RESOLUTION A.544(13)

Adopted on 17 November 1983
Agenda item 12

STANDARDS FOR PROCEDURES AND ARRANGEMENTS CALLED FOR BY ANNEX II OF THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

THE ASSEMBLY,

RECALLING Article 16(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations concerning marine pollution,

NOTING that Regulations 5 and 8 of Annex II of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) calls upon the Organization to develop standards for procedures and arrangements for the discharge of noxious liquid substances into the sea and for procedures for the removal of cargo residues from tanks by precleaning or ventilating such tanks, with a view to providing a uniform basis for the guidance of Parties to the Convention in approving such procedures and arrangements,

HAVING CONSIDERED the recommendation made by the Marine Environment Protection Committee at its eighteenth session,

1. ADOPTS the Standards for Procedures and Arrangements called for by Annex II of MARPOL 73/78 as set out in the Annex;

2. REQUESTS the Marine Environment Protection Committee to keep these Standards under review in the light of experience gained from trial application of them and other developments and to adopt any revision to the Standards not later than at its twenty-first session in the spring of 1985, in order to enable the timely modification of chemical tankers and training of their crew with a view to full compliance with the requirements of Annex II of MARPOL 73/78 when it enters into force;

3. REQUESTS FURTHER the Marine Environment Protection Committee not to adopt any further amendments to the revised Standards before the entry into force of Annex II of MARPOL 73/78;

4. RESOLVES that a chemical tanker equipped in accordance with the above revised Standards shall not be subject to equipment requirements of further amendments to the Standards which may be adopted by the Marine Environment Protection Committee after the entry into force of Annex II of MARPOL 73/78, unless there is a compelling need and the costs and benefits of the application of such requirements to existing chemical tankers have been fully considered in compliance with resolution A.500(XII).

ANNEX

STANDARDS FOR PROCEDURES AND ARRANGEMENTS CALLED FOR BY ANNEX II OF THE INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973, AS MODIFIED BY THE PROTOCOL OF 1978 RELATING THERETO

CONTENTS

PREAMBLE

1 The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78) in Annex II (hereinafter referred to as Annex II) *inter alia* provides for the control of operational discharges of noxious liquid substances carried by chemical tankers whether they be self-propelled or non-self-propelled. Operational discharges in this context mean the discharges of noxious liquid substances or water contaminated by these substances which are the result of cargo tank and line washing, deballasting of unwashed cargo tanks or bilge slops.

2 Annex II prohibits the discharge into the sea of noxious liquid substances listed in Annex II except when the discharge is made under specified conditions. These conditions vary according to the degree of hazard a noxious liquid substance poses to the marine environment. For this purpose the noxious liquid substances have been divided, in accordance with the guidelines set out in Appendix I to Annex II, into four Categories, A, B, C and D.

3 Annex II, Regulation 5, specifies the conditions under which discharge of residues of Category A, B, C and D substances may take place. These conditions are not reproduced in this document but include such parameters as: the maximum quantity which may be discharged into the sea; speed of ship; distance from nearest land; minimum depth of water; maximum concentration of substance in ship's wake or dilution of substance prior to discharge.

4 For certain sea areas, called "special areas", more stringent discharge requirements are given.

5 The Standards for Procedures and Arrangements for the Discharge of Noxious Liquid Substances into the Sea called for by Annex II (hereinafter referred to as the Standards) have been developed in response to resolution 13 of the International Conference on Marine Pollution, 1973, and in compliance with Regulations 5 and 8 of Annex II. The Standards provide a uniform basis for the guidance of the Parties to MARPOL 73/78 for the purpose of approving procedures and arrangements as required for each chemical tanker for discharging noxious liquid substances. The Standards will take effect upon the coming into force of Annex II.

6 Chemical tanker design and operational procedures were taken into account in developing these Standards.

7 The Annex II requirements are not restated in the Standards. To ensure compliance with Annex II, the requirements of Annex II and those contained in the Standards should be considered together.

8 The Standards were designed in such a manner so as to encourage shipowners to improve cargo tank stripping efficiencies in order to reduce the residue remaining in the tank to less than the maximum levels set out in Annex II. In this manner the quantity of Annex II Category B, C, and D noxious liquids as well as the quantity of unregulated substances that are discharged into the sea will be reduced.

9 The Standards are based on the following assumptions:

- Annex II discharge requirements and certification requirements have been interpreted as requiring each ship to have a Procedures and Arrangements Manual approved by the Administration and containing the information specified in the Standards and the requirements of Annex II;
- the quantities of residue remaining in a cargo tank after complete discharge as indicated in a ship's approved Procedures and Arrangements Manual will be accepted for every cargo discharge, provided the specified conditions are satisfied:
- the equations used in the residue assessment method of the Standards are based on values of favourable list and trim of 0.5° and 0.2° respectively (or equivalent slope of the tank bottom);

- the wake dilution formula as defined in the Standards specifies, within practical limits, maximum discharge rates of residue/water mixtures such that the concentration of noxious liquid substances in the wake does not exceed the limits specified in Annex II;
- the underwater discharge outlet required by Annex II will, if conforming to the Standards, direct any effluent into the wake of the ship;
- residue/water mixtures in a tank may be discharged directly from a cargo tank into the sea under specified conditions;
- the use of approved prewash procedures or the use of efficient stripping systems, to reduce the cargo residue quantity to that defined as acceptable in the above paragraph for direct discharge from the cargo tank into the sea will be taken as equal on the understanding that:
  (a) efficient stripping applies only to those Category B and C substances which are not solidifying and which have viscosities of less than 50 mPa·s (50 centipoise) at the carriage temperature; and
  (b) the efficient stripping systems must be capable of reducing the residues in the associated piping and near the suction point to one tenth of the acceptable quantities permitted by Annex II;
- prewash procedures performed in accordance with the Standards will fulfil the prewash requirements for Category B substances in special areas contained in Regulation 5(8)(a), and the requirements for Category A substances contained in Regulations 5(1) and 5(7) of Annex II and may be accepted as attainment of the prescribed residual concentrations as permitted by Regulation 8(4)(a);
- means of recording outflow of effluent are required to enable a ship's operator to comply and the Administration to ensure compliance with the requirements of the Convention;
- the presence of a "sheen" resulting after discharges of some Category B and C substances shall not be regarded as contrary to the principles of Annex II, provided that discharges have been made in accordance with the Standards;
- any water introduced into a cargo tank subsequent to the removal of cargo residues through ventilation procedures conducted in accordance with the Standards, shall be regarded as being clean and consequently will not be subject to the discharge requirements of Annex II as called for by its Regulations 5(5) and 5(10).

CHAPTER 1 – GENERAL

1.1 Purpose

The purpose of the Standards is to provide a uniform international basis for approving procedures and arrangements by which chemical tankers can satisfy the discharge provisions of Annex II. It is on the basis of the Standards that the Administration shall approve the procedures and arrangements necessary for the issue of an "International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk" to each such ship. For that purpose the procedures and arrangements for each ship are to be laid out in an approved Procedures and Arrangements Manual.

1.2 Scope

1.2.1 The Standards shall apply to all ships which carry Category A, B, C or D noxious liquid substances in bulk.

1.2.2 The Standards have been developed to ensure that the criteria for the discharge of noxious liquid substances specified in Regulations 5 and 8 of Annex II will be met. For Category A substances, the Standards identify a prewash procedure which may be used in lieu of monitoring the concentration of the effluent of a tank from which washwater containing a Category A substance is discharged. For Category B and C substances, the Standards identify procedures and arrangements which will ensure that the maximum quantity of residue that may be discharged per tank and the maximum permitted concentration of the substance in the ship's wake are not exceeded. For Category A, B, C and D substances, the Standards identify ventilation procedures which may be used to remove residues from cargo tanks.

1.2.3 The Standards do not cover the means by which the Administration ensures compliance with a ship's approved procedures and arrangements, and neither do they cover details of any constructions or materials used.

1.2.4 Regulation 13 of Annex II requires chemical tankers carrying Category A, B or C noxious liquid substances to comply with the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk* (hereinafter referred to as the Bulk Chemical Code) as may be amended. All constructions, materials and equipment fitted as a requirement of Annex II and of the Standards shall therefore comply with the Bulk Chemical Code for all substances the vessel is certified to carry in accordance with its Certificate of Fitness under that Code.

1.3 Definitions

1.3.1 "Average concentration" means the volume of the assessed quantity of residue divided by the total volume of residues and water present.

1.3.2 "Residue" means any noxious liquid substance which remains for disposal.

1.3.3 "Residue/water mixture" means residue to which water has been added for any purpose (e.g. tank cleaning, ballasting, bilge slops).

1.3.4 "Homogeneous mixture" means a residue/water mixture in which the concentration at any time during discharge from a tank does not exceed the average concentration in that tank by more than 25%.

1.3.5 "Non-homogeneous mixture" means a residue/water mixture which is not homogeneous.

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* After the entry into force of Annex II, it is anticipated that Regulation 13 will be amended to the effect that certain chemical tankers will be required to comply with the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code) adopted by the MSC at its forty-eighth session on 17 June 1983.

1.3.6 "Miscible" means soluble with water in all proportions at washwater temperatures.

1.3.7 "Associated piping" means the pipeline from the suction point in a cargo tank to the shore connection used for discharging the cargo and includes all ship's piping, pumps and filters which are in open connection with the discharge line.

1.3.8 "Potentially solidifying substance" means any noxious liquid substance which has a melting point above 0°C.

1.3.9 "Solidifying substance" means a potentially solidifying substance (as defined above) which at the time of discharge is at a temperature of:

.1 less than 5°C above the melting point for a substance with a melting point between 0°C and 15°C; and

.2 less than 15°C above the melting point for a substance with a melting point above 15°C

and which is discharged from an uninsulated tank having surfaces exposed to other cargoes or to seawater with temperatures less than the substance's melting point.

1.3.10 "High viscosity substance" means a noxious liquid substance with a viscosity greater than 50 mPa·s at 20°C.

1.4 Equivalents

1.4.1 The Administration may allow any procedure or arrangement as an alternative to that required by the Standards provided that such procedure or arrangement is at least as effective as that required by the Standards. The authority of the Administration does not extend to substitution of requirements contained in Annex II.

1.4.2 The Administration which allows a procedure or arrangement as an alternative to that required by the Standards shall promptly communicate to the Organization the particulars of the approved equivalent for circulation to the Parties to MARPOL 73/78.

1.5 Certification

1.5.1 Before issuing the International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk the Administration shall examine, and, if satisfied, approve:

.1 the Procedures and Arrangements Manual for compliance with Annex II and the Standards;

.2 the equipment provided for compliance with the Standards and other specifications recommended by the Organization.

1.5.2 When a ship's Procedures and Arrangements Manual has been approved by the Administration it shall be accepted by other Parties to MARPOL 73/78 on the basis of the issue of the Certificate.

1.5.3 Reference to this Manual shall be made by the Administration in the ship's International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk.

1.6 Safety considerations

The Standards are concerned with the marine environmental aspects of the cleaning of cargo tanks which have contained noxious liquid substances, the discharge of residues and mixtures from these operations and the discharge of residues from pump-room bilges. Certain of these operations are potentially hazardous but no attempt is made in the Standards to lay down

safety standards covering all aspects of these operations. For a description of potential hazards reference should be made to the Bulk Chemical Code and other documents as developed and published by the relevant associations or organizations, e.g. the Tanker Safety Guide (Chemicals) of the International Chamber of Shipping (ICS Guide). Some potential hazards are mentioned below.

1.6.1 *Incompatibility*

In mixing residue/water mixtures containing different substances, compatibility should be carefully considered. Reference should be made to an approved slops compatibility guide. An example of such a guide is set out at Appendix D.

1.6.2 *Electrostatic hazards*

Recirculation mixing methods or homogenization techniques provided for use in slop tanks, or in cargo tanks used as slop tanks, should be carefully considered in relation to electrostatic hazards.

1.6.3 *Tank entry hazards*

The safety of persons required to enter cargo tanks or slop tanks in order to collect data for the preparation of residue tables or for any other purpose should be carefully considered.

1.6.4 *Reactivity hazards*

Water washing of cargo tanks having contained certain substances may produce undesirable reactions. Substances producing such reactions are identified in column VII of Appendix B.

1.6.5 *Ventilation hazards*

The hazards associated with tank ventilation identified in the ICS Guide should be considered.

1.6.6 *Line clearing hazards*

The hazards associated with line clearing identified in the ICS Guide should be considered.

1.7 **Information on homogenization to be communicated to the Organization**

1.7.1 The Administration shall communicate to the Organization the particulars of approved homogenization equipment or homogenization methods for circulation to Parties to MARPOL 73/78.

CHAPTER 2 – EQUIPMENT AND CONSTRUCTIONAL STANDARDS

2.1 General

2.1.1 This chapter contains the standards for the equipment and constructional features enabling a chemical tanker to comply with the residue discharge requirements of Annex II.

2.1.2 The equipment requirements in this chapter must be read in conjunction with the operating requirements in chapters 3, 4 and 5 in order to determine what equipment is needed on the ship.

2.1.3 The master shall ensure that no residues or residue/water mixtures are discharged into the sea, unless the equipment listed in the Manual required by chapter 6 and needed for the discharge is used.

2.2 Pumping systems

2.2.1 The cargo pumping system shall be capable of pumping out the cargo to the maximum practical extent and preferably so that the residue left in the tank and pumping system does not exceed the amount permitted by Regulations 5(2)(c), (3)(c) or (9)(c) of Annex II.

2.2.2 The cargo pumping system may be used for the discharge of residues and residue/water mixtures provided that the discharge rate is below, or can be reduced to, rates set out in sections 4.5 and 4.6.

2.2.3 When, for the purpose of residue or residue/water mixture discharge, controlled pumping rates are needed to meet the requirements of chapter 4, one of the following systems shall be used:

.1 a variable rate pumping system in which:

.1.1 the capacity is adjusted by varying the pump speed; or

.1.2 the capacity is adjusted through the use of a throttling arrangement fitted on the discharge piping;

.2 a fixed rate pumping system with a capacity not exceeding the permissible discharge rate as set out under sections 4.5 and 4.6.

2.2.4 If the pumping rates are controlled in accordance with 2.2.3.1, a means of indicating the flow rate must be provided. The equipment provided in accordance with 2.6 may be used for this purpose.

2.3 Efficient stripping systems

2.3.1 An efficient stripping system may be used to prepare a cargo tank for direct overboard discharge of residue/water mixtures of non-solidifying substances with viscosities below 50 mPa·s (50 centipoise) at the carriage temperature. If fitted and used for this purpose, the equipment must meet the requirements of paragraphs 2.3.2 and/or 2.3.3 as applicable.

2.3.2 In the case of Category B substances to be discharged into the sea outside special areas and Category C substances to be discharged into the sea inside special areas, the equipment shall be able to reduce the amount of residue near the suction point and in the associated piping system after unloading to 0.1 m^3 or less.

2.3.3 In the case of Category C substances to be discharged into the sea outside special areas, the equipment shall be able to reduce the amount of residue near the suction point and in the associated piping system after unloading to 0.3 m^3 or less.

2.3.4 Each efficient stripping system must meet a test in which water is used as the liquid to be removed to determine compliance with the design requirements of paragraph 2.3.2 or paragraph 2.3.3. The amount of residues around the suction point and in the associated piping (including that of the stripping system) shall be determined by direct measurement. Where any portion of the piping does not naturally drain to the suction point, such portion shall have a drain plug or similar fitting equipment, for the purpose of direct measurement of the amount of residue. If drain plugs or similar devices cannot be fitted, the amount may be determined by a calculation method.

2.3.5 In all cases the stripping system shall be permanently installed and be able to operate with tank openings closed.

2.4 Effluent discharge outlet location

2.4.1 The discharge outlet (or outlets) shall be located within the cargo tank area in the vicinity of the turn of the bilge.

2.4.2 The discharge outlet (or outlets) shall be arranged so as to avoid the re-intake of noxious effluent by ship water intakes used for domestic purposes.

2.4.3 If dual outlets are provided to achieve a higher permissible discharge rate these shall be located on opposite sides of the ship.

2.5 Discharge outlet size

2.5.1 The discharge outlet arrangement shall be such that the effluent discharged into the sea in accordance with sections 4.4, 4.5, 4.6 or 4.8 of the Standards will not pass through the ship's boundary layer. To this end, when the discharge is made normal to the ship's hull, the minimum diameter of the discharge outlet is governed by the following equation:

$$D = \frac{Q_D}{5L}$$

where D = minimum diameter of the discharge outlet, in metres

L = distance from the forward perpendicular to the discharge outlet, in metres

Q_D = discharge rate, in cubic metres per hour

Q_D is the maximum rate at which residue/water mixtures, described in sections 4.4, 4.5, 4,6, and 4.8, may be discharged through that outlet.

2.5.2 When the discharge is directed at an angle to the hull, the above relationship shall be modified by substituting for Q_D the component of Q_D, which is normal to the vessel's hull.

2.6 Means of control

2.6.1 In addition to maintaining the cargo record book required by Regulations 8 and 9 of Annex II, the discharge of residue or residue/water mixtures into the sea in accordance with sections 4.4, 4.5, 4,6 and 4.8 shall be registered.

2.6.2 Means of registering outflow of effluent shall be fitted in accordance with one of the following:

.1 when using fixed rate discharge pumps: with time recording of the pump operation; or

.2 when using variable rate discharge pumps: with time recording of the flow rate of the pump effluent; or

.3 regardless of the type of pumping system: with time recording of the flow rate through the below water discharge pipe(s).

2.6.3 The above recording devices shall be capable of recording the start and stop time of discharge and/or the flow rate through the discharge pipe, with actual time (GMT or other standard time). The date shall be recorded either manually or automatically.

2.6.4 If the outflow recording unit becomes defective, a manual alternative method shall be used. The master shall report such a defect as soon as possible to the Administration and report again when the unit is restored to full operation or is replaced by a properly functioning unit. The defective unit shall be made operable as soon as possible but at least within a period of 60 days.

2.6.5 The accuracy of the outflow recording unit shall be within 10% of the actual flow.

2.7 **Slop tanks**

2.7.1 Although Annex II does not require the fitting of dedicated slop tanks, slop tanks may be needed for certain washing procedures. Cargo tanks may be used as slop tanks.

2.7.2 A slops compatibility guide shall be provided. An example of a slops compatibility guide is given in Appendix D.

2.8 **Homogenization equipment**

2.8.1 Homogenization equipment or a homogenization method shall be such as to ensure that the discharge effluent is a homogeneous mixture as defined in paragraph 1.3.4.

2.9 **Ventilation equipment**

2.9.1 If residues from cargo tanks are removed by means of ventilation, ventilation equipment meeting the requirements of Appendix F shall be provided.

CHAPTER 3 – OPERATIONAL STANDARDS FOR CATEGORY A SUBSTANCES

3.1 General

3.1.1 This chapter applies to any chemical tanker certified to carry Category A substances.

3.1.2 A chemical tanker to which this chapter applies shall be provided with an approved Procedures and Arrangements Manual developed in accordance with chapter 6 of the Standards. The master shall ensure that discharges of Category A substances are made in accordance with the approved Manual.

3.2 Precleaning of a Category A substance from a cargo tank

3.2.1 Annex II requires that when a tank that has contained a Category A substance is washed, the resulting residue/water mixtures be discharged to a reception facility until the concentration of the substance in the effluent is reduced below a specified value. Where it is found to be impracticable to measure the concentration of the substance in the effluent in accordance with Regulation 8(4) of Annex II, a precleaning procedure in accordance with Appendix C shall be applied.

3.2.2 Subsequent discharge of tank washings into the sea shall be in accordance with the other requirements of Regulation 5(1) or Regulation 5(7).

3.3 Ventilation of Category A substances from cargo tanks

3.3.1 Ventilation procedures may be used for the removal of cargo residues. Such procedures, however, may only be applied for those substances having a vapour pressure more than $5 \times 10^3 P$ (50 mbar) at 20°C.

3.3.2 The procedures set out in Appendix F shall be followed when a tank is to be ventilated to remove cargo residues.

3.3.3 In ventilating a tank the associated piping of the tank shall be cleared of liquid and the tank shall be ventilated until no visible remains of liquid can be observed in the tank. When direct observation is impossible or impractical, means for detection of liquid remains shall be provided.

3.3.4 When the tank has been dried in accordance with the Standards, water introduced into the cargo tank for ballasting or for preparing the tank to receive the next cargo shall be regarded as clean and should not be subject to the discharge requirements of Annex II.

3.4 Cleaning agents and additives

Each cleaning medium which falls under the definition of a "harmful substance" contained in article 2 of MARPOL 73/78 shall be treated in accordance with MARPOL 73/78.

CHAPTER 4 – OPERATIONAL STANDARDS FOR CATEGORY B AND C SUBSTANCES

4.1 General

4.1.1 This chapter applies to any chemical tanker certified for carrying Category B and C substances.

4.1.2 A chemical tanker from which residues of Category B and C substances are discharged shall be provided with a Procedures and Arrangements Manual developed in accordance with chapter 6 of the Standards. The master shall ensure that discharges of Category B and C substances are made in accordance with the procedures set out in the approved Manual.

4.1.3 For the purpose of this chapter, residue quantities shall be defined as follows:

.1 "Excessive quantity" means in the case of Category B substances a quantity more than 1 m^3 (or 1/3000th of the tank capacity, whichever is greater), and in the case of Category C substances a quantity more than 3 m^3 (or 1/1000th of the tank capacity, whichever is greater), when the discharge is to be made outside a special area and 1 m^3 (or 1/3000th of the tank capacity, whichever is greater), when the discharge is to be made inside a special area;

.2 "Efficient stripping quantity" means a quantity of residue equal to or less than the amount specified in 2.3.2 or 2.3.3, whichever is applicable;

.3 "Permitted quantity" means a quantity less than an excessive quantity but more than an efficient stripping quantity.

The method of residue discharge that can be used is dependent on the residue quantity and the area where the discharge is to be effected.

4.1.4 The requirements of sections 4.2, 4.3, 4.4, 4.5 and 4.6 only apply when a tank is to be washed or ballasted and some or all of the residue is to be discharged into the sea.

4.2 Pumping and stripping

4.2.1 In unloading a cargo tank containing a Category B or C substance, the tank and its associated piping shall be emptied to the maximum practical extent.

4.2.2 During draining of the tank, the vessel's list and trim shall be such as to ensure a positive flow of cargo to the tank's suction point. A minimum list of 0.5° and a minimum trim of 0.2° (or equivalent slope of the tank bottom) satisfy this requirement.

4.2.3 When the condition of paragraph 4.2.2 is not achieved, the tank shall be assumed to contain an excess quantity of residue and the requirements of paragraph 4.4.1 apply.

4.3 Assessment of the quantity of residue remaining

4.3.1 If, after unloading, draining and stripping a Category B or C cargo, the tank is to be washed or ballasted, the quantity of residue remaining shall be assessed in accordance with the Procedures and Arrangements Manual.

4.4 Tank washing, ballasting and residue disposal procedures for cargo tanks*

4.4.1 *Cargo tanks containing excessive quantities (Category B and C substances, where the discharge is to be made inside and outside special areas)*

.1 If such a cargo tank is to be washed or ballasted, subject to the provisions of subparagraph .3 below, a prewash procedure as specified in Appendix C shall be applied. The residue/water mixture generated during the prewash shall be discharged to a reception facility.

