of fireman's outfit is for a passenger ship 2 + 1 per each 80 m lenght of superstructure.

NASAN recommendation, include at least two units adapted for use with a face mask.

Annex to the N A S A N Notice !1975:A43! concerning personal protection equipment

	Ro-ro/Container General cargo ships Gross tonnage			Passenger ships with general cargo (not ro-ro) Gross tonnage	
	1000-2999	3000-9999	⩾ 10000	500-2999	⩾ 3000
Complete protection suits (Gas protection suits)	2	3	3	2	3
Aprons	3	3	3	3	3
Gloves with long sleeves	3	5	5	3	5
Boots	3	5	5	3	5
Overalls	3	5	5	3	5
Goggles, tight	3	5	5	3	5
Eye wash bottles	3	3	3	3	3
Face protection	3	3	3	3	3
Life line with steel wire core an lifting harness	3	3	3	3	3
Hand torch and head lamp (safety lamp)	4	6	6	4	6
Stretcher (see the NASAN notice *1970:A 24)	1	1	2	2	2
Tackle to stretcher to be stored together with the stretcher	1	1	2	2	2
Medical equipment for first aid including antidotes (for products the ship intends to carry)	To a sufficient extent having regard to the type fo the cargo and the number of persons who can need to use the equipment.				
Compressed air breathing apparatus (face mask with safety pressure)	2	3	3	2	3
Coupling and hose for quick connection of and extra face mask with safety pressure	1	1	1	1	1
Air compressor					
North Sea trade or less extended trade	-	-	1	-	-
Ocean trade	-	1	1	1	1
Spare air bottles for each air bottle if air compressor is not provided					
North Sea trade or less extended trade	2	2	-	2	4
Ocean trade	4	-	-	-	-
Spare bottles when compressor is provided	-	1	1	1	1
Oxygen equipment (see NASAN notive *1970:A 29)	1	1	1	1	1
Oxygen gas indicator	1	2	2	2	
2Measuring instrument for toxic gases (for products carried	1	2	2	2	2
Measuring instument for flammable gases fro products carried (with double scales)	1	1	1	1	1

x) For ships with a gross tonnage of less than 1000/500, equipment is decided in each individual case.

xx) The medical equipment shall include aslo the Medical First Aid Guide (MFAG) regardless of the size of the ship.

* NASAN National Swedish Administration for Shipping and Navigation.

2.5) If the passenger.ship is carrying dangerous goods chemical protection outfit is required.

- full protective clothing to a number of four

- breathing apparatus(+2)

Note that the equipment shall be stored so as to be readily available and ready to use.

3) Fixed fire fighting systems and the spaces allocated

Engine room:

a) Fire hydrants

b) Carbon dioxide

c) Halon gas (because of ozone 's layer deplete, it might be prohibited in the future)

d) High expansion foam

e) Pressure water - spray

b, c, d, and e are used alternatively. Only manual release or starting is permitted (except for "e".).

Cargo holds:

- Fire hydrants

- Water spraying system

- Carbon dioxide

Accommodations:

- Fire hydrant

- Water sprinkler

4) Fixed fire extinguishing system

The most commonly used fire extinguishing system nowadays on board passenger ships are:

- *The high expansion foam (Reg.9) and hydrant (for the protection of machinery space)*
- *The automatic sprinkler system (Reg. 12.for the protection of the accommodation and for special category spaces Reg. 37 & Res A.123(V))*
- *A pressure water-spraying system (Reg. 10)*
- *The halon system (Reg. 5.3) or carbon dioxide (Reg. 5.2 for the engine room).*