.2 Any water introduced into the tank subsequent to the application of the prewash described above for the purpose of further washing or ballasting may be discharged into the sea without any consideration of the discharge rate but must be in accordance with the other discharge requirements of Annex II (i.e. vessel's speed, position and discharge outlet location).

.3 Ballast water may not be introduced into the tank if the prewash procedure has not been applied, unless the ballast water is subsequently discharged to a reception facility.

4.4.2 *Cargo tanks containing permitted quantities (Category B substances where the discharge is to be made outside special areas, Category C substances where the discharge is to be made inside and outside special areas)*

.1 If such a cargo tank is to be washed or ballasted, subject to the provisions of subparagraph .3 below, a prewash procedure as specified in Appendix C shall be applied. The residue/water mixture generated during the prewash shall be discharged to a reception facility or alternatively shall be transferred to a slop tank or a cargo tank designated as a slop tank for subsequent discharge into the sea. The procedures for the discharge of residue/water mixtures from slop tanks or cargo tanks designated as slop tanks are set out under sections 4.5 and 4.6.

.2 Any water introduced into the tank subsequent to the application of the prewash described above for the purpose of further washing or ballasting may be discharged into the sea without any consideration of the discharge rate but must be in accordance with the other discharge requirements of Annex II (i.e. vessel's speed, position and discharge outlet location).

.3 Notwithstanding the provisions of subparagraph .1 above, ballast water may be introduced into the tank without applying a prewash procedure provided the discharge pipeline is flushed into the tank. For subsequent disposal of the residue/water mixture, such a tank shall be regarded as a slop tank. The procedures for the discharge of residue/water mixtures from slop tanks or cargo tanks designated as slop tanks are set out under sections 4.5 and 4.6.

4.4.3 *Cargo tanks containing permitted quantities (Category B substances where the discharge is to be made within special areas)*

.1 If such a cargo tank is to be washed or ballasted, subject to the provisions of subparagraph .3 below, a prewash procedure as specified in Appendix C shall be applied. The residue/water mixture generated during the prewash shall be discharged to a reception facility or alternatively to a slop tank or a cargo tank designated as a slop tank for subsequent discharge into the sea outside special areas.

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*Note: The requirements of paragraphs 4.4.1, 4.4.2, 4.4.3, 4.4.4 and 4.4.5 apply when the discharge occurs in the location specified. That is, 4.4.2 applies to the discharge of a Category B residue/water mixture outside a special area even though the cargo may have been unloaded in a port located within a special area.

.2 Any water introduced into the tank subsequent to the application of the prewash described above for the purpose of further washing or ballasting may be discharged into the sea without any consideration of the discharge rate but must be in accordance with the other discharge requirements of Annex II (i.e. vessel's speed, position and discharge outlet location).

.3 Ballast water may not be introduced into the tank if the prewash procedure has not been applied unless the ballast water is subsequently discharged to a reception facility or alternatively into the sea outside special areas. In the latter case the provisions set out in paragraph 4.4.2.3 apply.

4.4.4 *Cargo tanks containing an efficient stripping quantity (Category B substances where the discharge is to be made outside special areas and Category C substances where the discharge is to be made inside and outside special areas)*

.1 If such a cargo tank is to be washed or ballasted, no prewash procedure need be applied.

.2 Any water introduced into the tank for the purpose of washing or ballasting may be discharged into the sea without any consideration of the discharge rate but must be in accordance with the other discharge requirements of Annex II (i.e. vessel's speed, position and discharge outlet location).

4.4.5 *Cargo tanks containing efficient stripping quantities (Category B substances where the discharge is to be made within special areas)*

.1 If such a cargo tank is to be washed or ballasted, subject to the provisions of subparagraph .3 below, a prewash procedure as specified in Appendix C shall be applied. The residue/water mixture generated during the prewash shall be discharged to a reception facility or alternatively to a slop tank or a cargo tank designated as a slop tank for subsequent discharge into the sea outside special areas.

.2 Any water introduced into the tank subsequent to the application of the prewash described above for the purpose of further washing or ballasting may be discharged into the sea without any consideration of the discharge rate but must be in accordance with the other discharge requirements of Annex II (i e. vessel's speed, position and discharge outlet location).

.3 Ballast water may not be introduced into the tank if the prewash procedure has not been applied unless the ballast water is subsequently discharged to a reception facility or alternatively into the sea outside special areas. In the latter case the provisions set out in paragraph 4.4.4.2 apply.

4.5 **Discharge into the sea of a homogeneous residue/water mixture from a slop tank or cargo tank**

4.5.1 A residue/water mixture is a homogeneous mixture if one or both of the following conditions are met:

.1 only miscible substances as defined in paragraph 1.3.6 are present (an indication of the miscibility or immiscibility of substances is given in column VII of Appendix B);

.2 homogenization equipment as described in section 2.8 is used for discharge.

4.5.2 Before a homogeneous mixture is discharged into the sea, the composite concentration, C_s, shall be determined in accordance with the method in Appendix G.

4.5.3 The residue/water mixture may be discharged into the sea provided the rate does not exceed that defined by the equations:

$$Q_D = \frac{KV^{1.4} L^{1.6}}{C_s}$$ when a single outlet is used; or

$$Q_D = \frac{1.5\ KV^{1.4} L^{1.6}}{C_s}$$ when dual outlets are used

where Q_D = rate of discharge of residue/water mixture, in cubic metres per hour

V = ship's speed, in knots

L = ship's length, in metres

$K = 4.3 \times 10^{-5}$

C_s = composite concentration of substance in a residue/water mixture expressed as a volumetric ratio.

Calculation of permitted discharge rates by means of a nomogram is illustrated in Appendix E.

4.5.4 The discharge shall also be in accordance with the other discharge requirements of Annex II (i.e. vessel's position and speed and discharge outlet location). Prewash slops containing Category B substances must not be discharged into the sea inside a special area.

4.6 **Discharge into the sea of a non-homogeneous mixture from a slop tank or a cargo tank**

4.6.1 A residue/water mixture will be considered to be non-homogeneous if both of the following conditions are met:

.1 an immiscible substance or substances are present; and

.2 homogenization equipment as described in section 2.8 is not used.

4.6.2 If any Category B substances are present in a non-homogeneous mixture and the discharge takes place outside special areas, the residue/water mixture shall be treated as pure Category B substance whereby the discharge rate shall not exceed:

$$Q_D = KV^{1.4} L^{1.6}$$ when a single outlet is used; or

$$Q_D = 1.5\ KV^{1.4} L^{1.6}$$ when dual outlets are used.

4.6.3 If only Category C substances are present in a non-homogeneous mixture and the discharge takes place inside a special area, the residue/water mixture shall be treated as pure Category C substance whereby the discharge rate shall not exceed:

$$Q_D = KV^{1.4} L^{1.6}$$ when a single outlet is used; or

$$Q_D = 1.5\ KV^{1.4} L^{1.6}$$ when dual outlets are used.

4.6.4 If only Category C substances are present in a non-homogeneous mixture and the discharge takes place outside a special area, the residue/water mixture shall be treated as pure Category C substance whereby the discharge rate shall not exceed:

$$Q_D = 10\ KV^{1.4}\ L^{1.6}$$ when a single outlet is used; or

$$Q_D = 15\ KV^{1.4}\ L^{1.6}$$ when dual outlets are used.

4.6.5 The discharge shall also be made in accordance with the other discharge requirements of Annex II (i.e. vessel's position and speed and discharge outlet location).

4.7 Ventilation procedures for removal of cargo residues

4.7.1 When ventilation procedures are used to remove residue from cargo tanks, the requirements set out in section 3.3 apply.

4.8 Ballasting and deballasting of cargo tanks

4.8.1 After having been unloaded, a cargo tank may be ballasted.

4.8.2 The quality of this ballast is dependent on the degree of cleaning of the tank and may be categorized for discharge into the sea as follows:

.1 *Category 1.* Ballast introduced into an unwashed cargo tank. Provisions for the disposal of ballast of this category are set out in section 4.4

.2 *Category 2.* Ballast introduced into a cargo tank which has either been efficiently stripped or prewashed in accordance with Appendix C. Provisions for the discharge of ballast of this category are set out in section 4.4

.3 *Category 3.* Ballast introduced into a cargo tank which has been washed to an extent such that the ballast in the tank will not contain more than 1 ppm of the substance previously carried in the tank. This degree of cleanliness has generally been achieved when a prewash (as prescribed for 4.4.1, 4.4.3 and 4.4.5 as applicable) has been applied as specified in Appendix C and the tank has been subsequently washed by a complete cycle. This ballast may be discharged into the sea without regard to the flow rate or discharge outlet location provided that the vessel is not less than 12 miles from the nearest land and that the depth of water is not less than 25 m.

.4 *Category 4.* Ballast introduced into a cargo tank which has been thoroughly cleaned. Such ballast is defined as clean ballast by Annex II. The discharge of this ballast into the sea is not subject to any requirements of Annex II.

4.9 Cleaning agents and additives

Each cleaning medium which falls under the definition of a "harmful substance" contained in Article 2 of MARPOL 73/78 shall be treated in accordance with MARPOL 73/78.

CHAPTER 5 – OPERATIONAL STANDARDS FOR CATEGORY D SUBSTANCES

5.1 General

5.1.1 A chemical tanker from which residues of Category D substances are discharged shall be provided with a Procedures and Arrangements Manual developed in accordance with chapter 6 of the Standards. The master of the ship shall ensure that discharges of Category D substances are made in accordance with the procedures set out in the approved Manual.

5.2 Discharge of Category D residues

5.2.1 Although Category D substances are required to be discharged in a diluted form in accordance with Regulation 5(4) of Annex II, Category D substances may also be discharged in accordance with the operational standards for Category C substances as specified in chapter 4.

5.3 Ventilation of Category D substances from cargo tanks

5.3.1 When ventilation procedures are used to remove residue from cargo tanks the requirements set out in section 3.3 apply.

5.4 Cleaning agents and additives

Each cleaning medium which falls under the definition of a "harmful substance" contained in Article 2 of MARPOL 73/78 shall be treated in accordance with MARPOL 73/78.

CHAPTER 6 – PREPARATION OF THE PROCEDURES AND ARRANGEMENTS MANUAL

6.1 Each chemical tanker which carries Category A, B, C or D substances shall be provided with a Manual as defined in this chapter.

6.2 The Procedures and Arrangements Manual shall be based on the Standards. It shall cover all noxious liquid substances which the ship is certified to carry under the Bulk Chemical Code and Annex II.

6.3 The Procedures and Arrangements Manual shall as a minimum contain the following information and operational instructions:

.1 a description of the discharge requirements of Annex II (introduction);

.2 a table of noxious liquid substances which may be carried specifying their pollution category, relevant physical properties (viscosity, melting point, vapour pressure, water miscibility), whether they can be removed by ventilation and in the case of Category B and C substances whether they are potentially solidifying and/or high viscosity substances;

.3 a description of the tanks carrying noxious liquid substances;

.4 a description of all the equipment which is on board the ship and for which requirements are contained in chapter 2 including a list of all cargo tanks that will be used as slop tanks, a line drawing of the pumping system showing the respective position of pumps and control equipment and identification of means for ensuring that the equipment is operating properly (check lists);

.5 details of the procedures set out in chapters 3, 4 and 5 of the Standards as applied to the individual ship which should, where appropriate, include such instructions as:

.5.1 methods of stripping tanks and under what restrictions such as minimum list and trim the stripping system should be operated;

.5.2 methods of draining cargo pumps, cargo lines and stripping lines;

.5.3 tank prewash programmes for compliance with the Standards;

.5.4 procedures for ballasting and deballasting; and

.5.5 procedures for discharge of residue/water mixtures from slop tanks.

.6 residue tables developed in accordance with Appendix A, which indicate for each tank in which Category B and C substances are to be carried, the quantities of residues which will remain in a tank and associated piping system after unloading and stripping for the ranges of physical properties of Category B and C substances that the vessel is certified to carry under the Bulk Chemical Code;

.7 nomograms, graphs or tables based on the relevant formulae given in 4.5 and 4.6, indicating the rate at which residues of Category B and C substances can be discharged into the sea;

.8 a slops compatibility guide; and

.9 all the discharge requirements of Annex II additional to the above.

6.4 The Procedures and Arrangements Manual shall have the same format as the outline attached in Appendix I.

APPENDIX A

METHOD FOR PREPARING RESIDUE TABLES

1. INTRODUCTION

1.1 Purpose

1.1.1 The purpose of this Appendix is to provide the method for preparing residue tables for the cargo tanks and associated piping systems of a chemical tanker. The requirement for residue tables is set out in section 4.3 of the Standards.

1.1.2 The residue tables will form part of the Procedures and Arrangements Manual and will enable the ship operator to assess the quantities of residues remaining onboard without carrying out any complicated calculations. The residue tables shall only be used to assess the quantity of residue when the cargo has been discharged in accordance with the requirements of section 4.2 of the Standards.

1.1.3 In order to use the residue tables it will be necessary for the ship operator to know substance viscosity at the carriage temperature and, for substances with melting points above 0° C, substance melting point, carriage temperature and seawater temperature.

1.1.4 The viscosities and melting points of Annex II substances are listed in Appendix B. A nomogram for determining the viscosities of substances at different temperatures is also given in Appendix B.

1.2 Background

1.2.1 The residue tables are produced by making use of equations which quantify the various components of the residue. The two main components are:

.1 residues in the cargo tank;

.2 residues in the associated piping.

1.2.2 These components can be subdivided as follows:

.1 film residues on cargo tank surfaces;

.2 residues near the suction point;

.3 residues in the suction line;

.4 residues in the discharge line.

1.2.3 The values of some of the above components depend only on tank constructional features and the cargo discharge arrangement, while the values of others depend on substance viscosity and melting point. In order to simplify both the production and the shipboard use of the residue tables, substances have been divided into two broad groups, namely substances with melting points below 0° C and substances with melting points above 0° C. Residue equations have then been formulated so that they give residue values in the following viscosity ranges for each group:

.1 substances with viscosities less than 5 mPa·s;

.2 substances with viscosities between 5 and 50 mPa·s;

.3 substances with viscosities greater than 50 mPa·s.

1.2.4 The residue equations are set out in section 2, with a list of symbols and units in section 3. Section 4 explains how the residue equations are used to construct a residue table, while section 5 explains how the tables should be used by the ship operator. Section 6 contains a number of worked examples covering different cargo discharge arrangements.

2. RESIDUE EQUATIONS

2.1 **Residues in cargo tanks, Q_{RES} (tank)**

$$Q_{RES}\,(\text{tank}) = Q_{RES}\,(\text{surf}) + Q_{RES}\,(\text{sucpt})$$

2.1.1 *Residues on tank surfaces Q_{RES} (surf)*

.1 For substances with viscosities less than 5 mPa·s

$$Q_{RES}\,(\text{surf}) = 1.1 \times 10^{-4} A_d + 1.5 \times 10^{-5} A_w + 4.5 \times 10^{-4} L^{1/2} A_b \qquad \text{Eq. 1.2.1}$$

.2 For substances with viscosities between 5 and 50 mPa·s

$$Q_{RES}\,(\text{surf}) = 1.8 \times 10^{-4} A_d + 3.5 \times 10^{-5} A_w + 1.4 \times 10^{-3} L^{1/2} A_b \qquad \text{Eq. 1.2.2}$$

.3 For substances with viscosities greater than 50 mPa·s

$$Q_{RES}\,(\text{surf}) = 8.5 \times 10^{-4} A_d + 1.1 \times 10^{-4} A_w + 4.5 \times 10^{-3} L^{1/2} A_b \qquad \text{Eq. 1.2.3}$$

2.1.2 *Residues near suction point*

.1 Presence of sump or well

$$Q_{RES}\,(\text{sucpt}) = h_s A_s + 5.5 \times 10^{-6} (3.5\, a_w + 8.7\, b_w)^3 \qquad \text{Eq. 1.3}$$

.2 Absence of sump or well

$$Q_{RES}\,(\text{sucpt}) = 5.5 \times 10^{-6} (1000\, h_s + 3.5\, a_s + 8.7\, b_s)^3 \qquad \text{Eq. 1.4}$$

2.2 **Residues in the associated piping, Q_{RES} (pipe)**

$$Q_{RES}\,(\text{pipe}) = Q_{RES}\,(\text{suc}) + Q_{RES}\,(\text{dis}) \qquad \text{Eq. 2.1}$$

2.2.1 *Residue in the suction line, Q_{RES} (suc)*

.1 Positive drainage into pump

$$Q_{RES}\,(\text{suc}) = 0 \qquad \text{Eq. 2.2}$$

.2 No positive drainage into pump

$$Q_{RES}\,(\text{suc}) = V_v\,(\text{suc}) + V_h\,(\text{suc}) \qquad \text{Eq. 2.3}$$

2.2.2 *Residue in the discharge line, Q_{RES} (dis)*

.1 Line purged at a pressure of at least 6 bar

.1.1 For substances with viscosities less than 5 mPa·s

$$Q_{RES}\,(\text{dis}) = V_v\,(\text{dis}) + 0.1\, V_h\,(\text{dis}) \qquad \text{Eq. 2.4.1}$$

.1.2 For substances with viscosities between 5 and 50 mPa·s

$$Q_{RES}\,(\text{dis}) = V_v\,(\text{dis}) + 0.2\, V_h\,(\text{dis}) \qquad \text{Eq. 2.4.2}$$

.1.3 For substances with viscosities greater than 50 mPa·s

$$Q_{RES}\,(\text{dis}) = V_v\,(\text{dis}) + 0.4\, V_h\,(\text{dis}) \qquad \text{Eq. 2.4.3}$$

.2 Line not purged

$$Q_{RES}\,(\text{dis}) = V_v\,(\text{dis}) + V_h\,(\text{dis}) \qquad \text{Eq. 2.5}$$

2.3 **Additions for substances with melting points above 0°C**

$$Q_{RES}\,(\text{add}) = Q^{b}_{RES}\,(\text{add}) + Q^{w}_{RES}\,(\text{add}) \qquad \text{Eq. 3.1}$$

2.3.1 *Determination of Q^b_{RES} (add)*

.1 Tank bottom insulated

$$Q^b_{RES}\ (add) = 0 \qquad \text{Eq. 3.2}$$

.2 Tank bottom uninsulated

$$Q^b_{RES}\ (add) = 6.5 \times 10^{-5} \left(T_{mp} - \tfrac{1}{2}\ (T_C + T_{SW})\right) A_b \qquad \text{Eq. 3.3}$$

2.3.2 *Determination of Q^w_{RES} (add)*

.1 Tank walls insulated

$$Q^w_{RES}\ (add) = 0 \qquad \text{Eq. 3.4}$$

.2 Tank walls uninsulated

$$Q^w_{RES}\ (add) = 6.5 \times 10^{-5} \left(T_{mp} - \tfrac{1}{2}\ (T_C + T_{SW})\right) A_w \qquad \text{Eq. 3.5}$$

3. SYMBOLS AND UNITS USED IN RESIDUE EQUATIONS

A_b	=	Area of tank bottom	m^2
A_d	=	Area under decks	m^2
A_s	=	Cross-sectional area of sump or well	m^2
a_s	=	Distance from transverse bulkhead to centre of suction point	m
A_w	=	Surface area of tank walls	m^2
a_w	=	Shortest distance from well to transverse bulkhead	m
b_s	=	Distance from longitudinal bulkhead to centre of suction point	m
b_w	=	Shortest distance from well to longitudinal bulkhead	m
h_s	=	Height of suction pipe above tank or well bottom	m
L	=	Length of tank	m
Q_{RES} (dis)	=	Amount of residue in discharge line	m^3
Q_{RES} (pipe)	=	Amount of residue in associated piping system	m^3
Q_{RES} (suc)	=	Amount of residue in suction line	m^3
Q_{RES} (sucpt)	=	Amount of residue near suction point	m^3
Q_{RES} (surf)	=	Amount of residue on tank surfaces	m^3
Q^b_{RES} (add)	=	Additional residue on tank bottom	m^3
Q^w_{RES} (add)	=	Additional residue on tank walls	m^3
T_C	=	Carriage temperature of cargo	°C
T_{mp}	=	Melting point of cargo	°C
T_{SW}	=	Seawater temperature	°C
V_h (dis)	=	Volume of horizontal discharge line	m^3
V_h (suc)	=	Volume of horizontal suction line	m^3
V_v (dis)	=	Volume of vertical discharge line	m3
V_v (suc)	=	Volume of vertical suction line	m^3

NOTE: In determining A_b, A_d and A_w the relevant horizontal or vertical internal tank structures should be included as follows:—

(i) upper surfaces of horizontal structures should be included in A_b

(ii) under surfaces of horizontal structures should be included in A_d

(iii) all vertical surfaces of structures should be included in A_w

4. CONSTRUCTION OF RESIDUE TABLES

4.1 General

4.1.1 The aim of the residue equations is to produce a residue table for two groups of substances, namely substances with melting points less than 0° C and substances with melting points greater than 0° C; residue values are then given for three viscosity ranges in each group.

4.1.2 The flowchart given in fig. A1 should be used to ensure that the correct residue equations are used in the construction of the residue tables. The flowchart also specifies the data that are required as input to the equations.

4.1.3 Fig. A2 shows the discharge arrangements that are common on chemical tankers and table A1 shows the residue equations which would be used to construct the residue tables for these tanks. Note that only the arrangements shown as fig. A2(c) and fig. A2(f) would be considered as providing "positive drainage into the pump".

TABLE A1. – RESIDUE EQUATIONS USED IN THE CONSTRUCTION OF RESIDUE TABLES

(see fig. A2)

Figure	Residue equations				
	Film residues	Near suction point	Suction line	Discharge line	Additions (mpt > 0° C)
a	1.2.1/2/3	1.3	2.3	2.4.1/2/3 or 2.5	3.1
b	1.2.1/2/3	1.3	2.3	2.4.1/2/3 or 2.5	3.1
c	1.2.1/2/3	1.3	2.2	2.4.1/2/3 or 2.5	3.1
d	1.2.1/2/3	1.3	2.3	2.4.1/2/3 or 2.5	3.1
e	1.2.1/2/3	1.4	2.3	2.4.1/2/3 or 2.5	3.1
f	1.2.1/2/3	1.4	2.2	2.4.1/2/3 or 2.5	3.1

4.2 Procedure

4.2.1 From the ship's drawings and/or by taking measurements inside the tank, obtain the numerical values of the parameters that are specified in the flowchart. The units used should be those specified in section 3 of this Appendix.

4.2.2 Select the residue equations according to the discharge arrangement and calculate the value of each component.

4.2.3 Write down the amounts of residue on the tank surfaces for the three viscosity ranges. To these three values add the amounts of residue near the suction point, in the suction line and in the discharge line. Round the values obtained to the nearest 0.1 m^3. These are the three residue values for substances with melting points less than 0° C.

4.2.4 To the values obtained in 4.2.3 add the additional amounts for substances with melting points above 0° C (i.e. the amount obtained from eq. 3.1). These are the three values for substances with melting points above 0° C.

4.3 Tanks sharing a common discharge line

4.3.1 Where a cargo tank shares a discharge line with another cargo tank, two separate residue tables shall be prepared. One will specify the amount of residue in the cargo tank and suction line, the other shall specify the amount of residue in the discharge line.

4.3.2 The Procedures and Arrangements Manual shall specify that the tables are to be used together. The residue values in each table shall be quoted to the nearest 0.1 m^3.

4.4 Tanks which use an efficient stripping system

4.4.1 The following procedure should be used to construct residue tables for cargo tanks where efficient stripping procedures are used. It is emphasized that the residue table thus produced should only be used to assess quantities of non-solidifying substances with viscosities less than 50 mPa·s.

4.4.2 Use equations 1.2.1 and 1.2.2 to determine the amounts of residue on the tank surfaces for the two viscosity ranges 0-5 mPa·s and 5-50 mPa·s.

4.4.3 Add to these two values the quantity of residue obtained by carrying out the practical test as specified in paragraph 2.3.4 of the Standards. Round the values obtained to the nearest 0.1 m^3. These are the two residue values for non-solidifying substances when the tank has been efficiently stripped. These values would only be used for purposes of calculating C_S.

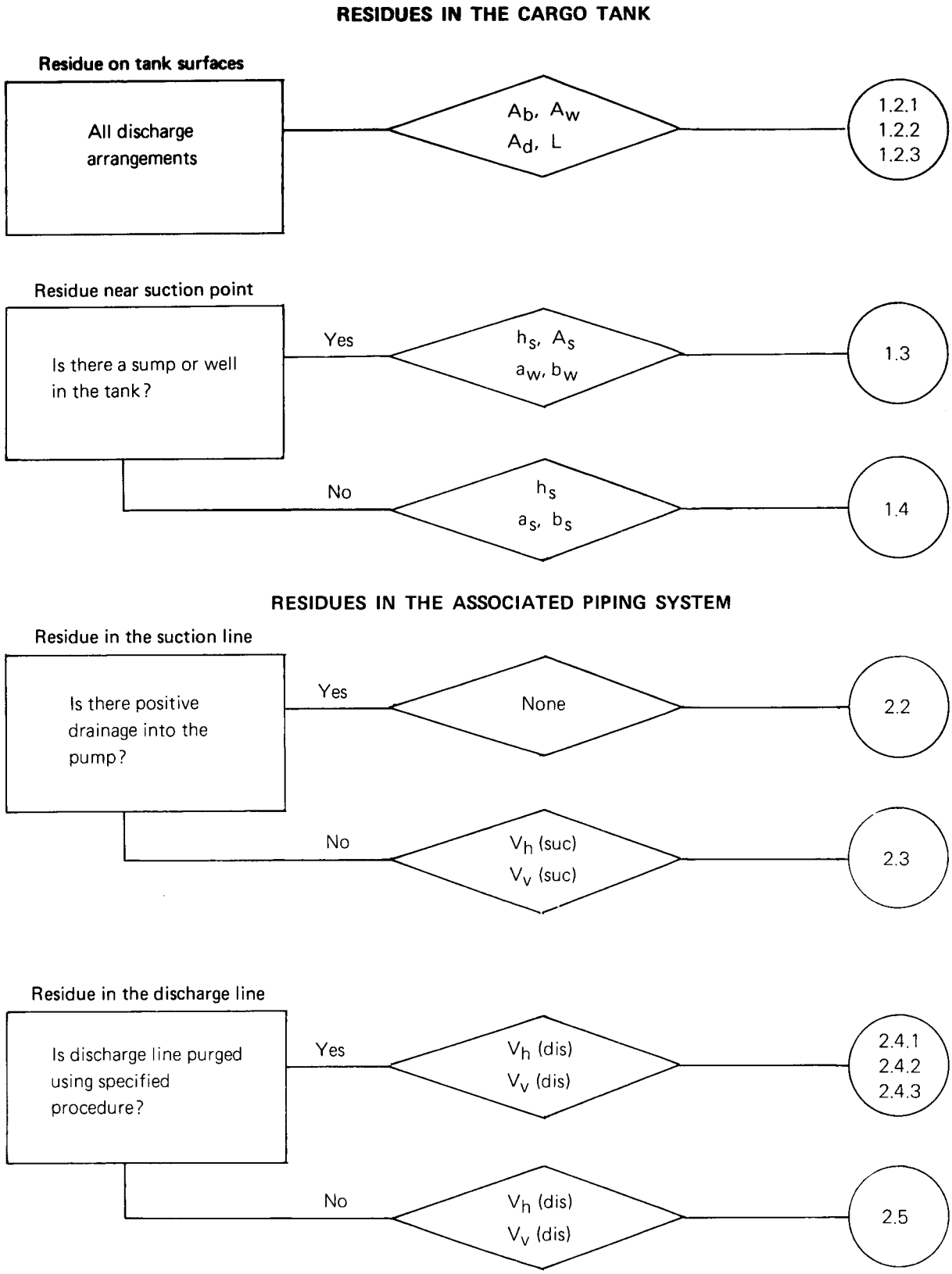


Figure A1 Flowchart for selecting residue equations

ADDITIONS FOR SUBSTANCES WITH MELTING POINTS ABOVE 0° C

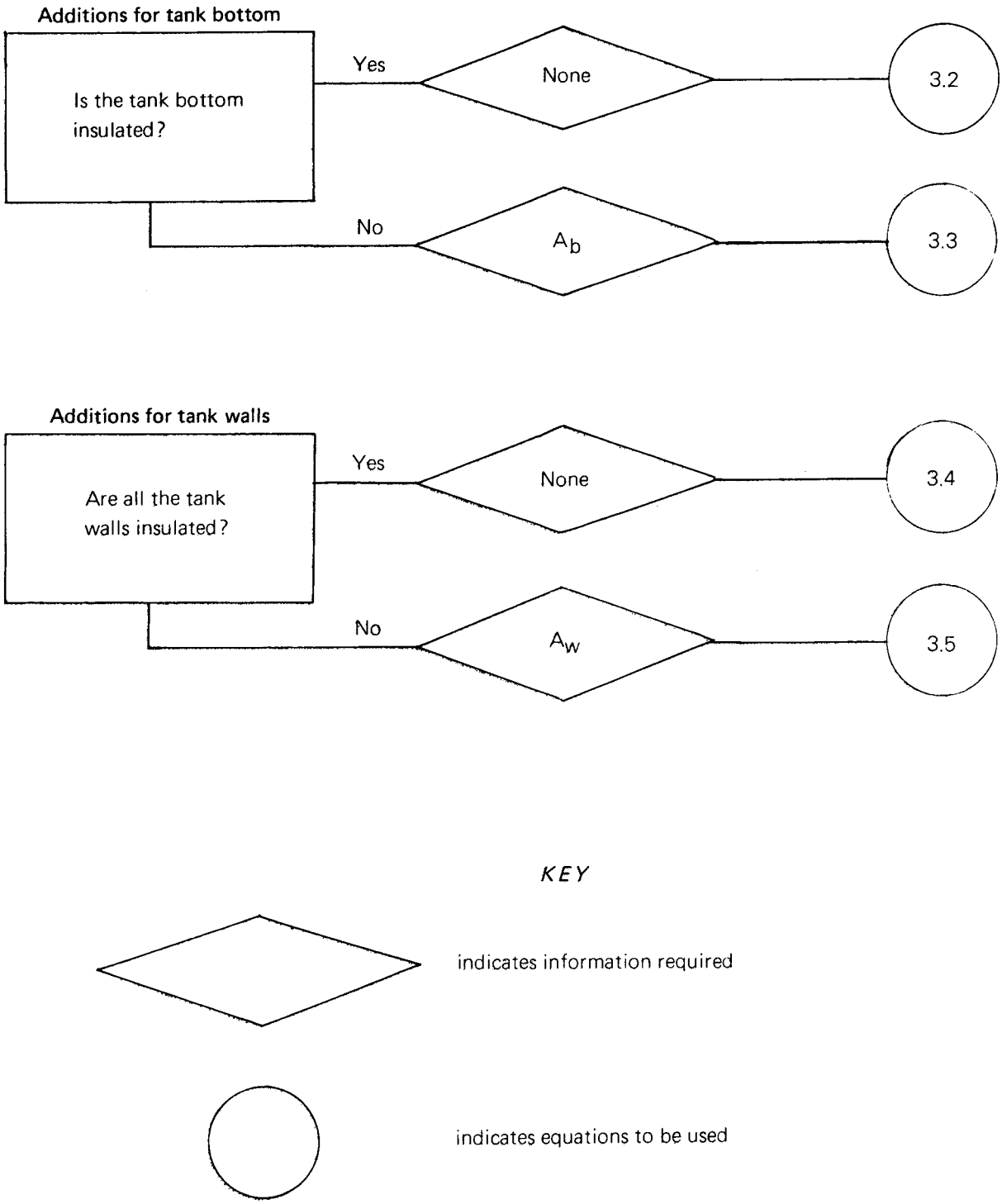


Figure A1 Flowchart for selecting residue equations (continued)

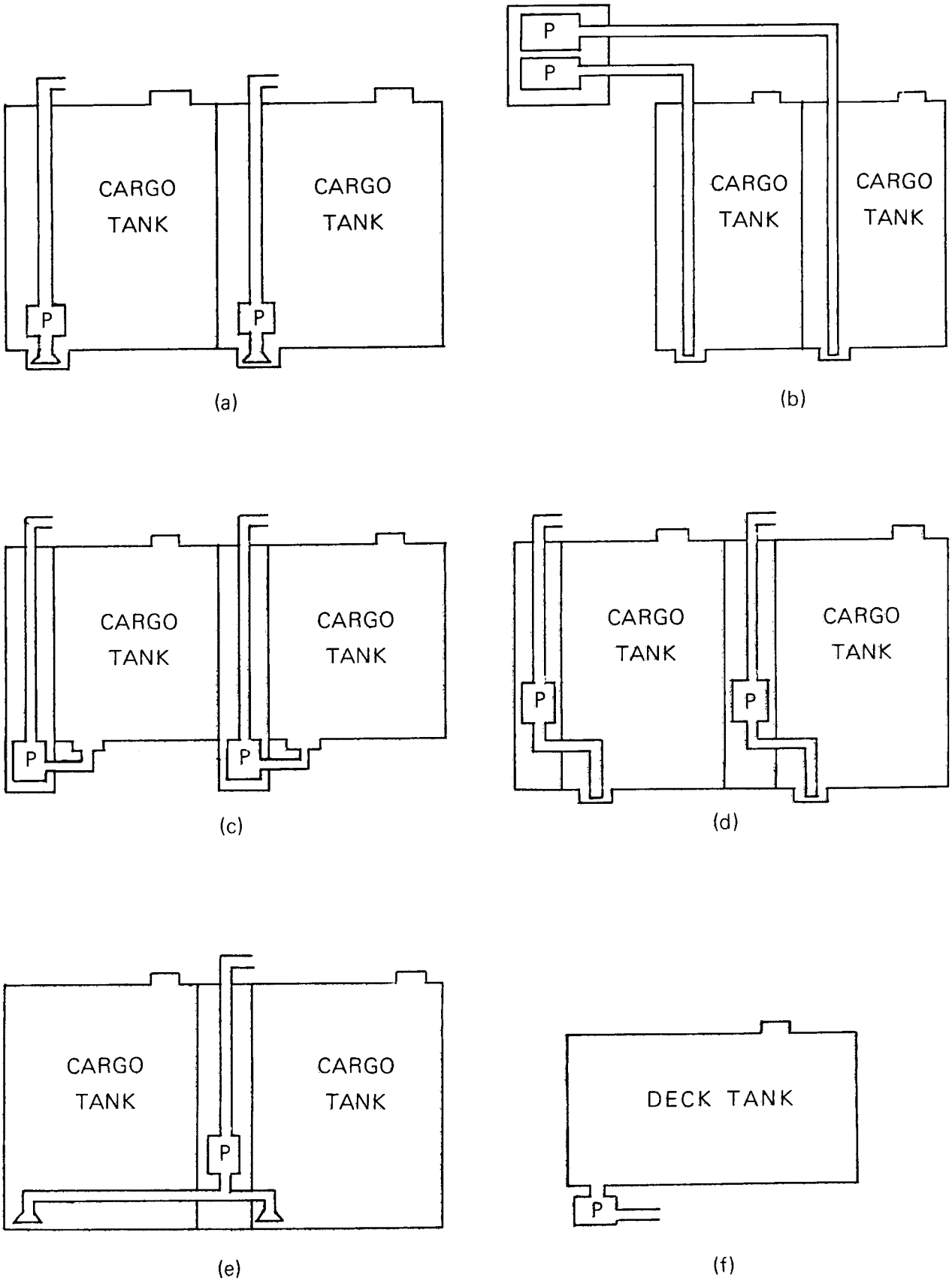


Figure A2 Cargo discharge arrangements on chemical tankers

5. NOTES ON THE SHIPBOARD USE OF THE RESIDUE TABLES

5.1 Substances with melting points less than 0° C

5.1.1 Determine the carriage temperature of the cargo.

5.1.2 Determine the substance viscosity at the carriage temperature.

5.1.3 Use the residue table to determine the amount of residue.

5.2 Substances with melting points above 0° C

5.2.1 Determine the carriage temperature and the seawater temperature.

5.2.2 Determine the substance viscosity at the carriage temperature, and the substance melting point.

5.2.3 Use the residue table to determine the amount of residue.

5.2.4 Important. The minimum value of the expression $T_{mp} - \frac{1}{2}(T_{sw} + T_c)$ is zero. If $T_{mp} < \frac{1}{2}(T_{sw} + T_c)$ then the expression $T_{mp} - \frac{1}{2}(T_{sw} + T_c)$ should be taken to be zero. A note explaining this important point shall accompany the residue tables in the Procedures and Arrangements Manual.

5.3 Tanks sharing a common discharge line

5.3.1 When tanks which are connected by a common piping system and which contain the same substance are discharged in the same port the residue remaining in the common piping shall be divided equally among the connected tanks for the purpose of the final residue assessment.

6. EXAMPLES

6.1 General

6.1.1 The four examples given below illustrate how a residue table is constructed. The first example corresponds to the arrangement shown in fig. A2(a) i.e. an uninsulated tank fitted with a deepwell pump. The second example corresponds to the arrangement shown in fig. A2(e) i.e. an uninsulated tank sharing a discharge line; in this example two residue tables are produced, one for the cargo tank and one for the discharge line. The third example corresponds to the arrangement shown in fig. A2(f) i.e. a deck tank which is assumed to be insulated. The fourth example deals with the case where an efficient stripping system is used. In the first three cases it is assumed that the discharge line is purged at a pressure of 600 kPa (6 bar) at the end of cargo discharge.

6.2 Example one

6.2.1 The flowchart indicates that the values of the following parameters must be obtained: A_b, A_w, A_d, L, h_s, A_s, a_w, b_w, V_h(suc), V_v(suc), V_h(dis), V_v(dis).

6.2.2. The following values would be obtained from the ship's drawings:

A_b	= 108 m²	V_h(suc)	= 0 m³
A_w	= 750 m²	V_v(suc)	= 0 m³
A_d	= 108 m²	V_h(dis)	= 1.5 m³
L	= 9 m	V_v(dis)	= 0.25 m³

6.2.3 The following values would be best obtained by taking measurements inside the cargo tank:

$h_s = 0.1$ m $\qquad a_w = 1.0$ m

$A_s = 1.5$ m^2 $\qquad b_w = 1.0$ m

6.2.4 The flowchart indicates that the following equations should be used: 1.2.1/2/3, 1.3, 2.3, 2.4.1/2/3, 3.3 and 3.5.

6.2.5 The following values are then obtained for the components of the residue:

Q_{RES}(surf) = 0.17 m^3 for substances with viscosities less than 5 mPa·s.

= 0.50 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 1.47 m^3 for substances with viscosities greater than 50 mPa·s.

Q_{RES}(sucpt) = 0.16 m^3

Q_{RES}(suc) = 0 m^3

Q_{RES}(dis) = 0.40 m^3 for substances with viscosities less than 5 mPa·s.

= 0.55 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 0.85 m^3 for substances with viscosities greater than 50 mPa·s.

Q^b_{RES}(add) = $7 \times 10^{-3} \left(T_{mp} - \frac{1}{2} (T_c + T_{sw})\right)$ m^3

Q^w_{RES}(add) = $4.9 \times 10^{-2} \left(T_{mp} - \frac{1}{2} (T_c + T_{sw})\right)$ m^3

6.2.6 By adding together the components as appropriate the residue table shown in fig. A3 is obtained.

6.3 Example two

6.3.1 The flowchart indicates that values of the following parameters must be obtained: A_b, A_w, A_d, L, h_s, a_s, b_s, V_h (suc), V_v (suc), V_h (dis), V_v (dis).

6.3.2 The following values would be obtained from the ship's drawings:

$A_b = 54$ m^2 $\qquad V_h$(suc) = 0.2 m^3

$A_w = 500$ m^2 $\qquad V_v$(suc) = 0.05 m^3

$A_d = 54$ m^2 $\qquad V_h$(dis) = 0.45 m^3

L = 9 m $\qquad V_v$(dis) = 2.0 m^3

6.3.3 The following values would be best obtained by taking measurements inside the cargo tank:

$a_s = 1$ m $\qquad h_s = 0.025$ m

$b_s = 1$ m

6.3.4 The flowchart indicates that the following equations should be used: 1.2.1/2/3, 1.4, 2.3, 2.4.1/2/3, 3.3 and 3.5.

6.3.5 The following values are then obtained for the components of the residue:

$Q_{RES}(surf)$ = 0.09 m^3 for substances with viscosities less than 5 mPa·s.

= 0.25 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 0.83 m^3 for substances with viscosities greater than 50 mPa·s.

$Q_{RES}(sucpt)$ = 0.28 m^3

$Q_{RES}(suc)$ = 0.25 m^3

$Q_{RES}(dis)$ = 0.65 m^3 for substances with viscosities less than 5 mPa·s.

= 0.85 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 1.25 m^3 for substances with viscosities greater than 50 mPa·s.

$Q^b_{RES}(add) = 3.5 \times 10^{-3} \left(T_{mp} - \frac{1}{2} (T_C + T_{SW})\right) m^3$

$Q^w_{RES}(add) = 3.3 \times 10^{-2} \left(T_{mp} - \frac{1}{2} (T_C + T_{SW})\right) m^3$

6.3.6 By adding together the components as appropriate the residue tables shown in fig. A4 are obtained.

6.4 **Example three**

6.4.1 The flowchart indicates that the values of the following parameters must be obtained: A_b, A_w, A_d, L, h_s, a_s, b_s, $V_h(dis)$, $V_v(dis)$.

6.4.2 The following values would be obtained from the ship's drawings:

A_b = 60 m^2 L = 12 m

A_w = 150 m^2 $V_h(dis)$ = 1.5 m^3

A_d = 60 m^2 $V_v(dis)$ = 0 m^3

6.4.3 The following values would be best obtained by taking measurements inside the tank:

h_s = 0 m b_s = 1.5 m

a_s = 1.5 m

6.4.4 The flowchart indicates that the following equations should be used: 1.2.1/2/3, 1.4, 2.2, 2.4.1/2/3, 3.2 and 3.4.

6.4.5 The following values are then calculated for the components of the residue:

$Q_{RES}(surf)$ = 0.10 m^3 for substances with viscosities less than 5 mPa·s.

= 0.31 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 1.00 m^3 for substances with viscosities greater than 50 mPa·s.

$Q_{RES}(sucpt)$ = 0.03 m^3

$Q_{RES}(suc)$ = 0 m^3

$Q_{RES}(dis)$ = 0.15 m^3 for substances with viscosities less than 5 mPa·s.

= 0.30 m^3 for substances with viscosities between 5 and 50 mPa·s.

= 0.60 m^3 for substances with viscosities greater than 50 mPa·s.

$Q^b_{RES}(add)$ = 0 m^3

$Q^w_{RES}(add)$ = 0 m^3

6.4.6 By adding together the components as appropriate the residue tables shown in fig. A5 are obtained.

6.5 **Example four**

6.5.1 The values of the following parameters are required: A_b, A_w, A_d, L.

6.5.2 The following values would be obtained from the ship's drawings:

$A_b = 108\ m^2$ $\quad A_w = 750\ m^2$

$A_d = 108\ m^2$ $\quad L = 9\ m$

6.5.3 The following values are then obtained from equations 1.2.1 and 1.2.2:

Q_{RES} (surf) = 0.17 m^3 for substances with viscosities less than 5 mPa·s.

= 0.50 m^3 for substances with viscosities between 5 and 50 mPa·s.

6.5.4 A practical test is carried out to determine the quantity of residue remaining in the associated piping system and near the suction point and this is found to be 0.06 m^3.

6.5.5 By adding together these values as appropriate the residue table shown in fig. A6 is obtained.

FIG A4 RESIDUE TABLE

EXAMPLE ONE

TANK NUMBER:

IS THE RESIDUE IN THE DISCHARGE LINE INCLUDED? YES

AMOUNT OF RESIDUE

A. **Substances with melting points less than 0° C**

(i) Substances with viscosities less than 5 mPa·s: 0.7 m^3

(ii) Substances with viscosities between 5 and 50 mPa·s: 1.2 m^3

(iii) Substances with viscosities greater than 50 mPa·s: 2.5 m^3

B. **Substances with melting points greater than 0° C**

(i) Substances with viscosities less than 5 mPa·s:

$$0.7 + 5.6 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_c + T_{sw})\right) m^3$$

(ii) Substances with viscosities between 5 and 50 mPa·s:

$$1.2 + 5.6 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_c + T_{sw})\right) m^3$$

(iii) Substances with viscosities greater than 50 mPa·s:

$$2.5 + 5.6 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_c + T_{sw})\right) m^3$$

FIG A4 RESIDUE TABLE
EXAMPLE TWO

TANK NUMBER:

IS THE RESIDUE IN THE DISCHARGE LINE INCLUDED? No, see table

AMOUNT OF RESIDUE

A. Substances with melting points less than 0°C

(i) Substances with viscosities less than 5 mPa·s: 0.7 m^3

(ii) Substances with viscosities between 5 and 50 mPa·s: 0.8 m^3

(iii) Substances with viscosities greater than 50 mPa·s: 1.4 m^3

B. Substances with melting points greater than 0°C

(i) Substances with viscosities less than 5 mPa·s:

$$0.6 + 3.7 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_C + T_{SW})\right) m^3$$

(ii) Substances with viscosities between 5 and 50 mPa·s:

$$0.8 + 3.7 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_C + T_{SW})\right) m^3$$

(iii) Substances with viscosities greater than 50 mPa·s:

$$1.4 + 3.7 \times 10^{-2} \left(T_{mp} - \tfrac{1}{2} (T_C + T_{SW})\right) m^3$$

PIPELINE NUMBER:

THIS PIPELINE SERVES THE FOLLOWING TANKS:

AMOUNT OF RESIDUE

(i) Substances with viscosities less than 5 mPa·s: 0.7 m^3

(ii) Substances with viscosities between 5 and 50 mPa·s: 0.9 m^3

(iii) Substances with viscosities greater than 50 mPa·s: 1.3 m^3

FIG A5 RESIDUE TABLE
EXAMPLE THREE

TANK NUMBER:

IS THE RESIDUE IN THE DISCHARGE LINE INCLUDED? YES

AMOUNT OF RESIDUE

A. Substances with melting points less than 0° C

(i) Substances with viscosities less than 5 mPa·s: 0.3 m^3

(ii) Substances with viscosities between 5 and 50 mPa·s: 0.6 m^3

(iii) Substances with viscosities greater than 50 mPa·s: 1.6 m^3

B. Substances with melting points greater than 0° C

(i) Substances with viscosities less than 5 mPa·s: 0.3 m^3

(ii) Substances with viscosities between 5 and 50 mPa·s: 0.6 m^3

(iii) Substances with viscosities greater than 50 mPa·s: 1.6 m^3

FIG A6 RESIDUE TABLE
EXAMPLE FOUR

TANK NUMBER:

NOTE: This table should only be used when the tank has been efficiently stripped.