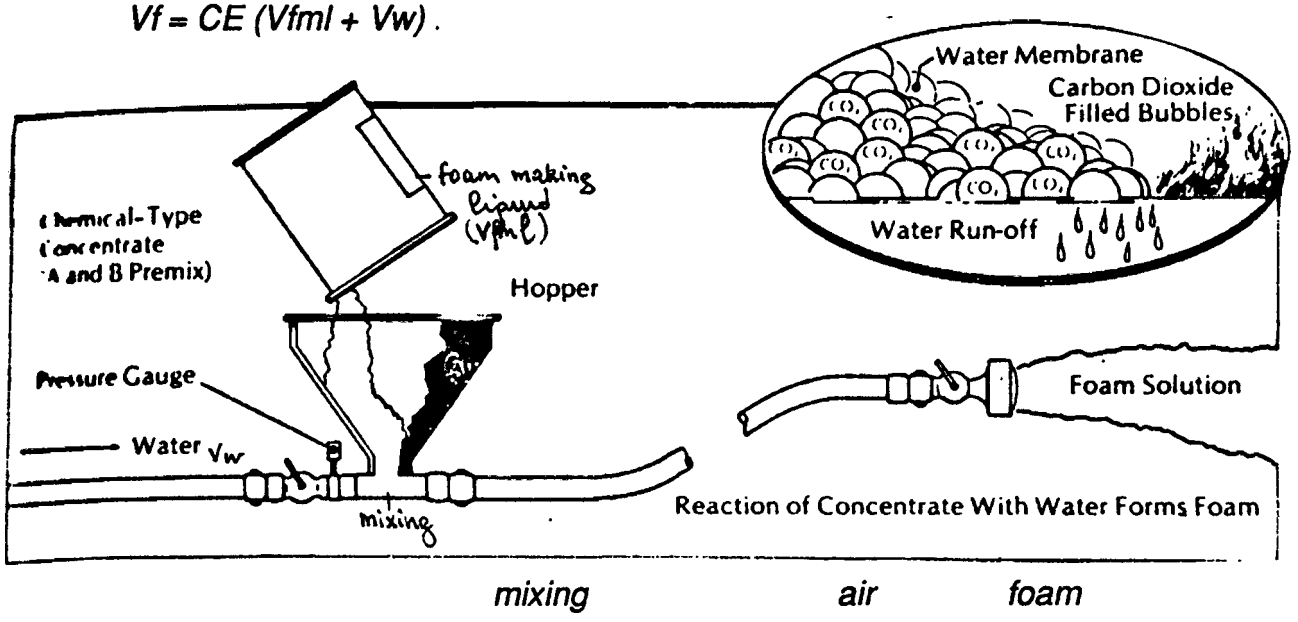
4.1) The high expansion foam system

There are three types of foam obtained accordingly to the foam expansion ratio "CE":

CE < 1000 for high expansion
CE < 100 for medium expansion
CE < 12 for low expansion

We obtain the desired foam according to this factor under the following formula.:

$Vf = CE\ (Vfml + Vw)$.



mixing *air* *foam*

Vfml foam-making liquid

4.2) The automatic sprinkler system (Reg.12)

a) Characteristics:

- For the protection of accommodation and service spaces (and control station)

- Shall come into operation automatically (within the temperature range from 68 to 79).

- The pressure is automatically maintained in the system.

b) Recommendations:

-It is stated to circulate fresh water in the system after each use of the sprinkler system and this for the purpose of avoiding the formation of rust.

- Section pipelines should be blown off to get all dirt away after each try of the system. A drencher system (dry pipe sprinkler is used for that purpose).

c) *In passenger ships there shall be not less than two sources of power supply for the sea water pump and automatic alarm and detection system. One supply for the pump shall be taken from the main switchboard by separate feeders reserved solely for that purpose. The design shall be arranged so that upon failure of the supply of power from the main switchboard, it will automatically change over to the supply from the emergency switchboard.*