IS THE RESIDUE IN THE DISCHARGE LINE INCLUDED? YES

AMOUNT OF RESIDUE

(i) Non-solidifying substances with viscosities less than 5 mPa·s: 0.2 m^3

(ii) Non-solidifying substances with viscosities between 5 and 50 mPa·s: 0.6 m^3

APPENDIX B

TABLE OF PHYSICAL PROPERTIES OF CHEMICALS

EXPLANATORY NOTES

1. The attached table lists those physical properties which the ship operator may need to know to:

(i) assess the quantity of residue in a cargo tank and associated piping;

(ii) carry out the correct prewash procedure;

(iii) discharge residues at the permitted rate.

2. The units of measurement are those of the International System.

3. In the second column (pollution Category A, B, C or D) some categories are given in brackets ( ), indicating that these Categories are based on environmental hazard ratings which, due to the lack of firm data, had to be partly assigned by analogy. Symbol III indicates that substances are meeting the criteria for inclusion in MARPOL 73/78 Annex II, Appendix III (List of other liquid substances carried in bulk). The abbreviation N.E.D. means that when this Appendix was prepared there were not enough data available to evaluate environmental hazards and to assign pollution categories. The pollution categories have been assigned on the basis of the hazard evaluations carried out by GESAMP* by January 1984.

4. In the last column, headed "Water miscibility", the meaning of the symbols are:

\+ the substance is miscible with water

– the substance is immiscible with water

Reference should also be made to section 1.3 of the Standards where the term "miscibility" is defined.

5. Figure B1 indicates how product viscosities at temperatures other than 20°C can be determined.

* IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution.

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Acetic acid	1842	C	1049	+16.6	14.66	1.26	+
Acetic anhydride	1715	C	1082	−73.1	5.33	0.90	decomposes
Acetone	1090	III	790	−95.4	246.38	0.30	+
Acetone cyanohydrin	1541	A	928	−19	10.66	3.79	+
Acrylamide solution (50% or less)		D	1048	+9	25.3		+
Acrylic acid	2218	D	1051	+13	8.13	1.28	+
Acrylonitrile	1093	B	806	−83.5	110.66	0.40	−
Adiponitrile	2205	D	968	+1	0	7.00	−
Alkyl benzene sulphonic acid	2584 2586	C	1198				+
Allyl alcohol	1098	B	854	−50	55.84 (21.1°C)	1.37	+
Allyl chloride	1100	B	938	−134.5	393.30	0.34	−
Aminoethoxy ethanol (2,2-)	1760	N.E.D.	1058	−9.5	20	39.99	+
Aminoethylethanol-amine		D	1030	−19		14.06	+
Ammonia (28% aqueous)	1005	C	900	−72.4	34.47 (28.2°C)		+
Amyl acetate (iso-)	1104	C	867	−78.5	5.33	0.88	−
Amyl acetate (n-)	1104	C	876	−70.8	6.67 (25°C)	0.93	−
Amyl alcohol (n-)	1105	D	814	−79	3.07	3.99	−
Aniline	1547	C	1022	−6.3	3.2	44.70	−
Benzene	1114	C	879	+5.5	113.3	0.69	−
Benzyl alcohol		C	1042	−15.3	0.2 (25°C)	5.80	−
Benzyl chloride	1738	B	1100	−39	4.83 (37.8°C)	0.80	−
Butyl acetate (n-)	1123	C	883	−77.9	13.33	0.77	−
Butyl acetate (sec-)	1124	D	864	−99	32 (25°C)	0.70	−
Butyl acrylate (n-)	2348	D	860	−54	5.33	0.95	−
Butyl alcohol (n-)	1120	D	810	−79.9	5.73	2.96	−
Butyl alcohol (sec-)	1120	(D)	808	−89	16.66	2.97	−

	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
Substance	I	II	III	IV	V	VI	VII
Butyl alcohol (tert-)	1120	D	789	+25.3	58.93	3.31 (30°C)	+
Butyl butyrate		B	871	−91.5		1.00	−
Butyl ether (n-)	1149	C	767	−98	6.4		−
Butyl methacrylate	2227	D	894	−50	6.53 (21°C)	1.14	−
Butylamine	1125 1214	C	740	−95.3	55.15	0.73	+
Butylene glycol(s)		D	1010	+16.0	0.08	80.80	+
Butyraldehyde	1129	B	817	−99	120	0.45	−
Butyric acid		B	958	−4.3	1.33	1.55	+
Calcium hydroxide (solution)	1824	D	1527(50%) 1704(73%)	+12 – +15 +63	1.2 0.13 (80°C)	114.98 (50%)	+
Camphor oil	1130	B	1000				−
Carbolic oil		A	1058	+41	1.37		−
Carbon disulphide*	1131	A	1263	−11.5	533.29 (28°C)	0.37	−
Carbon tetrachloride	1846	B	1595	−22.8	121.19	0.97	−
Cashew nutshell oil (untreated)		D	917				
Caustic potash (potassium hydroxide)	1814	C	1447(45%) 1507(50%)	+29 +9	14.66 (36.5°C) 14.66 (44°C)	2.39(22°C) 2.70(22°C)	+
Chloroacetic acid	1750	C	1404	+63		1.99(70°C)	
Chloroform	1888	B	1483	−63.5	213.32	0.58	−
Chlorohydrins (crude)		D	1198	−18.8		1.20	−
Chloropropionic acid (2- or 3-)	2511	C	1137	−30	0.29	1.07	+
Chlorosulphonic acid	1754	C	1766	−80		0.90	decomposes
Chlorotoluene(para)	2238	B	1070	+7.5		0.90	−
Creosote (wood tar)	1334	A	1000-1100	0		approx 4	−
Creosote (coal tar)		C					
Cresols	2076	A	1034-1047	11-34	1.33 (38-53°C)	approx 10 (40°C)	−
Cresylic acid	2022	A	1010-1050	+18 – +35	2.27-4.73 (60°C)	20	−

* Particular weight was given to special characteristics of the substance and therefore it was rated as Category A.

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Crotonaldehyde	1143	B	853	−76.5			−
Cumene	1918	B	862	−99	13.33	0.80	−
Cyclohexane	1145	C	779	+6.6	102.66	0.93	−
Cyclohexanol		C	962	+25.2	1.33 (21°C)	68.01	−
Cyclohexanone	1915	D	948	−31.2	2.67	2.20	−
Cyclohexylamine	2357	C	819	−17.7		2.38	+
Cymene (para-)	2046	C	857	−67.9	9.6 (25°C)	12.00	−
Decahydronaphthalene	1147	(D)	896	−43		2.24	−
Decane	2247	(D)	730	−29.7		0.92	−
Decyl acrylate		N.E.D.	883	−100	0.01		−
Decyl alcohol (n-)		B	838	+7	1.33	12.57	−
Di-n-propylamine	2383	C	737	−63	26.67	0.54	+
Diacetone alcohol	1148	D	939	−44	1.47	3.38	+
Dibenzyl ether		(C)	1043	+3.6			−
Dibutylamine	2248	C	758	−51	3.1	0.90	−
Dichlorobenzene	1591	A	o: 1305 m: 1288 p: 1248	o: −17 m: −25 p: +53		o: 1.40 m: 1.04 p: 0.84 (55°C)	−
Dichloroethane (1,1-)	2362	B	1177		24.13	0.52	−
Dichloroethyl-ether	1916	B	1220	−24.5		2.46	−
Dichloroisopropyl ether (2,2-)	2490	(B)	1128	−97	1.07		
Dichlorophenol (2,4-)		A	1379	+42	0.01	2.10 (60°C)	−
Dichloropropene/dichloropropane mixture	2047	B	1160	−70		8.70	−
Dichloropropane (1,3-)	1279	B	1185	−99.5	20.68		−
Dichloropropene (1,3-)	2047	B	1198	−60	137.89	0.80	−
Dichloropropionic acid (2,2-)	1759	D	1386	+8	0.01		+
Diethyl ether	1155	III	714	−116.2		0.24	−
Diethyl sulphate		(C)	1178	−24	0.03	1.79	−
Diethylamine	1154	C	705.6	−48	259.99	0.36	+

	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
Substance	I	II	III	IV	V	VI	VII
Diethylbenzene (mixed isomers)	2049	C	868	−43	1.33	0.85	–
Diethylene glycol mono-butyl ether acetate		(D)	979	−32.2	0.13	3.60	+
Diethylene glycol mono-ethyl ether acetate		(D)	1008	−25	0.07	2.80	–
Diethylenetriamine	2079	D	959	−39	0.49	5.75	+
Diethyleneglycol		III	1116	−7.8	0.01	35.00	+
Diethylethanolamine	2686	C	897	−38	0.05		+
Diethylketone	1156	D	814	−39.8		0.49	–
Diisobutylketone	1157	D	810	−41.5	2.27	1.05	–
Diisobutylene	2050	C	720	−101	48.26	0.54	–
Diisobutylamine	2361	(C)	745	−77	0.68	0.70	–
Diisopropanolamine		C	989	+44	0.48 (45.8°C)	197.8 (45°C)	+
Diisopropylamine	1158	C	717	−61	82.74	0.42	+
Diisopropylether	1159	D	724	−85.9		0.39	–
Dimethylamine (40% aqueous)	1160	C	898	−38		0.90	+
Dimethylethanolamine	2051	(D)	888	−59			+
Dimethylformamide	2265	D	949	−60.5	3.79	0.80	+
Dioxane (1,4-)	1165	D	1034	+11.8	34.47	1.27	+
Dipentene	2052	C	843	−95.5	1.58	1.12	–
Diphenyl ether		B	1071	+28	0.028	3.87 (25°C)	–
Diphenyl/ Diphenyloxide mixtures		A	1040-1100	+105			–
Diphenylmethane diisocyanate	2489	(B)	1198	+37.7	0	12.41 (40°C)	
Dipropylene glycol mono-methyl ether		(D)	949	−83	1.33	3.42	+
Dodecyl alcohol		B	818	+24	1.33	16.61 (25°C)	+
Dodecyl diphenyl oxide disulfonate solution		N.E.D.	1158	+25			+
Dodecyl methacrylate		N.E.D.	868	−29	1.38 (38°C)	5.69	–

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Dodecylbenzene		C	800	–34	0	8.00	–
Epichlorohydrin	2023	C	1187	–57.2	17.24	1.25	–
Ethoxyethyl acetate(2-)	1172	(D)	975	–61.7	1.6	1.30	–
Ethyl acetate	1173	D	899	–83.6	97.32	0.46	–
Ethyl acrylate	1917	D	923	–71.2	39.33	0.60	–
Ethyl amyl ketone	2271	C	822			0.80	–
Ethyl lactate	1192	(D)	1032			2.68	+
Ethyl methacrylate	2277	(D)	913	–50	20.68	0.93	–
Ethyl-3-propyl acrolein(2-)		(B)	855 (15°C)		268.9 (28.2°C)		–
Ethylbenzene	1175	C	876	–95	13.33 (26°C)	0.66	–
Ethylbutylamine	2733	(C)	740	–78	23.99	0.54	–
Ethylcyclohexane		D	784	–111	13.33	0.84	–
Ethylene chlorohydrin	1135	(D)	1199	–63	6.89	3.36	+
Ethylene cyanohydrin		(D)	1040	–46	0.10		+
Ethylene dibromide	1605	B	2179	+10	13.79	1.72	–
Ethylene dichloride	1184	B	1255	–35.4	89.63	0.84	–
Ethylene glycol monoethyl ether	1171	D	931	–100	5.52	1.86	+
Ethylenediamine	1604	C	1058	+11	14.48	1.69	+
Ethylhexyl acrylate(2-)		D	887	–9	1.33 (50°C)	1.70	–
Ethylhexyl alcohol(2-)		C	834	–76	0.27	10.01	–
Ethylhexylamine(2-)	2276	B	787	–70	1.6		–
Ethylidene Norbornene		N.E.D.	898	–80	6.03	1.10	–
Formaldehyde (37-50% solution)	1198	C	1070-1100		1.86	approx 2	+
Formic acid	1779	D	1220	+8.4	44.82	1.81	+
Furfural	1199	C	1160	–36.5	2.27	1.57	–
Furfuryl alcohol		C	1130	–14.6	1.33 (32°C)	4.75	+
Glutaraldehyde solution		N.E.D.	1122	–14	22.7	3.70	+

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Heptanoic acid		(D)	920	–7.5		4.35	–
Heptanol		(C)	822	–34.6	0.67	7.40	
Heptene	2278	C	695	–119	37.33	0.24	–
Hexamethylenediamine	1783	C		+41			+
Hexamethyleneimine	2493	C	879	–38	8.27	2.16	–
Hexan-1-ol	2282	D	817	–46.1	0.67	5.90	–
Hexene(1-)	2370	C	672	–139.9	266.64	0.17	–
Hydrochloric acid	1789	D	1180			2.10	+
Hydrofluoric acid (40% aqueous)	1790	C	1100				+
Hydrogen peroxide (greater than 60%)	2015	C	1195	–51	6.89	1.14	+
Hydroxyethyl acrylate (2-)		N.E.D.	1104	–35		5.50	+
Isobutyl acrylate	2527	D	890	–54			–
Isobutyl alcohol	1212	D	803	–108	11.73	3.70	–
Isobutyl methacrylate	2283	D	886			1.01	–
Isobutyraldehyde	2045	C	794	–66		0.54 (0°C)	–
Isooctane	1262	(D)	692	–107.4		0.51	–
Isopentane	1265	D	620	–160	793.27 (21°C)	0.20	–
Isophorone		D	923	–8.1	0.27	2.62	–
Isophorone diamine	2289	D	924	+10	0.02	18.04	+
Isophorone diisocyanate	2290	N.E.D.	1058	–60	0	15.00	–
Isoprene	1218	C	681	–146	620.53	0.22	–
Isopropyl cyclohexane		D	802	–89.8		1.10	–
Isopropyl ether	1159	D	724	–86	96.5	0.41	–
Isopropylamine	1221	C	889	–95.2	655.0	0.35	+
Isovaleraldehyde	2058	C	785	–51		0.55	–
Lactic acid		D	1200	+16.8			+
Maleic anhydride	2215	D	1477	+53	0.13	1.61	+
Mesityl oxide	1229	D	854	–59		0.88	–
Methacrylic acid	2531	(D)	1013	+14	1.87	1.30	+

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa-s	Water miscibility
	I	II	III	IV	V	VI	VII
Methyl acetate	1231	III	933	−98.1	226.38	0.38	–
Methyl acrylate	1919	C	957	−77	90.93	110.06	–
Methyl methacrylate	1247	D	944	−48	41.37	0.57	–
Methyl pentene (2-)		(C)	686	−135.1	266.64 (26°C)	0.32	–
Methyl pyridine (2-)		B	945	−66.8	10.34	0.81	+
Methyl styrene (alpha-)	2303	(B)	908	−24.5	2.76		–
Methyl-5-Ethyl pyridine (2-)	2300	(B)	922		4.14 (28.2°C)	1.90	–
Methyl-6-aniline (2-)	2294	N.E.D.	967	−25	0.8		–
Methylamyl alcohol	2053	D	808	−90	3.73	5.20	–
Methylene chloride	1593	D	1327	−95.1		0.44	–
Monochlorobenzene	1134	B	1106	−45.6		0.80	–
Monoethanolamine	2491	D	1019	+10.5	0.41	23.03	+
Monoethylamine	1036	C	681	−81	1379	0.23	+
Monoisopropanolamine		C	961	+1.7	0.96	viscous	+
Monoisopropylamine		C	889	−95.2		0.35	+
Monomethyl ethanolamine		C	937	−4.5		13.02	+
Mononitrobenzene		B	1204	+5.4	0.26	2.00	–
Morpholine	2054	D	1001	−4.8	10.34	2.1	+
Naphthalene (molten)	1334	A	975	+80.6		0.90 (85°C)	–
Naphthenic acids	9137	(A)	957-985			20-50 (60°C)	–
Nitric acid (90%)	2031/ 2032	C	1495	−49		1.15	+
Nitrochlorobenzene	1578	B	1365	+32	0		–
Nitrophenol (o-)	1663	B	1487	+44	2.07	1.35 (80°C)	–
Nitropropane (2-)	2608	D	988	−93	20.68	0.32	–
Nitrotoluene (ortho-)	1664	C	1163	−9.6	0.34	2.37	–
Nitrotoluene (meta-)	1664	N.E.D.	1153	+16	0.21	2.40	–
Nitrotoluene (para-)	1664	N.E.D.	1283	+51.7			–
Nonane	1920	(D)	716	−53.7	13.33	0.71	–

	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
Substance	I	II	III	IV	V	VI	VII
Nonyl alcohol		C	827	−5.5	0.4		−
Nonyl phenol		B	953	0		2.10	−
Octane	1262	(D)	702	−56.5	13.33	0.58	−
Octanol (n-)		C	827	−15	0.83	10.59	−
Oleum	1831	C	1900-2000	approx −35°C		approx 100	decomposes
Oxalic acid (10-25%)		D	1090-1230				+
Paraldehyde	1264	C	993	+12.6	34.47	1.10	−
Pentachloroethane	1669	B	1680	−29		2.70	−
Pentadiene (1,3-)		N.E.D.	689	−88	460	0.21	−
Pentane (n-)	1265	C	631	−129.7	666.61	0.23	−
Pentene (1-)	1108	(C)	640	−165	689.5	0.20	−
Perchloroethylene	1897	B	1623	−19	22.66	0.84	−
Phenol	1671	B	1071	+40.9	0.83	3.96 (45°C)	−
Phosphoric acid	1805	D	1750 (90%)	+28.8		61.25	+
Phosphorus (elemental)	1338	A	1820	+44.1			--
Phthalic anhydride (molten)	2214	C	1527	+131.6		1.37 (140°C)	−
Pinene	2368	(A)	857	−62.2	3	1.40	−
Polyethylene Polyamines	2734 2735	(C)	978	0	0.13	3.45	+
Polymethylene polyphenyl isocyanate	2206 2207	D	1198		0		+
Polypropylene glycol		D	1000	−50	0.01	70 - 300 (25°C)	+
Polyvinylbenzyltrimethyl ammonium chloride solution		N.E.D.	1058	0	27.46		+
Propiolactone (beta-)		D	1146	−33.4	6.89 (34°C)	0.83	− decomposes
Propionaldehyde	1275	D	806	−81	344.74	0.41	−
Propionic acid	1848	D	993	−20.8	4.48	1.10	+
Propionic anhydride	2496	C	1011	−45	1.65	1.12	chemical reaction
Propyl acetate (n-)	1276	D	898	−84.8	53.33 (29°C)	0.57	−

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Propyl alcohol (n-)	1274	D	804	–127	26.66	2.20	+
Propylamine (n-)	1277	C	718	–83	344.74	0.39	–
Propylene	1280	III	830	–112	620.5	0.28 (25°C)	–
Pyridine	1282	B	982	–42	20.68	0.98	+
Silicon tetrachloride	1818	D	1485	–68	262	0.48	chemical reaction
Sodium hydroxide	1824	C	1480	+5 – +8		59.2	–
Sodium bichromate (solution) (47% aqueous)	1497	B					+
Sodium borohydride (15% or less)/Sodium hydroxide solution		C	1397	+18			+
Sodium chlorate solution	2428	III	1497	+18			+
Sodium hydrosulphide solution (45% or less)	2922	B	1257	+41	17.23	1.19 (16°C)	+
Sodium hypochlorite solution (15% or less)	1791	C	1057	–6			+
Sodium pentachlorophenate (solution)		A					–
Sodium-2-mercaptobenzo-thiazol solution		(B)	1247	0	26.7	14.99	+
Styrene monomer	2055	B	906	–30.6	6.89	0.83	–
Sulphur, molten	2448	III	1796	+114			–
Sulphuric acid (spent)	1832	C	1008	0			+
Sulphuric acid	1830/ 1831/ 1832	C	1841	+10.5		28.54	–
Tallow		D	885	+20–56		8.85 (60°C)	–
Tetrachloroethane	1702	B	1594	–43.8	17.33	1.77	–
Tetraethyl lead	1649	A	1750	–28		0.53	–
Tetraethylenepentamine	2320	D	998	–30			+
Tetrahydronaphthalene	1540	C	970	–35.8	1.33	2.23	–
Tetrahydrofuran	2056	D	889	–108.5	179.26	0.41	–
Tetramethyl lead	1649	A	2000	–136	31.72	0.60	–
Tetramethylbenzene		(C)					–
Titanium tetrachloride	1838	D	1726	–24.1	13.1	0.40	decomposes
Toluene	1294	C	868	–95	32.40	0.58	–
Toluene diisocyanate	2078	B	1220	+6/+14		3.10	violent reaction

Substance	U.N. number	Pollution Category for operational discharge (Regulation 3 of Annex II)	Density at 20°C kg/m³	Melting point °C	Vapour pressure at 20°C mbar	Viscosity at 20°C m Pa·s	Water miscibility
	I	II	III	IV	V	VI	VII
Toluidine (o-)	1708	C	998	−24		4.40	–
Trichloroethylene	1710	B	1464	−73	82.74	0.60	–
Trichlorobenzene (1,2,4-)	2321	B	1447	+18			–
Trichloroethane	2831	B	1340 (1,1,1-) 1440 (1,1,2-)	−30.4 (1,1,1-) −36.5 (1,1,2-)	133.32 (1,1,1-)	0.66 (1,1,1-) 1.20 (1,1,2-)	–
Trichloropropane (1,2,3-)		B	1397	−15	2.0	2.31	–
Triethanolamine		D	1128	+17.9		902.4	+
Triethylamine	1296	C	728	−114.7	72.4	0.34	–
Triethylbenzene		(C)	868	−70	1.38	2.00	–
Triethylenetetramine	2259	C	984	−35			+
Triisopropanolamine		(C)	988	+58	0.01	109.96	+
Trimethyl benzene	2325	B	900	−68	6.67 (38°C)	1.04	–
Trimethylacetic acid		D	911	+34	13.17	1.69	–
Trimethylhexamethylene diamine (2,2,4- and 2,4,4- isomers)	2327	(D)	865	−80	0.06	5.60	+
Trimethylhexamethylene diisocyanate (2,2,4- and 2,4,4-isomers)	2328	B	1008	−80	0	5.00	+
Tripropylene glycol monomethyl ether		(D)	965	−79	0.03	5.60 (25°C)	+
Tritolyl phosphate		A	1160-1175	−33		75-100	–
Turpentine —	1299 (wood)	B	860-875	−55	40	1.24−1.28 (61°C)	
Vinyl acetate	1301	C	932	−93.2	131	0.45	–
Vinyl ethyl ether	1302	C	759	−115	551.6	0.22	–
Vinyl neodecanoate		N.E.D.	873	−20			–
Vinyl toluene	2618	(B)	897	−77	1.52	0.83	–
Vinylidene chloride	1303	B	1218	−122.1	689.48	0.33	–
Xylenes (mixed isomers)	1307	C	860-875	−48 to +13	8.96 (21°C)	0.62−0.82	–
Xylenols	2261	B	998	−40 to +45	0.69	23.00	–