4.3) *Gas extinguisher system*

a) *Halon 1301 extinguishing system (Reg. 5.3)*

- *Extinguishing medium container may be located in the space to be protected.*
- *Is used for the protection of machinery spaces and paint stores and similar spaces.*
- *A manual release only (except for small local)*

b) *Annual survey*

- *external inspection*
- *alarm system*
- *alarm at the opening of the door of the release system*
- *contents of container*
- *existence of instruction and marking*
- *condition of the nozzle and the pipe (if no corrosion on it)*

c) *Comparing to CO_2 gas extinguisher the Hallon is:*

- *a better extinguisher*
- *not risky for the personnel*
- *and for the material (no corrosion, no chemical reaction, no thermal stresses etc.)*

3.4) CO_2 Gas extinguishing system (Reg. II-2/5.2)

Two types of systems:

- high pressure system (bottles) see figure

- low pressure systems (container)

Contents of cylinders:

- for cargo spaces (Reg.II-2/5. 2.1)

the quantity of CO_2 , in case of container spaces, shall be 30 per cent at least of the gross volume of the largest cargo space so protected.

- for machinery spaces (Reg. II-2/5.2.3)

the volume of free carbon dioxide shall be calculated at 0,56 m^3/kg

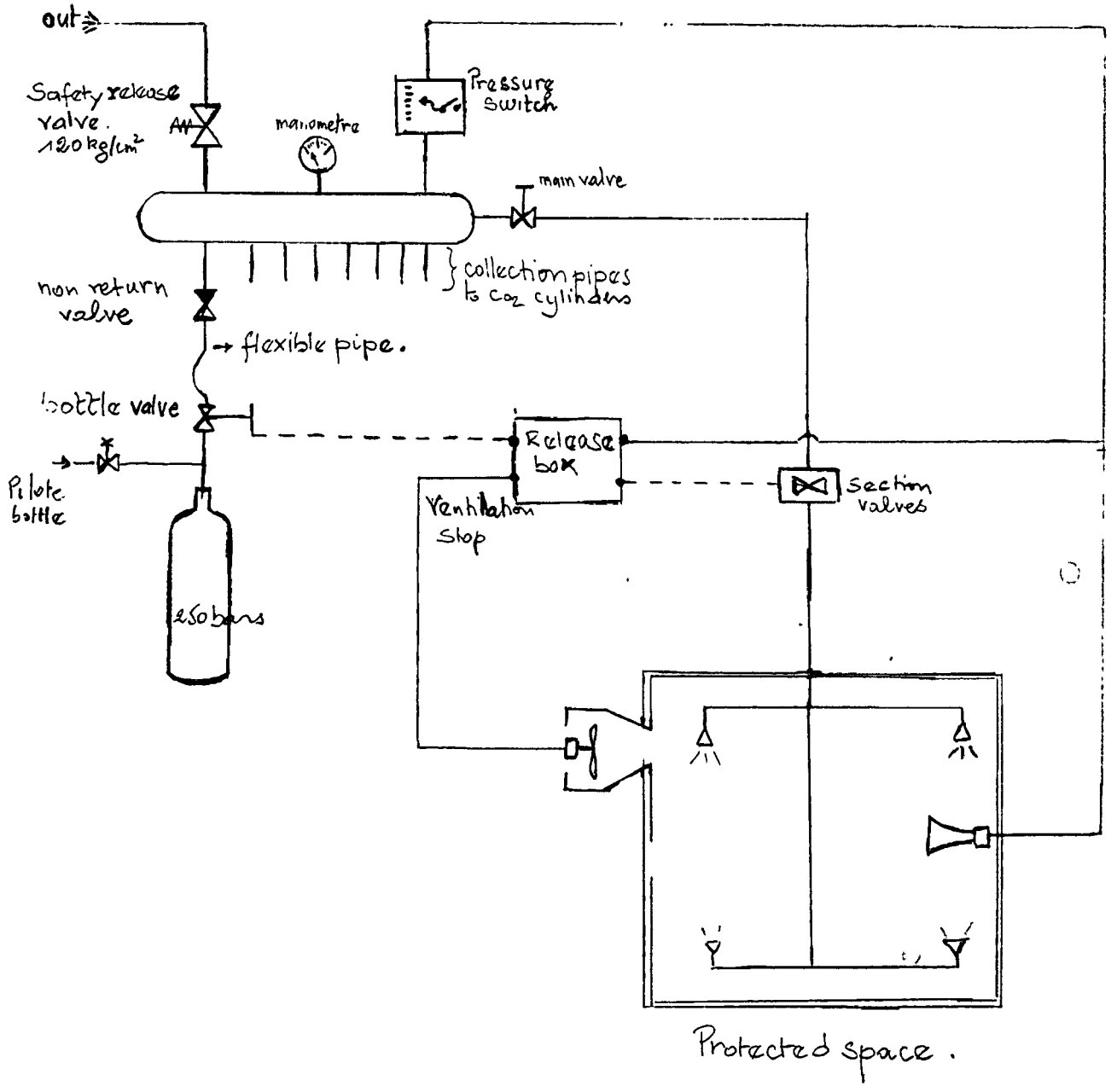
- Extinguishing medium stored outside of the space to be protected

- used for protection of:

- *machinery spaces*
- *paint stores and similar spaces*
- *galley exhaust duct*
- *cargo spaces*

- Manual release only (except very small local systems)

CO_2 - SYSTEM (HIGH PRESSURE)



Pilote bottle connection to collection pipe. Reg. II-2/2.4 for machinery spaces, 85 % fo the gas can be discharged into the space within 2 minutes.

CO_2 Fire extinguishing system survey

A. Initial survey

1) *Inspection of design (drawings, calculations)*
2) *Pressure tests of pipelines (High pressure pipeline up to the main valve or distribution valve; medium pressure pipeline thereafter*
3) *Arrangmentment of CO_2 storage room and release stations.*
4) *Fixing of the pipelines, nozzles etc. Direction of the nozzle.*

B. Annul survey

1) *External inspection*
2) *Alarm systems*
3) *Pipelines shall be blown with air (about 6 bar)*
4) *Contents of containers - weighing, level gauge (radioactivity, temperature)*
5) *Existence of instructions and markings*

C. Periodical survey

1) *Servocylinders, remote control valves shall be tested by opening one pilot bottle . (Note that the bottle battery shall be coupled off during this test!)*
2) *Check the relief valve set (pressure valve test about 100 bars)*
3) *Tightness of high pressure part of pipeline shall be checked with air (245bars).*
4) *Pipes shall be checked by blowing air (At 25 bars) . Check especially places where corrosion or other damages are evident. Check also discharge nozzles.*

5) Plus the contents of annual survey

It was requested in the draft Assembly Resolution A (16) during the MSC 57/27/ass.2 to reduce the increasing use of halons 1211, 1301 and 2402 as fire-fighting media on board ships because they were identified as ozone depleting substances.

Comparing these two extinguishing media CO_2 and Halon regarding the risk or danger to our planet, the CO_2 is not an innocent agent either because of the atmosphere's pollution.

How are the halon and the CO_2 acting?

The Halons are not directly pollutants. I mean that the halons once used evaporate, take time to arrive at the ozone's layer and deplete it. When the ozone's layer is depleted in some point our planet is not protected from the ultraviolet rays which explains the overheating of this planet in some areas today.

The CO_2 is polluting the atmosphere slowly and directly by reducing the concentration in oxygene. By this fact nature is also affected. We all know the photosynthesis phenomenon. The vegetation during the day is giving oxygene by absorbing the carbon dioxide. This phenomenon is reversed during the night. Looking at this point we think that the carbon dioxide plays a major role, consequently it is indispensable. That is true but to a certain rate or concentration. But nowadays the carbon dioxide is over produced. It comes from the smoke, the factories' machines, fumes etc. All is not absorbed by the actual vegetation.