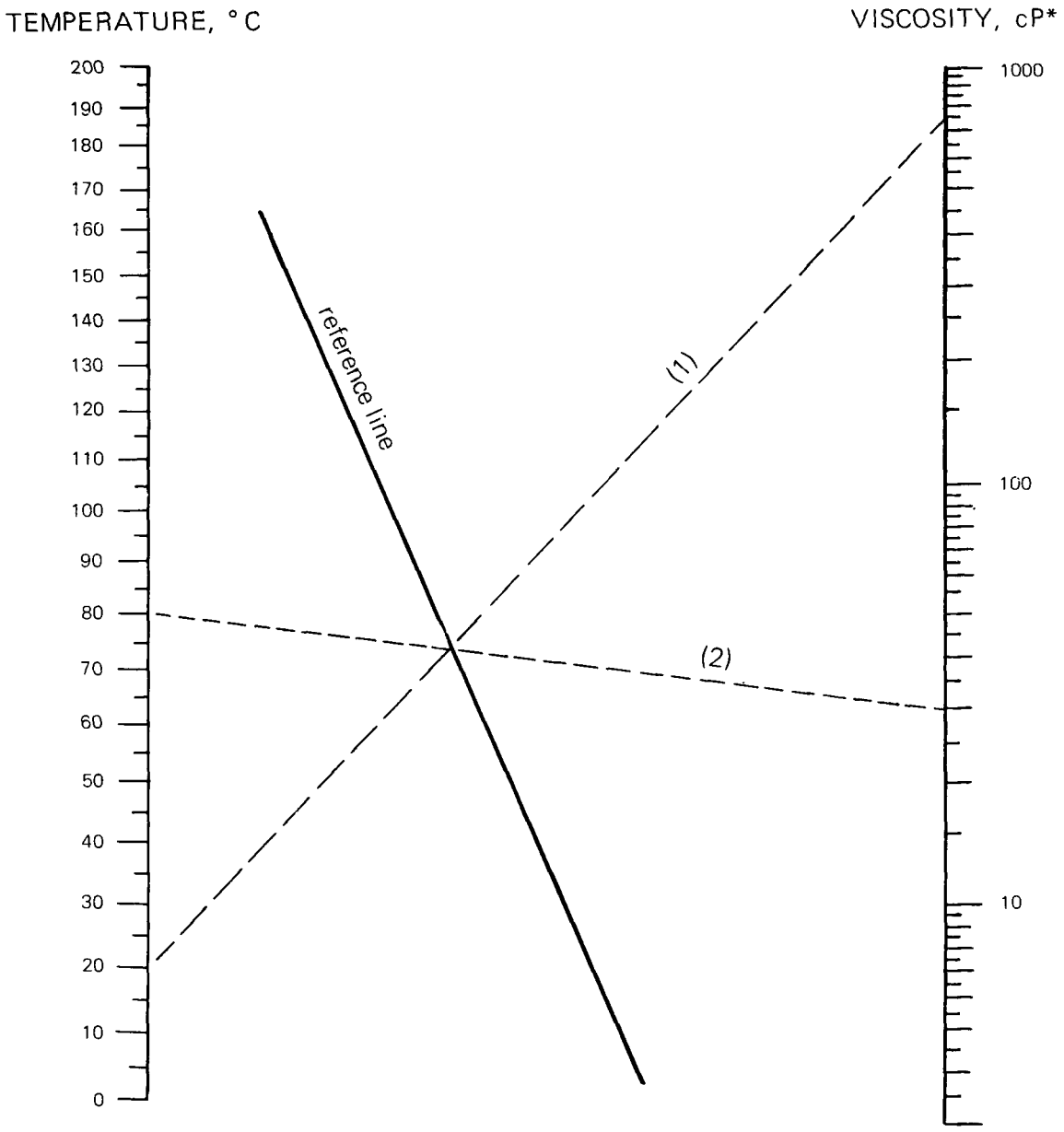


Figure B1 Nomogram for temperature correction of viscosity

To use the nomogram connect known values of temperature and viscosity with a straight line (e.g. 750 cP at 20°C: line (1)). The intersection of this line with the reference line gives a reference point. Draw a line from the known temperature through this reference point to intersect the viscosity scale. This gives the viscosity at this temperature (e.g. line (2): at 80°C the viscosity is found to be 30 cP).

* For conversion in SI Units: 1 centipoise (cP) = 1 millipascal second (mPa·s)

APPENDIX C

PREWASH PROCEDURES

In several sections of the Standards a prewash procedure is required in order to meet certain Annex II requirements. This Appendix explains how these prewash procedures should be performed according to the requirements of the particular section of the Standards that are being met.

Prewash procedures for non-solidifying substances

1 Tanks should be washed by means of a rotary water jet, operated at sufficiently high water pressure. In the case of Category A substances washing machines should be operated in such locations that all tank walls are reached. In the case of Category B and C substances only one location need be used.

2 During washing the amount of water in the tank should be minimized by continuously pumping out slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met the washing procedure should be repeated three times, with thorough stripping of the tank between washings.

3 Those products which have a viscosity in excess of 20 mPa·s (20cP) should be washed with hot water (temperature at least 60°C).

4 The number of cycles of the washing machine used should not be less than that specified in table C1. A washing machine cycle is defined as the period between two consecutive identical orientations of the washing machine (rotation through 360°). In most cases this involves between 10 m^3 and 20 m^3 of washwater.

5 After washing, the washing machine(s) should be kept operating long enough to flush the pipeline, pump and filter.

TABLE C1 – NUMBER OF WASHING MACHINE CYCLES TO BE USED IN EACH LOCATION (NON-SOLIDIFYING SUBSTANCES)

Section of Standards specifying prewash procedure	Two-nozzle machine	Three-nozzle machine
3.2 (Residual concentration 0.1% or 0.05%)	1	1
3.2 (Residual concentration 0.01% or 0.005%)	2	2
4.4.1	½	⅓
4.4.2	½	⅓
4.4.3	½	⅓
4.4.5	½	⅓

Note: for explanation of "residual concentration" see Regulations 5(1) and 5(7) of Annex II

Prewash procedures for solidifying substances

1 Tanks should be washed as soon as possible after unloading. If possible they should be heated prior to washing e.g. by hot water channels or by steaming.

2 Residues in hatches and manholes should preferably be removed prior to the prewash.

3 Tanks should be washed by means of a rotary water jet operated at sufficiently high water pressure and in locations to ensure that all tank walls are reached.

4 During washing the amount of water in the tank should be minimized by pumping out slops continuously and promoting flow to the suction point (positive list and trim). If this condition cannot be met, the washing procedure should be repeated three times with thorough stripping of the tank between washings.

5 Tanks should be washed with hot water (temperature at least 60°C).

6 The number of cycles of the washing machine used should not be less than that specified in table C2. A washing machine cycle is defined as the period between two consecutive identical orientations of the machine (rotation through 360°C). In most cases this involves between 10 m^3 and 20 m^3 of washwater.

7 After washing, the washing machine(s) should be kept operating long enough to flush the pipeline, pump and filter.

TABLE C2 – NUMBER OF WASHING MACHINE CYCLES TO BE USED IN EACH LOCATION (SOLIDIFYING SUBSTANCES)

Section of Standards specifying prewash procedure	Two-nozzle machine	Three-nozzle machine
3.2 (Residual concentration 0.1% or 0.05%)	2	2
3.2 (Residual concentration 0.01% or 0.005%)	3	3
4.4.1	1	1
4.4.2	1	1
4.4.3	1	1
4.4.5	1	1

Note: for explanation of "residual concentration" see Regulations 5(1) and 5(7) of Annex II

APPENDIX D

EXAMPLE OF A COMPATIBILITY GUIDE FOR THE MIXING OF CHEMICALS IN A SLOP TANK

General

The purpose of this Appendix is to provide an example method for determining the compatibility of substances mixed in a slop tank.

In this Appendix about a hundred substances that are known to be carried in bulk have been considered for compatibility. Substances that are not included in the list of substances should either be evaluated for compatibility or not mixed with substances of this compatibility guide.

Substances that are included in Annex I of MARPOL 73/78 have not been considered.

Criteria for compatibility:

Criteria for compatibility in this example are:

- evolution of gas, formation of solid products, heat evolution and total vapour pressure of the contents of the slop tank;
- the slop tank has sufficient corrosion resistance towards the contents in the presence of (sea) water; and
- the incompatible combinations have been considered on a conservative basis.

Restrictions

This compatibility guide has been prepared with the following restrictions:

- the temperature in the slop tank is not allowed to rise to over 40° C;
- if volatile substances (boiling point below 100° C) that are not completely miscible with water are to be combined with a substance that requires the use of warm washing water, the volatile substances and their cold washing water are transferred first to the slop tank;
- substances that are not included in the list of substances are regarded as incompatible with those mentioned and should be discharged from the slop tank or cargo tank separately without mixing with another substance or mixture; and
- the slop tank does not contain residues of previous slops.

Use of compatibility guide

The substances considered in this guide are given in two lists of substances.

The list of substances part I shows the substances by chemical groups.

The list of substances part II shows the substances in alphabetical order together with the chemical groups to which each substance belongs.

In the compatibility chart chemical groups are used.

The compatibility chart shows which groups are compatible and which are not.

This is also valid for combinations of more than two substances.

Thus if for more than two substances all binary combinations of two substances are compatible these substances can be combined in one slop tank.

This means that for four substances there are six of such binary combinations and can be shown as follows.

With four substances called a, b, c and d the following binary combinations should be considered for compatibility: ab, ac, ad, bc, bd and cd.

Substances belonging to the same chemical group are by definition compatible.

Alternative use of this guide

In case that a chemical tanker transports an increasing number of substances the number of binary combinations to be checked increases very rapidly.

An alternative procedure is shown in the table headed "Alternative slop tank groups".

The use of this table is as follows.

The table gives eight alternative slop tank groups.

These groups show which multicomponent combinations can be allowed in one slop tank.

For example, column A shows that all substances of the chemical groups 1 to 8, some of group 9 and all of groups 10 and 13 can be combined in all combinations in one slop tank.

Another example is that column D shows that one slop tank can be used to contain all substances belonging to the groups 1, 4, 6, 7, 8, 10, 11, 12, some of group 2 and most of group 9.

In general, one slop tank will often be sufficient but two slop tanks will suffice for any combination of the approximately 100 substances considered.

Follow: List of substances part I

List of substances part II

Compatibility chart

Table of alternative slop tank groups.

LIST OF SUBSTANCES, part I (by chemical group)

Group 1 (Paraffins)

Cyclohexane
Decane (C_{10}-paraffins)
Dodecane (C_{12}-paraffins)
n-Hexane
iso-Hexane
Heptane (n-, iso-)
Octane (n-, iso-)
Nonane (n-, iso-)

Group 2 (Aromatic hydrocarbons)

Benzene
Cumene
Cymene (para-isopropyltoluene)
Decylbenzene
Diethylbenzene
Dodecylbenzene
Ethylbenzene
Tetradecylbenzene
Toluene
Tridecylbenzene
Xylene (ortho, meta, para)

(These include: "BTX", alkylbenzene. detergent alkylate)

Group 3 (Olefins)

Decene (C_{10}-olefins)
Diisobutene
Dodecene (C_{12}-olefins)
Heptene (C_7-olefins)
n-Hexene
iso-Hexene (C_6-olefins)
Nonene (C_9-olefins)
Octene (C_8-olefins)
Tetradecene (C_{14}-olefins)
Undecene (C_{11}-olefins)

(These include: Dipentene, propylene-trimer, propylene-tetramer)

Group 4 (Alcohols, mono-glycols)

Amyl alcohol (n-, iso-)
Butyl alcohol (n-, iso-, sec-)
1,3-Butylene glycol
Cyclohexanol
Decanol (n-, iso-) (C_{10}-alcohols)
Dodecanol (n-, iso-) (C_{12}-alcohols)
Ethanol
Ethylene glycol
Glycerol
Hexanol (n-, iso-)
Hexylene glycol
Methanol
Nonanol (n-, iso-) (C_9-alcohols)
Octanol (n-, iso-) (C_8-alcohols)
Propanol (n-, iso-)
Propylene glycol
Tetradecanol (C_{14}-alcohols)
Tridecanol (C_{13}-alcohols)
Undecanol (C_{11}-alcohols)

(These include: ethylbutanol, ethylhexanol, methylamylalcohol, methyl-isobutyl carbinol)

Group 5 (Glycol ethers)

Diethylene glycol
Dipropylene glycol
Diethylene glycol monobutyl ether
Diethylene glycol monoethyl ether
Diethylene glycol monomethyl ether
Ethoxy triglycol
Ethylene glycol monobutyl ether
Ethylene glycol monoethyl ether
Ethylene glycol monomethyl ether
Polyethylene glycol
Polypropylene glycol
Polypropylene glycol methyl ether
Tetraethylene glycol
Triethylene glycol
Tripropylene glycol

LIST OF SUBSTANCES, part I (continued)

Group 6 (Esters)

Amyl acetate (n-, iso-)
Butyl acetate (n-, iso-, sec-)
Butyl benzyl phthlate
Dibutyl phthlate
Di(iso)decyl phthlate
Di(iso)heptyl phthlate
Di(iso)nonyl phthlate
Di(iso)octyl phthlate
Diundecylphthlate
Ethyl acetate
Methyl acetate
Methyl amyl acetate
Propyl acetate (n-, iso-)

Group 7 (Organic acids)

Acetic acid
Butyric acid*
Formic acid
Propionic acid

Group 8 (Ketones)

Acetone
Cyclohexanone
Diisobutyl ketone
Methyl ethyl ketone
Methyl isobutyl ketone

Group 9 (Halogenated hydrocarbons)

Carbon tetrachloride*
Methylene chloride (B.P. 40°C)*
Perchloroethylene*
1,1,1-Trichloroethane
Trichloroethylene*

Group 10 (Phenols)

Cresol (ortho, meta, para)**
Nonylphenol
Phenol*

Group 11 (Styrenes)

Styrene
Vinyltoluene

Group 12

Vinyl acetate

Group 13

Aniline

* Butyric acid, carbon tetrachloride, methylene chloride, perchloroethylene, trichloroethylene and phenol fall under pollution category B.

** Cresols fall under pollution category A.

LIST OF SUBSTANCES, part II (alphabetical)

Substance	Group
Acetic acid	7
Acetone	8
Alkylbenzene	2
Amyl acetate (n-, iso-, sec-)	6
Amyl alcohol (n-, iso-, sec-)	4
Aniline	13
Benzene	2
Butanol (n-, iso-, sec-)	4
Butyl acetate (n-, iso-, sec-)	6
Butyl alcohol, see butanol	
Butyl benzyl phthlate	6
1,3-butylene glycol	4
Butyric acid*	7
"BTX"	2
Carbon tetrachloride*	9
Cresol (ortho, meta, para)**	10
Cumene	2
Cyclohexane	1
Cyclohexanol	4
Cyclohexanone	8
Cymene (para)	2
Decane	1
Decanol (n-, iso-)	4
Decene (n-, iso-)	3
Decyl alcohol, see decanol	
Decylbenzene	2
Detergent alkylate	2
Dibutyl phthlate	6
Didecyl phthlate	6
Diethylbenzene	2
Diethylene glycol	5
Diethylene glycol monobutyl ether	5
Diethylene glycol monoethyl ether	5
Diethylene glycol monomethyl ether phthlate	5
Diheptyl phthlate	6
Diisobutene (= diisobutylene)	3
Diisobutyl ketone	8
Diisodecyl phthlate	6
Diisoheptyl phthlate	6
Diisononyl phthlate	6
Diisoctyl phthlate	6
Dinonyl phthlate	6
Dioctyl phthlate	6
Dipentene	3
Dipropylene glycol	5
Diundecyl phthlate	6
Dodecane	1
Dodecanol	4
Dodecene	3
Dodecyl alcohol, see dodecanol	
Dodecylbenzene	2
Ethanol	4
Ethoxy triglycol	5
Ethyl acetate	6
Ethyl alcohol, see ethanol	
Ethylbenzene	2
Ethylbutanol	4
Ethylhexanol (=ethylhexyl alcohol)	4
Ethylene glycol	4
Ethylene glycol monobutyl ether	5
Ethylene glycol monoethyl ether	5
Ethylene glycol monomethyl ether	5
Formic acid	7
Glycerol	4
Heptane (n-, iso-)	1
Heptene (n-, iso-)	3
Hexane (n-, iso-)	1
Hexanol (n- iso-)	4
Hexene (n-, iso-)	3
Hexyl alcohol, see hexanol	
Hexylene glycol	4
Iso. . . . ., see under parent names	
Isopropylbenzene, see cumene	
Isopropyltoluene, see cymene	
Methanol	4
Methyl acetate	6
Methyl alcohol, see methanol	
Methylamyl acetate	6
Methylamyl alcohol	4
Methylene chloride*	9
Methyl ethyl ketone	8
Methyl isobutyl ketone	8
Methyl isobutyl carbinol	4

LIST OF SUBSTANCES, part II (continued)

Substance	Group	Substance	Group
Nonane (n-, iso-)	1	Styrene (-monomer)	11
Nonanol (n-, iso-)	4		
Nonene (n-, iso-)	3	Tetrachloroethylene, see perchloroethylene	
Nonyl alcohol, see nonanol			
Nonylphenol	10	Tetradecanol	4
		Tetradecylbenzene	2
Octane (n-, iso-)	1	Tetradecene	3
Octanol (n-, iso-)	4	Tetraethylene glycol	5
Octene (n-, iso-)	3	Toluene	2
Octyl alcohol, see octanol		1,1,1-Trichloroethane	9
Olefins, see group 3		Trichloroethylene*	9
		Tridecanol (=tridecyl alcohol)	4
Perchloroethylene*	9	Tridecylbenzene	2
Phenol*	10	Triethylene glycol	5
Polyethylene glycol	5	Tripropylene glycol	5
Polypropylene glycol	5		
Polypropylene glycol methyl ether	5	Undecanol (=undecyl alcohol)	4
Propanol (n-, iso-)	4	Undecene	3
Propionic acid	7		
Propyl acetate (n-, iso-)	6	Vinyl acetate (-monomer)	12
Propyl alcohol, see propanol		Vinyltoluene	11
Propylene glycol	4		
Propylene tetramer	3		
Propylene trimer	3	Xylene (ortho, meta, para)	2

* Butyric acid, carbon tetrachloride, methylene chloride, perchloroethylene, phenol and trichloroethylene fall under pollution category B.

** Cresols fall under pollution category A.

COMPATIBILITY CHART

Group 1 (Paraffins)	1											
Group 2 (Aromatic hydrocarbons)	+	2										
Group 3 (Olefins)	+	+	3									
Group 4 (Alcohols, monoglycols)	+	+	+	4								
Group 5 (Glycol ethers)	+	+	+	+	5							
Group 6 (Esters)	+	+	+	+	+	6						
Group 7 (Organic acids)	+	+	+	+	+	+	7					
Group 8 (Ketones)	+	+	+	+	+	+	+	8				
Group 9 (Halogenated hydrocarbons) *	+	+	(B)	+	+	(E)	+	(D)	9			
Group 10 (Phenols)	+	+	+	+	+	+	+	+	+	10		
Group 11 (Styrenes)	+	(A)	(–)	+	(C)	+	+	+	+	+	11	
Group 12 (Vinyl acetate)	+	(A)	(–)	+	(–)	+	+	+	(D)	+	+	12
Group 13 (Aniline)	+	+	+	+	+	+	+	+	+	+	+	(–)

A: + for benzene, toluene, and ethylbenzene-free xylenes;
– for other members of group 2.

B: – for carbon tetrachloride;
+ for the other members of group 9.

C: + for diethylene glycol;
– for the other members of group 5.

D: – for methylene chloride;
+ for the other members of group 9 provided they do not contain more than 3% (total) of any one or more of the following substances: 1,1-dichloroethane, 1,1,2-trichloroethane, tetrachloroethane, pentachloroethane.

E: + for phthalates; for acetates, see D.

* For methylene chloride (boiling point 40°C) the maximum allowed slop tank temperature is 25°C.

ALTERNATIVE SLOP TANK GROUPS

	A	B	C	D	E	F	G	H
Group 1 (Paraffins) Group 4 (Alcohols, monoglycols) Group 7 (Organic acids) Group 10 (Phenols)	yes	yes	yes	yes	yes	yes	yes	yes
Group 2 (Aromatic hydrocarbons)	yes	yes	yes	a)	a)	a)	a)	a)
Group 3 (Olefins)	yes	yes	no	no	no	no	no	no
Group 5 (Glycol ethers)	yes	yes	yes	no	no	b)	b)	b)
Group 6 (Esters)	yes	d)	yes	yes	d)	yes	yes	d)
Group 8 (Ketones)	yes	no	yes	yes	no	no	yes	no
Group 9 (Methylene chloride) *	no	yes	no	no	yes	no	no	yes
Carbon tetrachloride	no	no	yes	yes	yes	yes	yes	yes
Other halogenated hydrocarbons	yes[c)]	yes	yes[c)]	yes[c)]	yes	yes	yes[c)]	yes
Group 11 (Styrenes)	no	no	no	yes	yes	yes	yes	yes
Group 12 (Vinyl acetate)	no	no	no	yes	no	yes	no	no
Group 13 (Aniline)	yes	yes	yes	no	no	no	yes	yes

a) **Yes** for benzene, toluene and ethylbenzene-free xylenes;
No for other members of this group.

b) **Yes** for diethylene glycol;
No for other members of this group.

c) **Yes** only if these substances do not contain more than 3% (total) of any one or more of the following substances: 1,1-dichloroethane, 1,1,2-trichloroethane, tetrachloroethane, pentachloroethane.

d) **Yes** for phthalates.
No for acetates.

* For methylene chloride (boiling point 40°C) the maximum allowed slop tank temperature is 25°C.

APPENDIX E

DETERMINATION OF PERMITTED DISCHARGE RATES

1 Chapter 4 of the Standards contains formulae which define the rate at which Category B and C substances may be discharged into the sea.