If we don't reduce the production of CO_2 by decreasing for instance its use onboard ships as it was agreed upon to reduce the use of halons, the concentration in CO_2 of the atmosphere will be over the limit in long term and the eco-system of our planet will be affected.

5) International shore connection (water Reg.19. shore side Rs. A.470(XII))

The international shore connection (ISC) shall be capable of being used on both sides of the ships.

- fixed or portable

- on board ship each ISC shall be provided with

4 bolts and nuts (16 mm, l= 50 mm)

8 washers

gaskets

See figure.

6) Fire control plan (Reg.20)

1) - Shall be located so that it can be used when leading to fire fighting

- Permanently exhibited for guidance of ship's crew

- The marking shall be clear

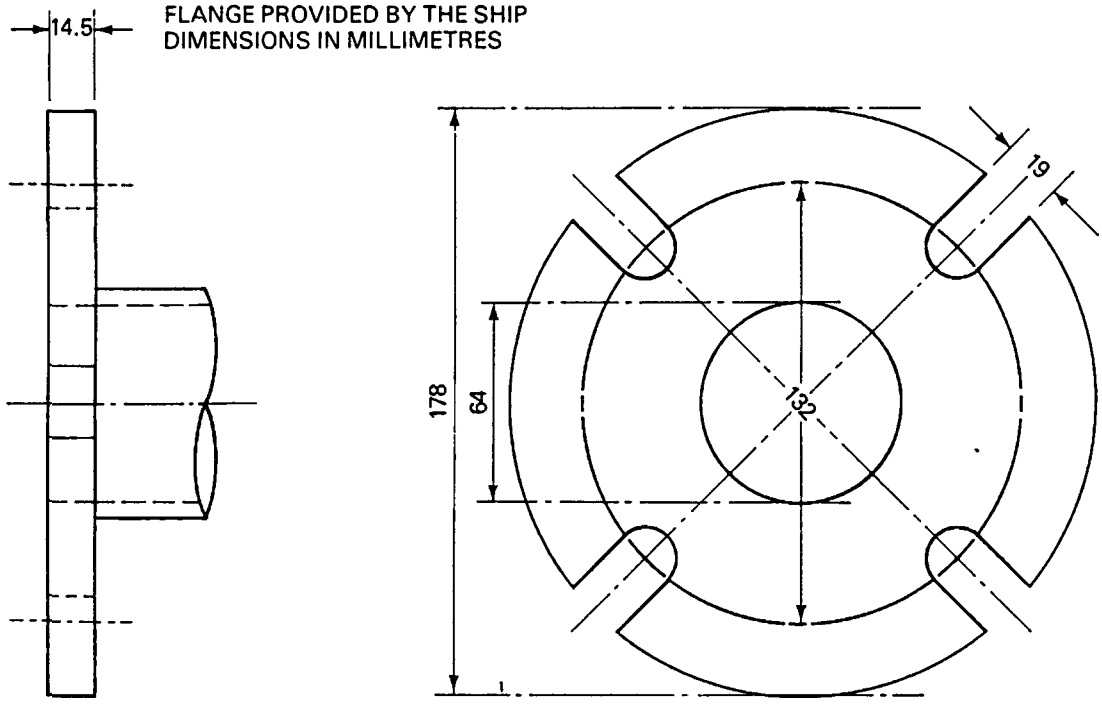
- One extra set for outside assistance "Permanently stored in a prominently marked weathertight enclosure outside the deckhouse".

2) The following shall be shown on the plan:

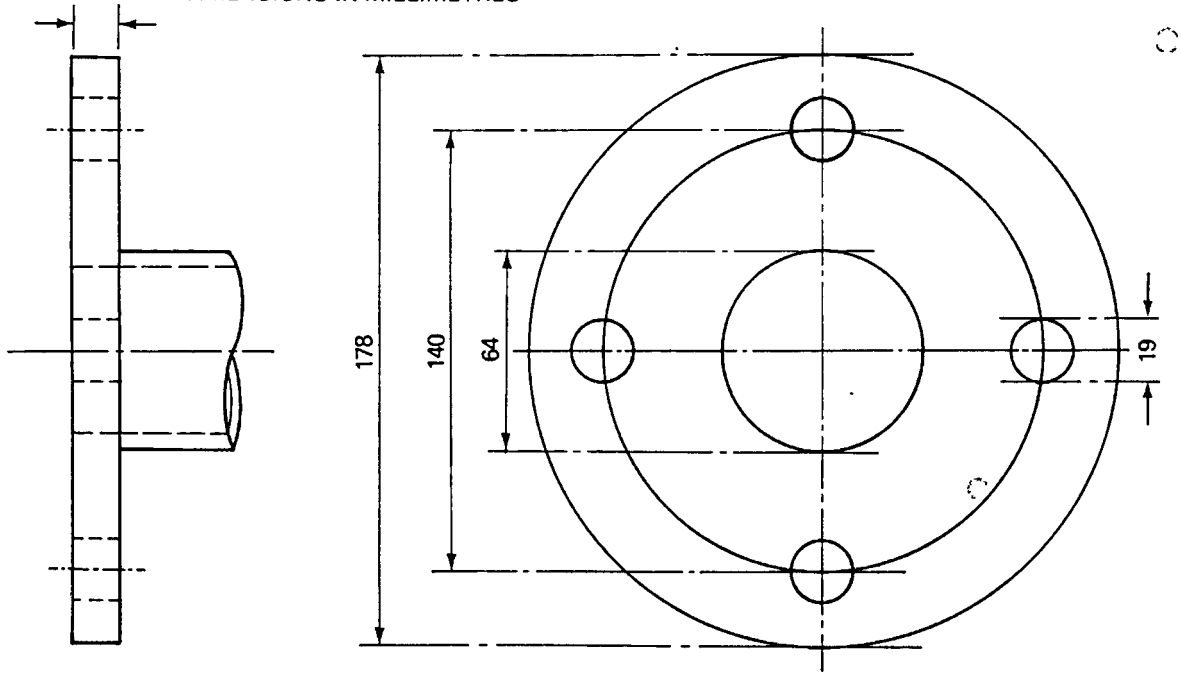
a) Emergency exits from accommodation and passenger rooms, engine room and other working spaces, cargo holds.

INTERNATIONAL SHORE FIRE CONNECTION

FLANGE PROVIDED BY THE SHIP
DIMENSIONS IN MILLIMETRES



FLANGE PROVIDED BY THE SHORE
DIMENSIONS IN MILLIMETRES



b) *Fire resistant and retarding division*

- *A class division*
- *B class division*
- *Fire doors*
- *Control stations*

c) *Ventilation arrangement*

- *Fans and fan control positions*
- *Location of damper with identification number*
- *Location of ventilation openings and shutters*

d) *Fire fighting arrangement*

- *Fire pumps and hydrants*
- *Fixed systems (Gas, foam, sprinkler)*
- *Location of fireman's outfit (Fire station)*

e) *Fire alarm*

- *Fire detection system*
- *Alarm system*

The description shall be in the flag state language and in English or French.

7) *Fire patrols (Reg. 40.3)*

the arrangements of fire patrols shall be checked:

- *The routes*
- *Intervals*
- *Way of controllling the fire patrols*
- *The instruction given to the fire patrols*

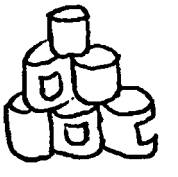
8) *Public address system and other communications (Reg. 40.5)*
The passenger ship shall be generally provided with a public address system. The ship officers should be trained in using the system in emergency situations especially in order to avoid panic among passengers.