2 The maximum rates at which a residue/water mixture may be discharged can be derived by the following formulae:

$$Q_D C_S = K V^{1.4} L^{1.6}$$ when a single discharge outlet is used; or

$$Q_D C_S = 1.5 K V^{1.4} L^{1.6}$$ when dual discharge outlets are used

where Q_D = rate of discharge of residue/water mixture, cubic metres per hour

C_S = composite concentration of substance in a residue/water mixture, expressed as a volumetric ratio

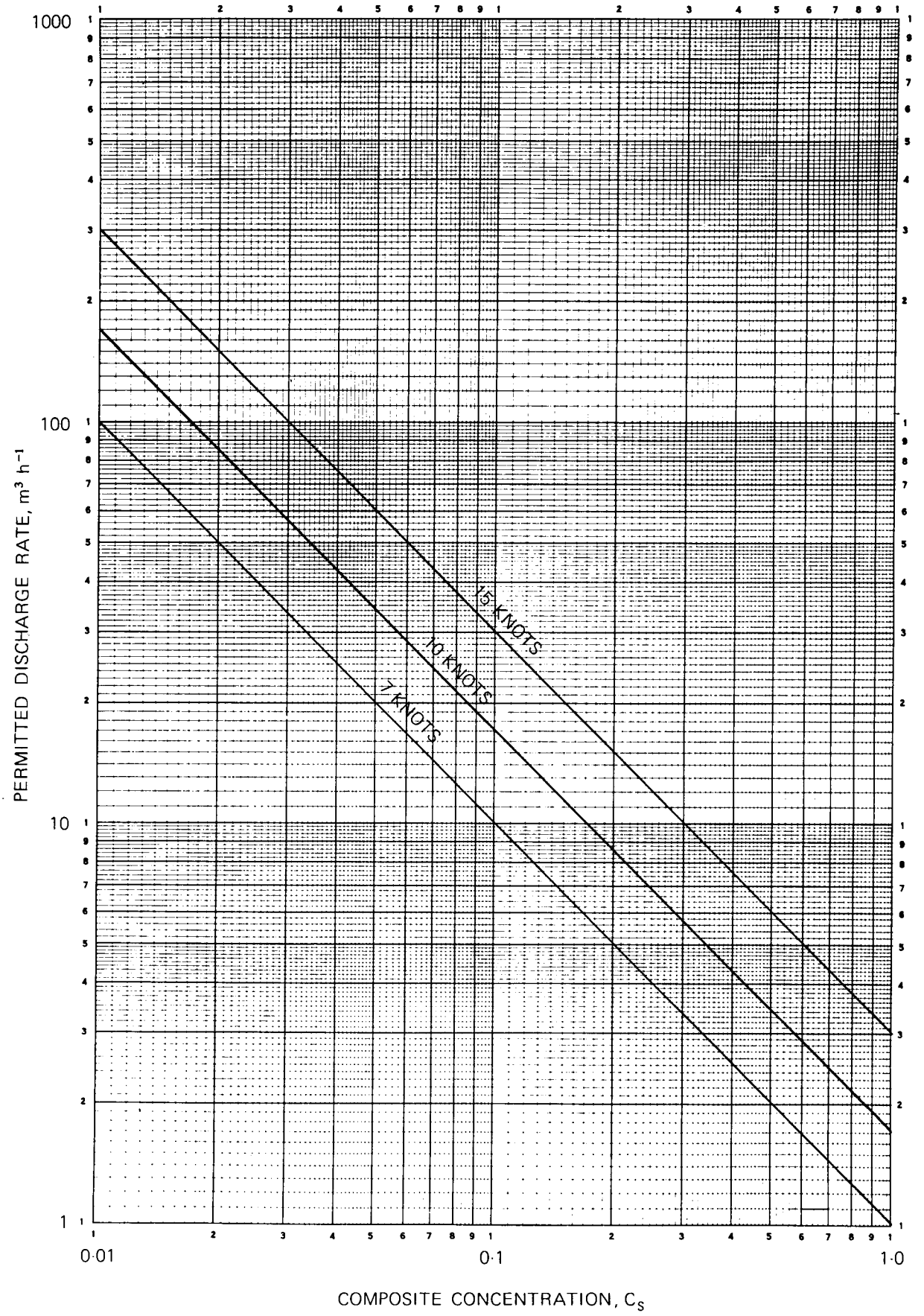
V = ship's speed, knots

L = ship's length, metres

$K = 4.3 \times 10^{-5}$

3 Using the formulae or the nomogram (figure E1) contained in this Appendix each ship shall be provided with means of indicating the rate at which residues may be discharged. Figure E2 is an example of a graph produced for a ship 100 m long fitted with a single discharge outlet.

Figure E2 Graph showing permitted discharge rates for a particular ship (single discharge outlet)



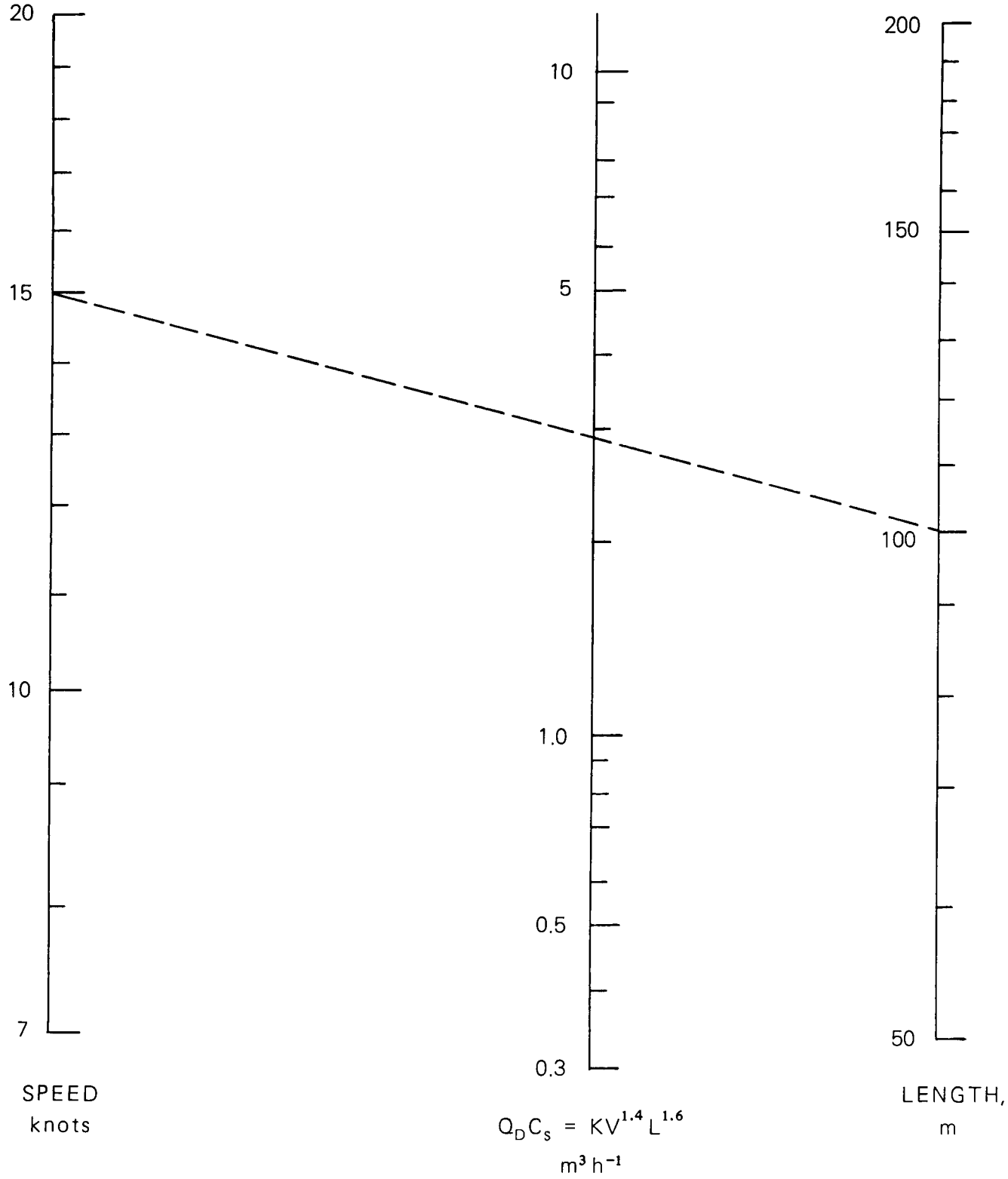


Figure E1 Nomogram of $Q_D C_s$ values (single discharge outlet)

To use the nomogram connect length of ship (RH column) to speed of ship during discharge (LH column) by a straight line. Read off the $Q_D C_s$ value where this straight line crosses centre column (e.g. 100 metres length at 15 knots ⟶ 2.9). With the aid of this value and the composite slops concentration the permitted discharge rate can easily be calculated. (e.g. C_s = 0.1 ⟶ discharge rate residue/water mixture is 29 m^3/h.

APPENDIX F

SUITABILITY FOR VENTILATION PROCEDURES

1 Products having a vapour pressure over 5 kPa (50 mbar) at 20°C selected from Appendix II to Annex II of the International Convention for the Prevention of Pollution from Ships, 1973 are listed in the table. These products are regarded as suitable for ventilation procedures from a volatility point of view, for the purpose of residue removal.

2 The procedure to remove cargo residue from a tank should take into account:

.1 the volatility of the product at the tank temperature; in general only products with a saturated vapour pressure over 5 kPa (50 mbar) may be suitable for ventilation;

.2 the positioning of the ventilation openings (these should be as close as possible to the sump or the suction point);

.3 the list and trim of the vessel (minimum list and trim favour evaporation);

.4 the presence of structures inside the tank, especially bottom structure, may considerably hamper evaporation; and

.5 the airjet should reach the tank bottom. This means that a minimum capacity is required, depending on the density of air/vapour mixture, fan diameter and tank height. The minimum flow rates for various inlet diameters for all tank sizes are given in figure F 1.

3 It should be noted, however, that ventilation procedures have inherent hazards due to the production of toxic and/or flammable vapours. Amongst the substances listed in the table set out below are some which are liable to produce highly toxic vapours. Furthermore, some substances have very low autoignition temperatures. With regard to safety aspects, the operational requirements for openings in cargo tanks in the Bulk Chemical Code and the ventilation procedures in the ICS Tanker Safety Guide (Chemicals) should be consulted.

4 In addition, it should be borne in mind that port authorities may have regulations on ventilation which have to be adhered to.

VOLATILE ANNEX II PRODUCTS

Product	UN No.	Vapour pressure (in 10^2 Pa (mbar) at 20°C)	Category	B.C. Code toxicity
Acetaldehyde (Ethanal)	1089	1000	C	
Acetone	1090	243	D	
Acetyl chloride (at 16°C)	1717	263	C	
Acrolein	1092	280	A	
Acrylonitrile	1093	112	B	T
Allyl chloride	1100	447	C	T
Benzene	1114	99	C	T
n-Butyraldehyde	1129	120	B	T
Carbon disulphide	1131	391	A	T
Carbon tetrachloride	1846	112	B	T
Chloroform	1888	210	B	T
Cyclohexane	1145	101	C	
Diethylamine	1154	250	C	T
Diethyl ether	1155	582	D	T
Diisopropylamine	1158	79	C	T
Diisopropylether	1159	171	D	
Ethyl acetate	1173	96	D	
Ethylene dichloride	1184	86	B	T
Formic acid	1779	47	D	T
Isobutyraldehyde	2045	151	C	T
Isopentane (at 21°C)		783	D	
Isopropylamine	1221	553	C	T
Isoprene	1218	592	D	
Methyl acetate (at 25°C)	1231	309	D	
Methyl acrylate	1919	86	C	T
Methylene chloride	1593	500	B	T
2-Methyl pentene		333	D	
n-Pentane	1265	566	C	
Propionaldehyde	1275	339	D	T
n-Propylamine	1277	316	C	T
Silicon tetrachloride	1818	254	D	
Tetrahydrofuran	2056	191	D	T
Trichloroethylene	1710	79	B	T
Triethylamine	1296	76	C	T
Vinyl acetate	1301	118	C	
Vinylidene chloride	1303	651	B	T

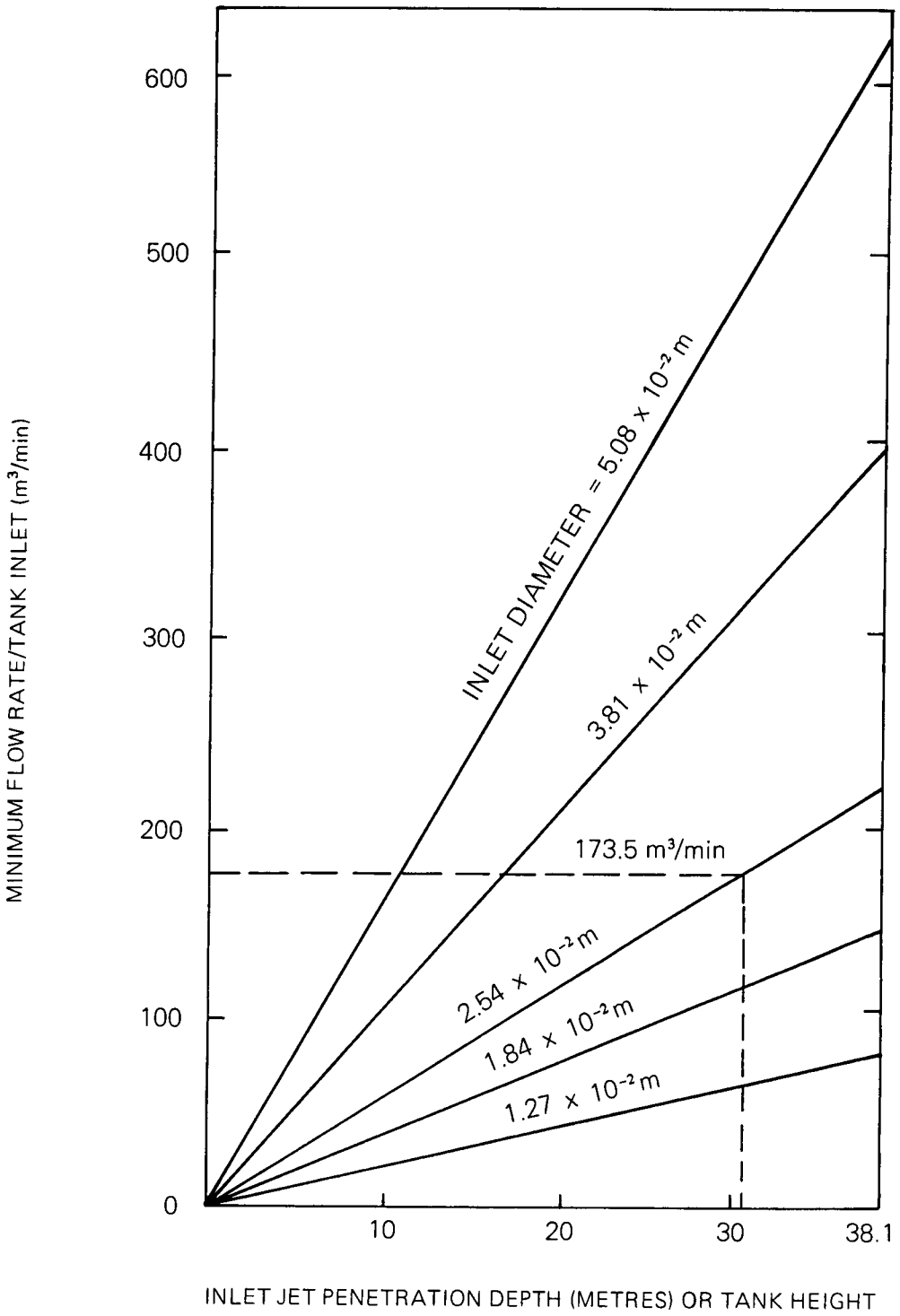


Figure F 1 — Minimum flow rate as a function of tank depth for selected inlet diameter

APPENDIX G

METHOD FOR DETERMINING THE COMPOSITE CONCENTRATION IN A SLOP TANK

1 Introduction

When discharging a homogeneous mixture from a slop tank which contains more than one product it is necessary to determine a composite concentration (C_S) so that residue/water mixture can be discharged in accordance with section 4.5 of the Standards. This Appendix identifies a procedure for calculating C_S. More simplified procedures are also acceptable provided that they yield higher values of C_S.

2 Determination of C_S (for discharge of residue/water mixtures outside special areas)

2.1 Using the residue tables determine the quantity of each substance present in the slop tank.

2.2 Add the quantities of Category C substances present and divide this sum by ten.

2.3 Add the quantities of Category B substances which are present.

2.4 Add the amounts determined in 2.2 and 2.3 above.

2.5 C_S is determined by dividing the figure obtained in 2.4 by the volume of the residue/water mixture in the slop tank. This volume is normally obtained from ullage tables.

3 Determination of C_S (for discharge of residue/water mixtures inside special areas)

3.1 Using the residue tables determine the quantity of each Category C substance* present in the slop tank.

3.2 Add these figures.

3.3 C_S is obtained by dividing the figure obtained in 3.2 by the volume of the residue/water mixture in the slop tank. This volume is normally obtained from ullage tables.

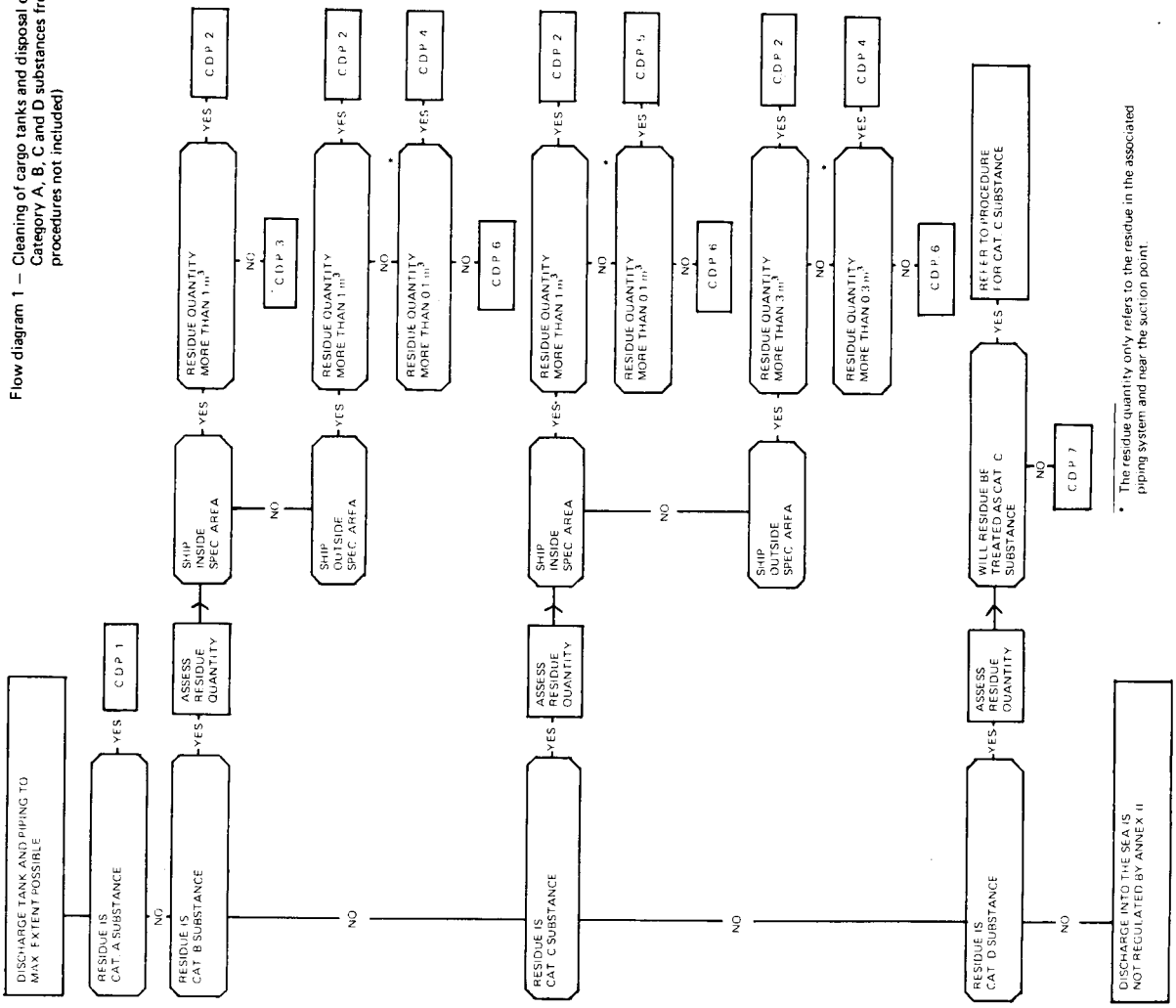
---

* Only measurable quantities of Category C substances should be present in the slop tank since prewash slops containing Category B substances must be discharged to shore reception facilities or discharged into the sea outside a special area.

APPENDIX H

FLOW DIAGRAMS FOR A CHEMICAL TANKER OPERATING UNDER MARPOL 73/78 ANNEX II REQUIREMENTS

CLEANING AND DISPOSAL PROCEDURES (C.D.P.)	SEQUENCE OF PROCEDURES						
	1	2	3	4	5	6	7
APPLY PREWASH IN ACCORDANCE WITH APPENDIX C	x	x	x				
EITHER PREWASH IN ACCURDANCE WITH APPENDIX C OR FLUSH DISCHARGE PIPELINES INTO TANK				x	x		
PREWASH SLOPS MUST BE DISCHARGED ASHORE	x	x					
PREWASH OR LINE FLUSH SLOPS MAY BE TRANSFERRED TO SLOP TANKS FOR DISCHARGE INTO THE SEA INSIDE SPECIAL AREAS*					x		
PREWASH OR LINE FLUSH SLOPS MAY BE TRANSFERRED TO SLOP TANKS FOR DISCHARGE INTO THE SEA OUTSIDE SPECIAL AREAS*			x	x	x		
ALTERNATIVELY PREWASH SLOPS MAY BE DISCHARGED ASHORE			x	x	x		
FILL TANKS WITH WATER TO AT LEAST 5% OF CAPACITY	x						
DILUTE RESIDUE IN CARGO TANK WITH WATER TO OBTAIN RESIDUE CONCENTRATION IN MIXTURE OF 10% OR LESS						x	
WASH TANK TO COMMERCIAL REQUIREMENTS		x	x	x	x	x	
CONDITIONS FOR DISCHARGE RESIDUE/WATER MIXTURES OTHER THAN PREWASH OR LINE FLUSH SLOPS**							
> 12 MILES OFFSHORE	x	x	x	x	x	x	x
> 7 KNOTS SHIP'S SPEED	x	x	x	x	x	x	x
> 25 METRES DEPTH OF WATER	x	x	x	x	x	x	
USING UNDERWATER DISCHARGE	x	x	x	x	x	x	
ALTERNATIVELY RESIDUE/WATER MIXTURES MAY BE DISCHARGED ASHORE	x	x	x	x	x	x	x
ANY WATER SUBSEQUENTLY INTRODUCED INTO THE TANK MAY BE DISCHARGED TO THE SEA WITHOUT RESTRICTIONS	x	x	x	x	x	x	x



Flow diagram 1 — Cleaning of cargo tanks and disposal of tank washings containing Category A, B, C and D substances from cargo tanks (ventilation procedures not included)