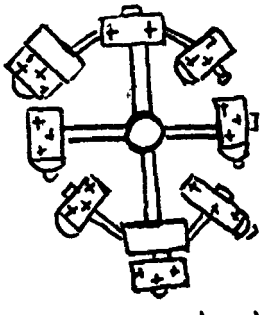
9) *Training in fire fighting*

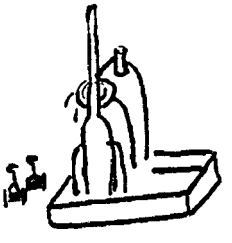
a) *Onboard training*
- periodically
- to be recorded in the log book

b) *Courses in shortside training centres required for certain certificates and for certain services onboard ships (STCW).*
As example of training centre I can mention the Malmö Rescue Fire Brigade Training Centre and the Helsingborg Training Centre , in Sweden where the concerned are trained for the use of different types of extinguishers according to the type of fire. For such purpose different arrangements are prepared such as the:

- Pyramid
- The roundabout
- The rocket
- Gasol container
- Gas welding unit
- Coach , etc.


- Pyramid


- round about


- The rocket.

The concerned are trained in how to fight against different types of fire, how to protect themselves when fighting, what is the best way to stop the spreading of fire according to the type of fire, investigation and life-saving training in the smoke-room and teaching manual charging of portable extinguishers.

10) Survey according to NASAN

When a surveyor is carrying our the annual survey he should bear in mind for the items visited fire safety first e.g. dampers or fan closing flaps. The surveyor shall check the closing first before checking the condition of the rubber for the weather tightness. See attached chek list for fire safety survey.

3 FIRE SAFETY ARRANGEMENTS

3.1 PORTABLE FIRE EXTINGUISHERS AND SAFETY PLANS

01 PORTABLE FIRE EXTINGUISHERS (Res. A. 518(13))

02 Equipment according to the Safety Plan and the Survey Book

03 Portable extinguishers - SIS marking and periodical control

04 Spare charges available

04 A Foam making liquid

05 One arbitrary extinguisher released

06 Fire hoses, nozzles , couplings, etc

07 Fire stations, number, location, content

08 One of the fire stations arranged as a training station

09 No significant changes after the previous survey

10 DRAWINGS

11 Watertight subdivision,, fire protection

12 Electrical system , ventilation system

13 Drawings posted up in a prominent and accessible place

13A Duplicate set of fire control plans or booklet stored in a prominently marked weathertight enclosure outside the deckhouse

14 Drawings correspond to the information in the Survey Book

15 Instructions, signs - Swedish and English

16

17

18

19

20

21 Safety arrangements at oil fired boilers

22 IACS proposed requirements for cargo ships of less than 500GRT

	Unrestricted trade	Restricted trade
25 Minimum three portable extinguishers in accommodation and service spaces	x	x
26 Minimum two in machinery spaces	x	x
27 Minimum 2-6 in access to machinery space	x	-
28 One 45 kg foam or 25 kg powder	x	-
29 One fireman's outfit	x	-