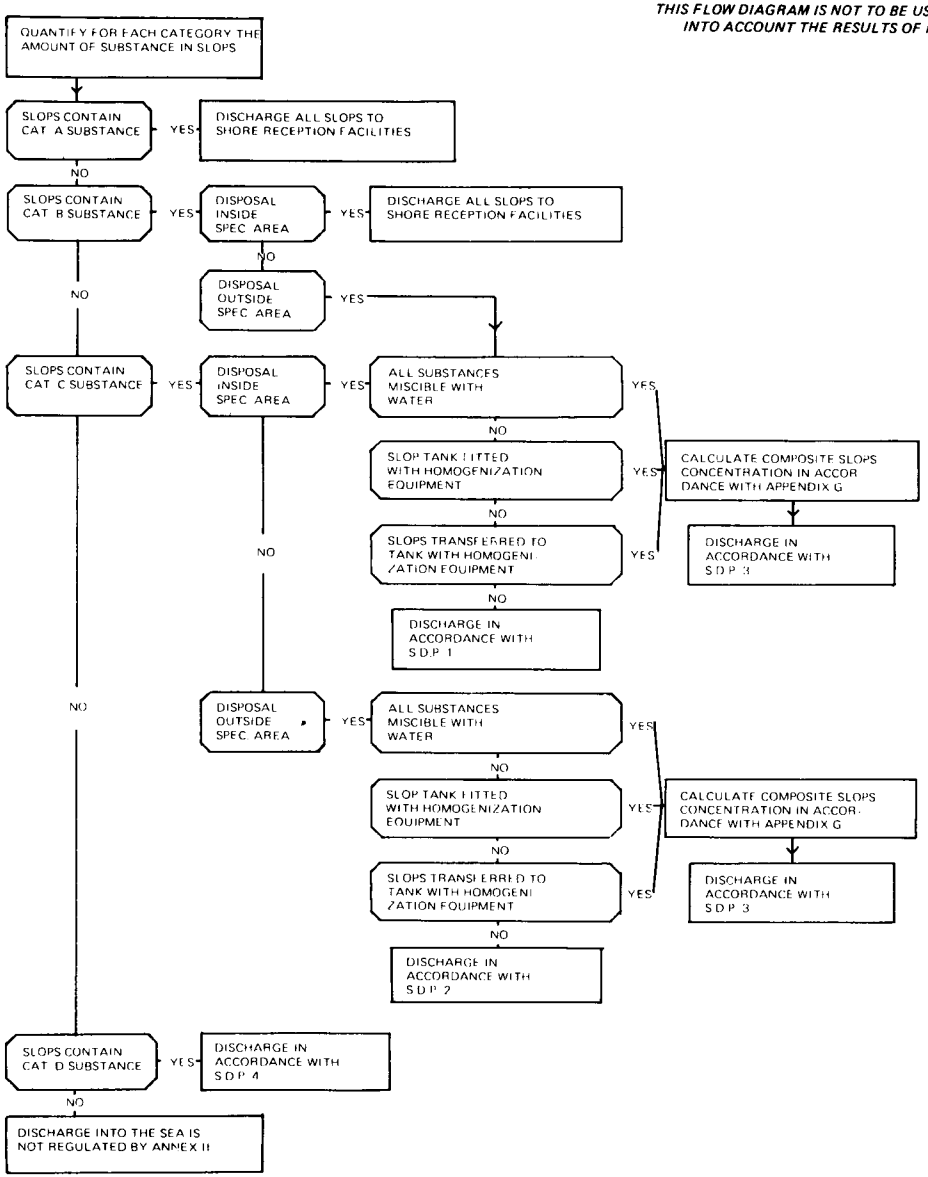
* The residue quantity only refers to the residue in the associated piping system and near the suction point

NOTE

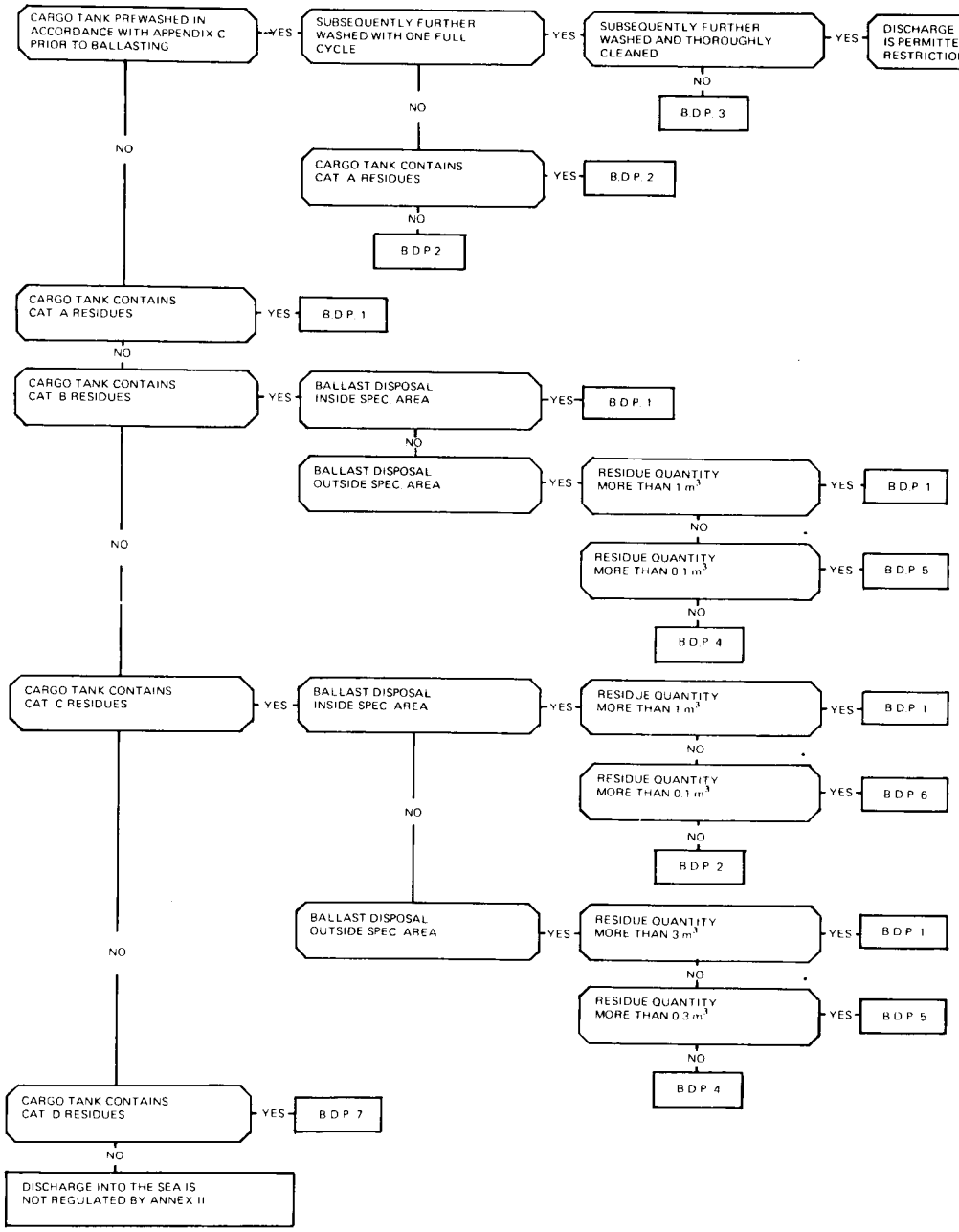
* For discharge of prewash or line flush slops from slop tanks refer to flow diagram 2
** For discharge of ballast water refer to flow diagram 3

Flow diagram 2 – Disposal of prewash or line flush slops containing Category A, B, C or D substances from dedicated or designated slop tanks or cargo tanks containing tank washings or slops

THIS FLOW DIAGRAM IS NOT TO BE USED WITHOUT TAKING INTO ACCOUNT THE RESULTS OF FLOW DIAGRAM 1.



SLOPS DISPOSAL PROCEDURES (S.D.P.)	SEQUENCE OF PROCEDURES			
	1	2	3	4
ESTABLISH DISCHARGE RATE OF PURE PRODUCT IN ACCORDANCE WITH APPENDIX E	x	x	x	
DIVIDE OBTAINED DISCHARGE RATE OF PURE PRODUCT BY COMPOSITE SLOPS CONCENTRATION			x	
THE FIGURE OBTAINED SHOWS THE RATE AT WHICH DISCHARGE IS PERMITTED	x		x	
THE FIGURE OBTAINED MULTIPLIED BY TEN SHOWS THE RATE AT WHICH DISCHARGE IS PERMITTED		x		
DILUTE SLOPS WITH WATER TO OBTAIN A SOLUTION OF 10% OR LESS – NO RESTRICTION ON DISCHARGE RATE				x
ADDITIONAL DISCHARGE CONDITIONS				
– SHIP'S SPEED AT LEAST 7 KNOTS	x	x	x	x
– OUTSIDE 12 MILES FROM NEAREST LAND	x	x	x	x
– DEPTH OF WATER AT LEAST 25 METRES	x	x	x	
– USE UNDERWATER DISCHARGE OUTLET	x	x	x	
– DISCHARGE ABOVE WATERLINE PERMITTED				x



Flow diagram 3 – Disposal of ballast water from cargo tanks

BALLAST DISPOSAL PROCEDURES (B.D.P.)	SEQUENCE OF PROCEDURES						
	1	2	3	4	5	6	7
BALLAST MUST BE DISCHARGED ASHORE	X						
BALLAST MAY BE DISCHARGED AT SEA INSIDE SPECIAL AREA		X	X			X	X
BALLAST MAY BE DISCHARGED AT SEA OUTSIDE SPECIAL AREA		X	X	X	X	X	X
DISCHARGE RATE OF BALLAST WATER UNRESTRICTED		X	X	X			X
DISCHARGE RATE OF BALLAST WATER RESTRICTED IN ACCORDANCE WITH DISCHARGE RATE FOR SLOPS AS SET OUT IN FLOW DIAGRAM 2					X	X	
ADDITIONAL DISCHARGE CONDITIONS							
– SHIP'S SPEED AT LEAST 7 KNOTS		X		X	X	X	X
– OUTSIDE 12 MILES FROM NEAREST LAND		X	X	X	X	X	X
– DEPTH OF WATER AT LEAST 25 METRES		X	X	X	X	X	
– USE UNDERWATER DISCHARGE OUTLET		X		X	X	X	
– DISCHARGE ABOVE WATERLINE PERMITTED			X				X

* The residue quantity only refers to the residue in the associated piping system and near the suction point.

APPENDIX I

OUTLINE OF A PROCEDURES AND ARRANGEMENTS MANUAL

CHAPTER 1 – INTRODUCTION

1 General

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Tanker Safety and Pollution Protocol (TSPP) of 1978 (hereinafter referred to as MARPOL 73/78) was established in order to prevent the pollution of the marine environment by discharges into the sea from ships of harmful substances or effluents containing such substances.

In order to achieve its aim, MARPOL 73/78 contains five Annexes in which detailed regulations are given with respect to the handling on board ships and the discharge into the sea of five main groups of harmful substances i.e. Annex I (mineral oils), Annex II (liquid noxious substances carried in bulk), Annex III (harmful substances carried in packaged form), Annex IV (sewage) and Annex V (garbage).

The main purpose of this Manual, which is approved by the Administration, is to identify for the ship's officers all operational procedures with respect to cargo handling, tank cleaning, slops handling, ballasting and deballasting, which must be followed in order to comply with the requirements of Annex II to MARPOL 73/78.

In addition, this approved Manual, together with the ship's Cargo Record Book and International Pollution Prevention Certificate, will be used by Administrations for control purposes in order to ensure full compliance with the requirements of Annex II by chemical tankers.

2 Main features of Annex II

The requirements of Annex II apply to all ships carrying liquid chemicals in bulk. Chemicals posing a threat of harm to the marine environment are divided into four categories, A, B, C and D and listed as such in Appendix II to Annex II. Category A chemicals are those posing the greatest threat to the marine environment, whilst Category D chemicals are those posing the smallest threat.

Annex II prohibits the discharge into the sea of any effluent containing chemicals falling under these categories, except when the discharge is made under conditions which are specified in detail for each category. These conditions include such parameters as:

- the maximum quantity of chemicals per tank which may be discharged into the sea;
- the speed of the ship during the discharge;
- the minimum distance from the nearest land during discharge;
- the minimum depth of water at sea during discharge;
- the maximum concentration of chemicals in the ship's wake or the dilution of chemicals prior to discharge;
- the need to effect the discharge below the waterline.

For certain sea areas identified as "special areas" more stringent discharge criteria are given. Under Annex II the special areas are the Baltic Sea Area* and the Black Sea Area**.

In addition to the conditions referred to above, an important requirement contained in Annex II is that discharge operations of effluents containing chemicals and certain tank cleaning and ventilation operations may only be executed in accordance with approved procedures and arrangements based upon standards developed by the International Maritime Organization (IMO).

To enable this requirement to be complied with, this Manual contains in chapter 2 all particulars of the ship's equipment and arrangements and in chapter 3 operational procedures for cargo handling, discharge of cargo residues, tank washing, slops collection, ballasting and deballasting as called for by Annex II for those chemical products the ship may carry.

By following the procedures and arrangements as set out in this Manual, it is ensured that the ship complies with all relevant requirements of Annex II to MARPOL 73/78.

3 Responsibilities of the master

The master shall ensure that no discharges into the sea of cargo residues or residue/water mixtures containing Category A, B, C or D substances shall take place, unless such discharges are made in full compliance with the operational procedures contained in this Manual and that the equipment required by this Manual and needed for such discharges is used.

If the outflow recording unit as prescribed in this Manual becomes defective, the master shall report such defect as soon as possible to the Administration. The defective unit shall be made operable as soon as possible, but at least within a period of 60 days, and when this has been effected, the master shall report this to the Administration.

Note: MARPOL 73/78 defines these areas as follows:

* The Baltic Sea area means the Baltic Sea proper with the Gulf of Bothnia, the Gulf of Finland and the entrance to the Baltic Sea bounded by the parallel of the Skaw in the Skagerrak at 57°44.8'N.

** The Black Sea area means rhe Black Sea proper with the boundary between the Mediterranean and the Black Sea constituted by the parallel 41°N.

CHAPTER 2 – DESCRIPTION OF THE SHIP'S EQUIPMENT AND ARRANGEMENTS

Chapter 2 of the Manual contains all particulars of the ship's equipment and arrangements, as well as the basic parameters which will enable the ship's officers to follow the operational procedures set out in chapter 3. The information contained in chapter 2 is given under the following headings:

1. Type of ship.
2. Description of ballast tanks and ballast pumping and piping arrangements.
3. Description of cargo pumping and piping arrangements and stripping system.
4. Description of dedicated slop tanks and cargo tanks designated as slop or holding tanks with associated pumping and piping arrangements.
5. Description of underwater discharge outlet for effluents containing chemicals.
6. Homogenizing equipment.
7. Control recording devices.
8. Description of ventilation system.
9. Description of tank washing arrangements and washwater heating system.

The following information under each heading is required as a minimum for this part of the Manual.

1 Type of ship

Under this heading the following information should be provided:

- type of ship in accordance with the IBC Code;
- general arrangement indicating the position of cargo tanks in longitudinal and athwartship directions.

2 Description of ballast tanks and ballast pumping and piping arrangements

Under this heading the following information should be provided:

- a general arrangement showing the segregated ballast tanks and cargo tanks to be used as ballast tanks together with the cubic capacity per ballast tank;
- ballast piping arrangement with ballast pipeline diameters;
- pumping capacity for segregated ballast tanks;
- pumping capacity for those cargo tanks which may also be used as ballast tanks;
- the interconnection between the ballast piping arrangements and the underwater outlet system.

3 Description of cargo pumping and piping arrangements and stripping system

Under this heading the following information should be provided:

- cargo piping arrangements with diameters and cubic capacity of pipelines;
- cargo pumping arrangements with capacities;

- piping arrangements of stripping system with diameters and cubic capacity of stripping lines;
- pumping arrangements of stripping system with capacities;
- location of suction points of cargo lines and stripping lines inside every cargo tank;
- if a sump or well is fitted, the location and cubic capacity thereof;
- minimum list and trim required during discharge;
- line draining and/or blowing arrangements; and
- capacity of nitrogen or air available or required for line blowing.

4 **Description of dedicated slop tanks and cargo tanks designated as slop or holding tanks with associated pumping and piping arrangements**

Under this heading the following information should be provided:

- which dedicated slop tanks are provided and which cargo tanks are designated as slop or holding tanks together with the capacities of such tanks;
- piping arrangements of dedicated and designated slop or holding tanks with piping diameters and their connection with the underwater discharge outlet; and
- pumping arrangements of slop tanks and the basic principles of their operation in relation to their capacities.

5 **Description of underwater discharge outlet for effluents containing chemicals**

Under this heading the following information should be provided:

- location of underwater discharge outlet;
- single or dual outlet;
- location of intakes used for domestic purposes in the engine-room;
- diameters of the discharge outlet; and
- indication of the angle of the discharge outlet to the hull or any baffle provided at the outlet.

6 **Homogenizing equipment**

Under this heading the following information should be provided:

- full description of the equipment or method to be used for homogenizing slops;
- discharge capacity of the equipment or method; and
- interconnection with slops pipeline system.

7 **Control recording devices***

Under this heading the following information should be provided:

- the method by which the discharge of effluents containing chemicals is registered;

Note:

* It should be noted that the Cargo Record Book shall be completed in accordance with the instructions given in chapter 3.

- how the start and stop time of such discharges or the flow rate and the actual time (GMT or other standard time) is recorded;
- whether the date recording is effected manually or automatically; and
- alternative method of recording if the actual recording device becomes defective.

8 **Description of ventilation system**

Under this heading the following information should be provided:

- the products the ship is certified to carry having a vapour pressure over 5 kPa at 20°C intended for cleaning by ventilation to be listed;
- position of the ventilation openings;
- the minimum capacity of the ventilation system to reach the bottom of the cargo tank;
- the presence of structures inside the tank;
- the minimum list and trim during ventilation procedure; and
- the method of ventilating the cargo pipeline system with pumps, filters, etc.

9 **Description of tank washing arrangements and washwater heating system**

Under this heading the following information should be provided:

- arrangements for piping dedicated for tank washing with pipeline diameters;
- type of tank washing machines with capacities and pressure rating;
- maximum number of tank washing machines which can operate simultaneously;
- position of deck openings for cargo tank washing;
- the number of washing machines and their location required for ensuring complete coverage of the cargo tank walls;
- maximum capacity of washwater for heating equipment to reach 60°C; and
- maximum number of tank washing machines which can operate simultaneously at 60°C.

CHAPTER 3 – PROCEDURES RELATING TO THE CLEANING OF CARGO TANKS, THE DISCHARGE OF RESIDUE/WATER MIXTURES, BALLASTING AND DEBALLASTING

1 Operational procedures

.1 Based on the ship's design, equipment and arrangements, operational procedures have been set out in this chapter in respect of tank cleaning, ballast and slops handling which ensure compliance with the requirements of Annex II.

.2 Section 2 of this chapter outlines the sequence of actions to be taken. Further sections of this chapter contain the information essential for the proper execution of these actions. Only by following the sequence shown, can it be ensured that noxious liquid substances are discharged without posing a threat of harm to the marine environment.

2 Step by step method for tank cleaning, disposal and ballast procedures

.1 Establish if the last cargo in the tank is included in section 3 of this chapter. If not, no special tank cleaning and disposal procedures apply under the provisions of Annex II.

.2 If the last cargo in the tank is included in section 3 turn to the residue assessment page for that particular product in section 4 of this chapter. The page number is indicated in the right-hand column of the table in section 3.

.3 By means of the residue assessment page, establish the residue remaining in the cargo tank in accordance with paragraph 4.3.

.4 In addition to assessing the residue quantity, use the residue assessment pages to select other information essential for correct cleaning, disposal and ballast operations such as:

- category of product;
- compatibility with slops containing other products;
- melting point;
- viscosity;
- solubility in water.

.5 Having established the above information refer to section 5 of this chapter for:

.1 Tank cleaning and disposal procedures;

2 Slops disposal procedures;

.3 Ballasting and deballasting of cargo tanks procedures.

.6 Further details necessary to comply with the required procedures have been set out in addenda as follows:

Addendum A : Prewash programmes; and

Addendum B : Determination of permitted discharge rates of slops containing Category B or C products.

3 List of Annex II substances allowed to be carried

Substance	U.N. No.	Marpol Cat.	Allowed to be carried in	Assess. page

4 **Residue on board assessment**

.1 The residue assessment pages contained in this section show information on the quantity of residues remaining in a tank after the cargo has been discharged.

.2 Each page contains the relevant information for a product in so far as this product may be carried in the ship and comes under Annex II.

.3 By means of the assessment pages, the residue quantity of a product remaining in a tank after discharge is to be assessed as follows:

.1 Turn to the residue assessment page for that product.

.2 Determine the basic residue quantity from the tank diagram.

.3 Determine the viscosity correction at cargo temperature from the tank diagram.

.4 Ascertain if solidification correction is necessary.

.5 If so, determine deckhead residue from the appropriate table, using ambient temperature.

.6 Also determine tank walls residue from the appropriate table, using temperatures of adjacent tanks.

.7 Also determine pipeline residue from the appropriate table, using ambient temperatures.

.8 If no direct pipe routeing is employed, establish the additional pipeline residue.

.9 Calculate total residue in tank by addition of:

- basic quantity;
- viscosity correction;
- solidification correction, if any, for
  - deckhead;
  - tank walls;
  - piping;
- solidification correction of extra piping if any.

.4 The diagrams and tables are based on a trim of at least ..... m by the stern and a list of at least 0.5° towards the suction point inside a tank.

.5 If for operational reasons the above trim and heel figures cannot be achieved, it should be assumed that the quantities of residues per tank always exceed:

- 1 m^3 for substances of Category B; and
- 3 m^3 for substances of Category C.

N.B. For substances of Category A the quantity of residues is irrelevant for further operations, i.e. tank washing, disposal of residue and ballast procedures remain the same, irrespective of quantities.

PRODUCT	:	Acetic acid
PRODUCT GROUP	:	Organic acid
VISCOSITY AT 20°C	:	1.26 cP
MELTING POINT	:	+ 16.6°C
SOLUBLE	:	Yes
COMPATIBILITY GROUP	:	7
CATEGORY	:	C

TANK DIAGRAM.

PORT AND STARBOARD SIMILAR

1.	RESIDUE QUANTITY TANK ..... CBM PIPELINE ..... CBM [1), 2)]
2.	RESIDUE QUANTITY TANK ..... CBM PIPELINE ..... CBM [1), 2)]
3.	ETC.
4.	
5.	
6.	
7.	

TOTAL RESIDUE QUANTITY CONSISTS OF

RESIDUE QUANTITY TANK (REFER TO TANK DIAGRAM)

RESIDUE QUANTITY PIPELINE (REFER TO TANK DIAGRAM)

SOLIDIFICATION CORRECTION (REFER TO OPPOSITE PAGE)

N.B. The solidification correction need only be applied if air temperature or adjacent temperature (sea or product) are below 16°C (melting point).

COMPATIBILITY

SLOPS CONTAINING "ACETIC ACID" MAY NOT BE PUT INTO A TANK CONTAINING SLOPS OF THE FOLLOWING PRODUCT GROUPS

N/A

CLEANING AND BALLASTING

FOR TANK CLEANING, SLOPS DISPOSAL AND BALLAST PROCEDURES REFER TO THE FLOW DIAGRAMS OF SECTION 5

PREWASHING

IF THE CLEANING AND DISPOSAL PROCEDURES OF SECTION 3 REQUIRE A PREWASH REFER TO ADDENDUM A FOR DETAILS.

NOTE:

1) When other than routeing to manifold is employed add (or subtract) ..... CBM per 10 m length of piping.

2) When pipelines are not purged, or when temperatures are below 16°C add solidification correction for residue in pipelines on opposite page.

SOLIDIFICATION CORRECTION

RESIDUE ON DECKHEAD FOR PARTIALLY FILLED TANKS

Air temp.	1	2	3	4	5	6	7
15							
10							
5							
0							
−5							

N.B. If tanks are completely filled (.....%) the residue on deckheads is 0.

RESIDUE ON TANKWALLS

F = FOWD.
A = AFT.
P = PORT
S = STARB.

Temp. in adjacent spaces	1 F−A−P−S	2 F−A−P−S	3 F−A−P−S	4 F−A−P−S	5 F−A−P−S	6 F−A−P−S	7 F−A−P−S
15							
10							
5							
0							
−5							

RESIDUE IN PIPELINES

(DIRECT ROUTEING TO MANIFOLD)

Air temp.	1	2	3	4	5	6	7
Below 16							

TOTAL SOLIDIFICATION CORRECTION CONSISTS OF:

RESIDUE ON DECKHEAD

RESIDUE ON TANKWALLS

RESIDUE IN PIPELINES.