30

3.2 FIRE ALARMS

01 Main and sub centrals

02 Location, marking, maintenabe manual

03 Alarm for power failure, earth failure, failure in any loop

04 Alarm for internal fuse failure

05 Continous charging of spare batteries

06 Location signs / drawings

07 Circuits

08 All circuits intact

09 Alarm from some arbitrary chosen "manually operated call points"

10 Alarm from some arbitrary chosen detectors

11 Heat detectors - short circuit / heating

12 Diferentioal detectors - heated air

13 Smoke detectors - smoke/special equipment

14 Flame detectors - Flashlight

15 Line detectors - Breaking of the line

16 Simulation of failure

17 Fan stop and magnetic holders

18 Accommodation fans stop at accommodation alarm

19 Engine room fans stop at engine room alarm

20 Door magnets without power supply at alarm

21 Manual release at the doors

22 Timers

23 Timer for disconnection of loops.

24 Manually operated call points not disconnected by timer

25 Alarm apparatus (clocks, typhoons, etc)

26 Location, marking, character, audibility, etc

27 Smoke alarm

28 Central, alarm apparatus as above

29 Piping system, clamming purging, drainage

30 Maintenance manual

31 Fire alatm for cargo holds

32 CO_2 extinguisher in the galley

Annual survey

3.3 FIRE MAIN

01 Piping

02 Condition, securing

03 Isolation valves at every 40 metres

04 Isolation valve in the discharge line from the engine room

05 Safety valves - location, performance

06 International shore connection

07 Hydrants - good working order

08 Fire pumps

09 Pumps - marking, performance

10 Controls - location, marking

11 Emergency fire pump

12 Pump - location, marking, performance

13 Controls - location, marking

14 Bottom valves - controls where the pump is located

15 Electrical driven pump ?

16 Connected to the emergency source of power

17 Diesel driven pump ?

18 Motor - location, accessibility

19 Emergency pump room - ventilation, heating

20 Oil tank - volume, location, isolation valve

21 Test running with two jets of water in operation

22 -"- with emergency fire pump

23 Sprinkler/Water spray ?

24 Emergency bilge system

25 IACS PROPOSED REQUIREMENTS FOR CARGO SHIPS OF LESS

26

27

		Unrestricted trade	Restri trade
28	No 1 main fire pump	x	x
29	No 2 main fire pump	x	-
30	Emergency hand pump outside E.R.	x	x
	Fire hydrants with hose and nozzle		
31	One fire hose for each 30 m length	x	x
32	Minimum three	x	-
33	On jet/fog nozzle for E.R.	x	x

3.4 FIXED FIRE EXTINGUISHING SYSTEMS

01 CO_2 and halon systems

02 Release - alarm, fan stop, instruction, marking

03 Alarm - performance, marking, character, power supply

04 Evacuation - power supply, controls, dampers, suction level

05 Maintanance manual, signs

06 Additions for CO_2

07 CO_2 room - ventilation, key location

08 Manifold - gauging, manoeuvring, main valve

09 Additions for halons

10 Leakage indication, correct filling

11 Electrical release - connection to the emergency source of power

12 High - expansion foam systems

13 Electrical motor/emergency power
Diesel motor/two starting arrangements

14 Apparatus room - insulation, heating, ventilation, key

15 Foam ducts - closing arrangements

16 Water tank - level indicator, connection to the fire main

17 Foam liquid - quantity, quality, level gauging

18 Pipelines - location, clamping, marking

19 Alarm - performance, marking, character, power supply

20 Maintenance manual, signs

21 Performance test

22 Pressure water-spraying systems

23 Electrical motor - emergency power,
Diesel motor - two starting arrangements

24 Bottom valves - Controls where the pump is located

25 Valve central - heating, ventilation, key

26 Piping system - condition, securing, marking

27 Connection to the fire main, non-return valve

28 Maintenance manual, signs

29 Drainage of the space protected

30 Performance test

31 Fixed fir extinguishing system for cargo pump room

3.5 VENTILATION SYSTEMS AND EMERGENCY DISCONNECTION ARRANGEMENTS, ETC.

01 Ventilation arrangements
02 Fans
03 Automatic stopping at a central control place
04 Instructions, marking
05 Manually operated dampers
06 Performance, marking
07 Electrical/pneumatic/hydraulic dampers
08 Performance, marking
09 Closing at power failure, remote control
10 Indication panel, marking
11 Emergency closing arrangements
12 Oil pipes, fuel pumps, separators
13 Performance, marking
14 Bottom and overboard valves, quick closing
15 Performance, marking, indication
16 Emergency escapes
17 Engine room, cargo spaces, accommodation and service spaces
18 Marking, not blocked, locking arrangements
19 Insulation, if applicable
20
21 Remote cut out of electric power consumers
22 Number of air changes
23
24
25 Cowls and flaps for ventilators
26
27
28 Remote closing of seawater valves
29
30

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