N.B. When other than direct routeing to manifold is employed add (or subtract) ..... CBM per 10 m. length of piping

5 Flow diagrams

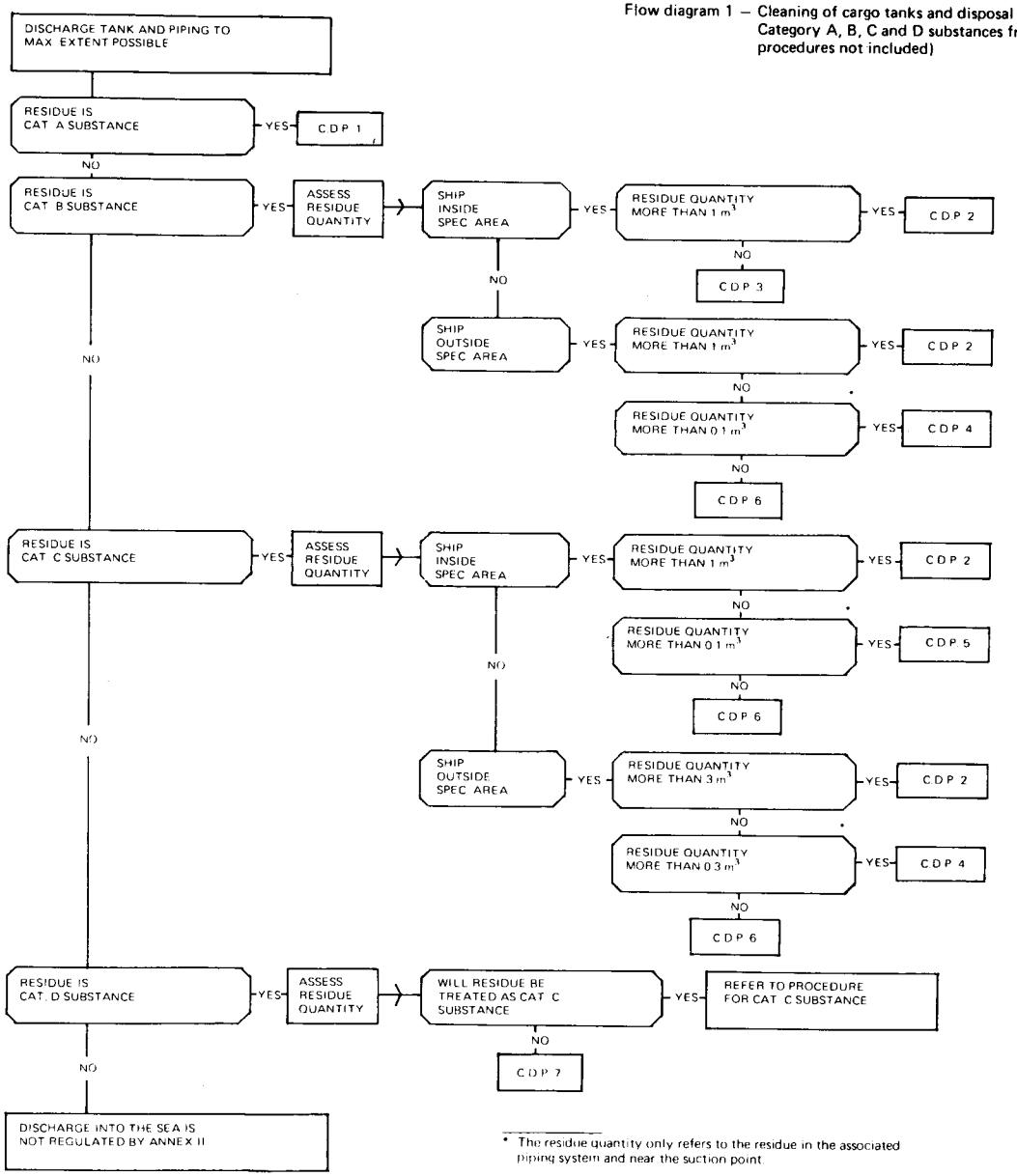
.1 This section shows procedures in respect of tank cleaning, slops handling and ballast handling.

.2 These procedures have been set out in flow diagrams as follows:

- Flow diagram 1 : Cleaning of cargo tanks and disposal of tank washings containing Category A, B, C and D substances from cargo tanks:
- Flow diagram 2 : Disposal of prewash or line flush slops containing Category A, B, C or D substances from dedicated slop tanks or cargo tanks designated as slop tanks;
- Flow diagram 3 : Disposal of ballast water from cargo tanks.

.3 The flow diagrams have been arranged in a set sequence. Diagrams 2 and 3 should not be used without taking into account the results of the previous diagrams.

Flow diagram 1 – Cleaning of cargo tanks and disposal of tank washings containing Category A, B, C and D substances from cargo tanks (ventilation procedures not included)



* The residue quantity only refers to the residue in the associated piping system and near the suction point.

CLEANING AND DISPOSAL PROCEDURES (C.D.P.)	SEQUENCE OF PROCEDURES						
	1	2	3	4	5	6	7
APPLY PREWASH IN ACCORDANCE WITH ADDENDUM A	x	x	x				
EITHER PREWASH IN ACCORDANCE WITH ADDENDUM A OR FLUSH DISCHARGE PIPELINES INTO TANK				x	x		
PREWASH SLOPS, MUST BE DISCHARGED ASHORE	x	x					
PREWASH OR LINE FLUSH SLOPS MAY BE TRANSFERRED TO SLOP TANKS FOR DISCHARGE INTO THE SEA INSIDE SPECIAL AREAS*					x		
PREWASH OR LINE FLUSH SLOPS MAY BE TRANSFERRED TO SLOP TANKS FOR DISCHARGE INTO THE SEA OUTSIDE SPECIAL AREAS*			x	x	x		
ALTERNATIVELY PREWASH SLOPS MAY BE DISCHARGED ASHORE			x	x*	x		
FILL TANKS WITH WATER TO AT LEAST 5% OF CAPACITY	x						
DILUTE RESIDUE IN CARGO TANK WITH WATER TO OBTAIN RESIDUE CONCENTRATION IN MIXTURE OF 10% OR LESS							x
WASH TANK TO COMMERCIAL REQUIREMENTS		x	x	x	x	x	
CONDITIONS FOR DISCHARGE RESIDUE/WATER MIXTURES OTHER THAN PREWASH OR LINE FLUSH SLOPS**							
> 12 MILES OFFSHORE	x	x	x	x	x	x	x
> 7 KNOTS SHIP'S SPEED	x	x	x	x	x	x	x
> 25 METRES DEPTH OF WATER	x	x	x	x	x	x	
USING UNDERWATER DISCHARGE	x	x	x	x	x	x	
ALTERNATIVELY RESIDUE/WATER MIXTURES MAY BE DISCHARGED ASHORE	x	x	x	x	x	x	x
ANY WATER SUBSEQUENTLY INTRODUCED INTO THE TANK MAY BE DISCHARGED TO THE SEA WITHOUT RESTRICTIONS	x	x	x	x	x	x	x

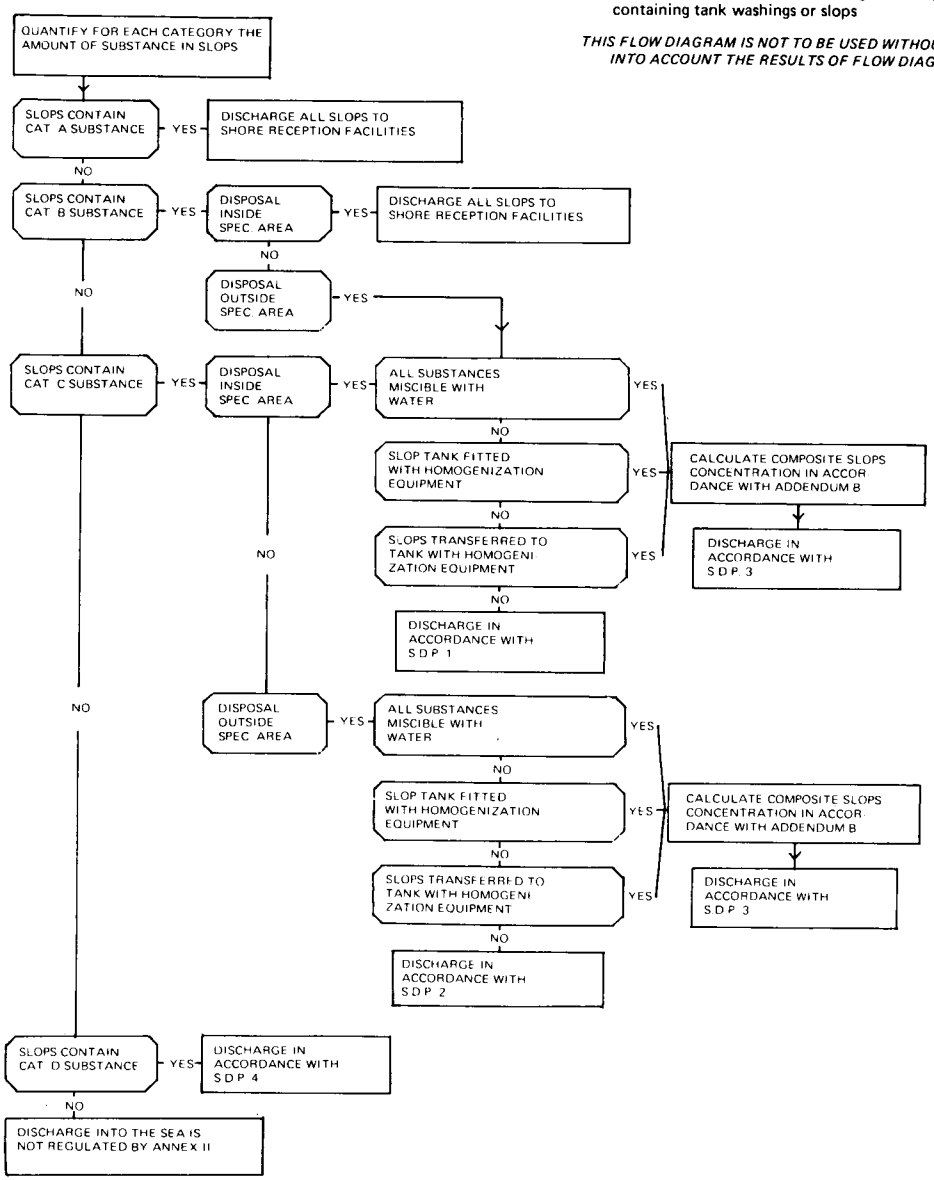
NOTE

* For discharge of prewash or line flush slops from slop tanks refer to flow diagram 2.

** For discharge of ballast water refer to flow diagram 3.

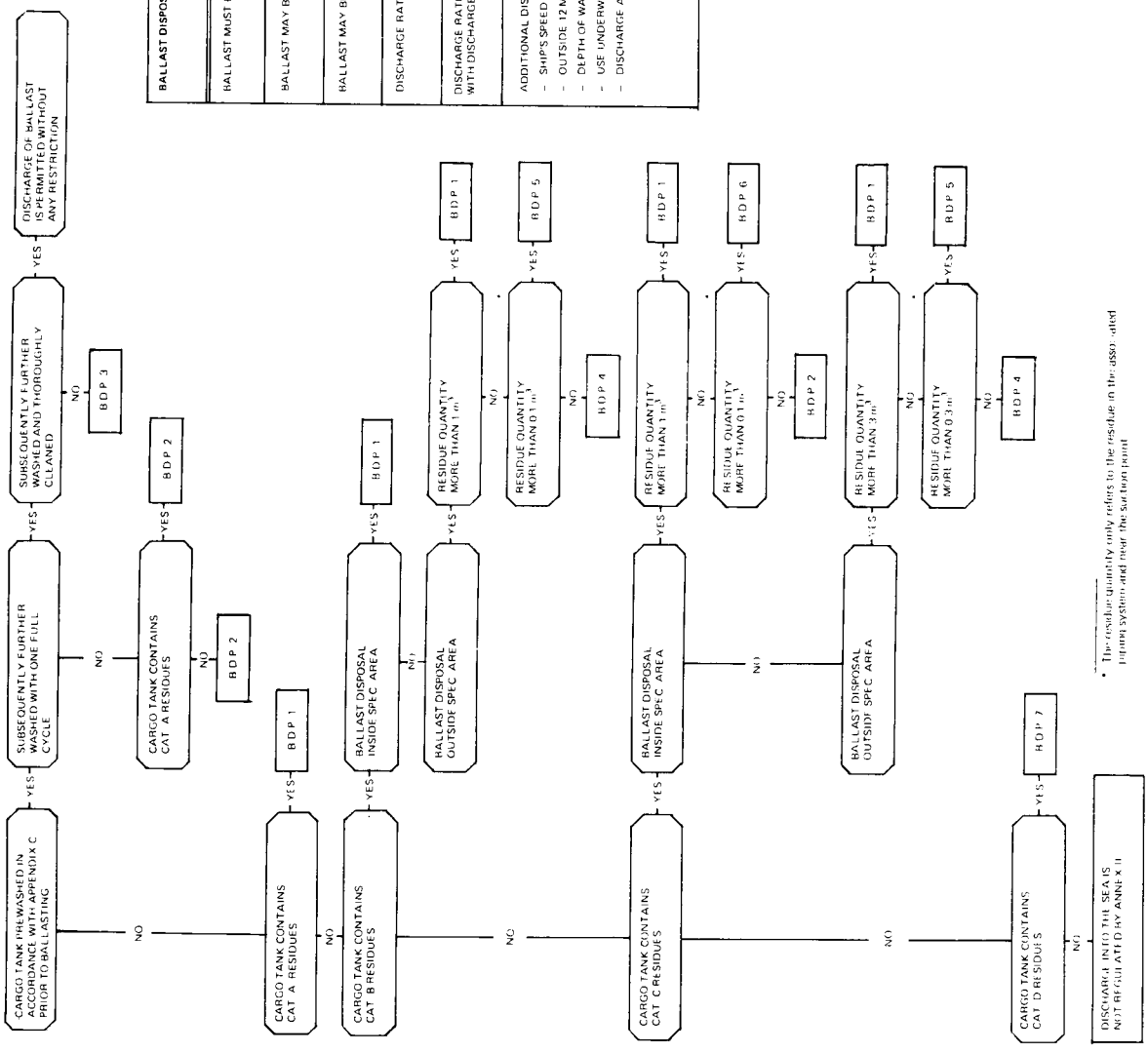
Flow diagram 2 – Disposal of prewash or line flush slops containing Category A, B, C or D substances from dedicated or designated slop tanks or cargo tanks containing tank washings or slops

THIS FLOW DIAGRAM IS NOT TO BE USED WITHOUT TAKING INTO ACCOUNT THE RESULTS OF FLOW DIAGRAM 1.



SLOPS DISPOSAL PROCEDURES (S.D.P.)	SEQUENCE OF PROCEDURES			
	1	2	3	4
ESTABLISH DISCHARGE RATE OF PURE PRODUCT IN ACCORDANCE WITH ADDENDUM B	X	X	X	
DIVIDE OBTAINED DISCHARGE RATE OF PURE PRODUCT BY COMPOSITE SLOPS CONCENTRATION			X	
THE FIGURE OBTAINED SHOWS THE RATE AT WHICH DISCHARGE IS PERMITTED	X		X	
THE FIGURE OBTAINED MULTIPLIED BY TEN SHOWS THE RATE AT WHICH DISCHARGE IS PERMITTED		X		
DILUTE SLOPS WITH WATER TO OBTAIN A SOLUTION OF 10% OR LESS – NO RESTRICTION ON DISCHARGE RATE				X
ADDITIONAL DISCHARGE CONDITIONS				
– SHIP'S SPEED AT LEAST 7 KNOTS	X	X	X	X
– OUTSIDE 12 MILES FROM NEAREST LAND	X	X	X	X
– DEPTH OF WATER AT LEAST 25 METRES	X	X	X	
– USE UNDERWATER DISCHARGE OUTLET	X	X	X	
– DISCHARGE ABOVE WATERLINE PERMITTED				X

Flow diagram 3 – Disposal of ballast water from cargo tanks



BALLAST DISPOSAL PROCEDURES (B.D.P.)	SEQUENCE OF PROCEDURES						
	1	2	3	4	5	6	7
BALLAST MUST BE DISCHARGED ASHORE	X						
BALLAST MAY BE DISCHARGED AT SEA INSIDE SPECIAL AREA		X	X			X	X
BALLAST MAY BE DISCHARGED AT SEA OUTSIDE SPECIAL AREA		X	X	X	X	X	X
DISCHARGE RATE OF BALLAST WATER UNRESTRICTED		X	X	X			X
DISCHARGE RATE OF BALLAST WATER RESTRICTED IN ACCORDANCE WITH DISCHARGE RATE FOR SLOPS AS SET OUT IN FLOW DIAGRAM 2					X	X	
ADDITIONAL DISCHARGE CONDITIONS							
– SHIP'S SPEED AT LEAST 7 KNOTS		X		X	X	X	X
– OUTSIDE 12 MILES FROM NEAREST LAND		X	X	X	X	X	X
– DEPTH OF WATER AT LEAST 25 METRES		X	X	X	X	X	
– USE UNDERWATER DISCHARGE OUTLET		X		X	X	X	
– DISCHARGE ABOVE WATERLINE PERMITTED			X				X

* The residue quantity only refers to the residue in the associated piping system and near the suction point

ADDENDUM A

PREWASH PROGRAMMES

1 GENERAL REMARKS

.1 After the discharge of a product, when a tank is to be washed, the flow diagram on cleaning and disposal procedures may stipulate a prewash.

.2 The prewash serves several distinct purposes and should be strictly adhered to. These are:

.1 Limiting the quantity of slops which have to be discharged to reception facilities and increasing the product concentration in the slops.

.2 Limiting the quantity of slops to be transferred to the slop tanks or tanks designated as such.

.3 Facilitating the discharge to the sea of subsequent tank washings.

.4 Ensuring that discharges into the sea are in compliance with the requirements of Annex II.

.3 The prewash programme is mainly dependent on the product previously carried in a tank. Different categories of cargo require a different prewash, likewise solidifying products need a prewash different from non-solidifying products. The programmes set out in this section cater for these different parameters.

.4 The required prewash programme may be found by referring to section 2 of this addendum which summarizes the different options.

2 SUMMARY OF PROPERTIES OF SUBSTANCES IN RELATION TO PREWASH PROGRAMMES

.1 **Category A**

non solidifying

viscosity (at 20° C) not in excess of 20 mPa·s.

If subsequent tank flushing water is to be discharged to the sea ***outside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

If subsequent tank flushing water is to be discharged to the sea ***inside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

.2 **Category A**

non solidifying

viscosity (at 20° C) in excess of 20 mPa·s.

If subsequent tank flushing water is to be discharged to the sea ***outside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

If subsequent tank flushing water is to be discharged to the sea ***inside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

.3 **Category A**

solidifying.

If subsequent tank flushing water is to be discharged to the sea ***outside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

If subsequent tank flushing water is to be discharged to the sea ***inside*** special areas, refer to prewash programme . . . . . of section 3 of this addendum.

.4 **Category B**

non solidifying

viscosity (at 20° C) not exceeding 20 mPa·s.

Refer to prewash programme . . . . . .

etc.

.5 **Category C**

non solidifying

viscosity (at 20° C) not exceeding 20 mPs·s.

Refer to prewash programme . . . . . .

etc.

3 DESCRIPTION OF PREWASH PROGRAMMES

Prewash programme 1

.1 Tanks should be washed by means of a rotary water jet, operated at sufficiently high water pressure.

.2 During washing the amount of water in the tank should be minimized by continuously pumping out slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met the washing programme should be repeated 3 times, with thorough stripping of the tank between washings.

.3 Washing machines should be used from each location at a height underdeck of about . . . . . m

.4 The number of cycles of the washing machine(s) should not be less than 2, irrespective whether two nozzle or three nozzle machines are used.

.5 After washing, the washing machine(s) should be kept operating long enough to flush the pipeline pump and filter.

.6 After the prewash a tank flush is required. The quantity of water used should not be less than 5% of the tank capacity.

Prewash programme 2

.1 Tanks should be washed by means of a rotary water jet, operated at sufficiently high water pressure.

.2 During washing the amount of water in the tank should be minimized by continuously pumping out slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met the washing programme should be repeated 3 times, with thorough stripping of the tank between washings.

.3 Washing machines should be used from each location at a height underdeck of about . . . . . m.

.4 The number of cycles of the washing machine(s) should not be less than 3, irrespective whether two nozzle or three nozzle machines are used.

.5 After washing the washing machine(s) should be kept operating long enough to flush the pipeline pump and filter.

.6 After the prewash a tank flush is required. The quantity of water used should not be less than 5% of the tank capacity.

Prewash programme 3

.1 Tanks should be washed by means of a rotary water jet operated at sufficiently high water pressure.

.2 The temperature of the washing water should be not less than 60°C.

.3 During washing the quantity of water in the tank should be minimized by continuously pumping out the slops and promoting flow to the suction point (positive list and trim). If this condition cannot be met the programme should be repeated 3 times with thorough stripping of the tank between washings.

.4 Washing machines should be used from each location at a height underdeck of about . . . . . m.

.5 The number of cycles of the washing machine(s) should not be less than 2, irrespective whether two nozzle or three nozzle machines are used.

.6 After washing, the washing machines should be kept operating long enough to flush the pipeline pump and filter.

.7 After the prewash a tank flush is required. The quantity of water used should not be less than 5% of the tank capacity.

Prewash programme 4

etc.

ADDENDUM B

DETERMINATION OF PERMITTED DISCHARGE RATES OF SLOPS CONTAINING CATEGORY B OR C PRODUCTS

1 DETERMINING THE MAXIMUM PERMITTED DISCHARGE RATE

.1 For a ship, the maximum permitted discharge rate for slops containing Category B and C products is dependent on

- ship's speed;
- concentration of such products in the slops;
- presence of non-soluble products in the slops.

For Category C products also,

- discharge inside or outside special area.

.2 The parameters set out under .1 above lead to the following method for the determination of the discharge rate for slops.

.1 Soluble products:

- Determine the maximum discharge rate for undiluted product in cubic metres per hour, in accordance with the table shown under section 2 of this addendum (= a).
- Calculate the composite product concentration in the slops in accordance with the method set out under section 3 of this addendum (= b).
- The maximum discharge rate for the slops in cubic metres per hour is derived by dividing the discharge rate for undiluted product by the composite slops concentration ($= \frac{a}{b}$).

.2 Non-soluble products. Means to effect homogenization are available:

- Follow the procedure set out for soluble products set out in .1 above.

.3 Non-soluble products. Means to effect homogenization are not available:

- Determine the maximum discharge rate for undiluted product in cubic metres per hour, in accordance with the table shown under section 2 of this addendum (= a).
- The maximum discharge rate for the slops shall not exceed that figure (= a).
- If *only* Category C products are present in the slops and discharge outside special areas is intended, the maximum discharge rate for the slops shall not exceed 10 times that figure (= 10 a).

2 DISCHARGE RATE FOR UNDILUTED PRODUCT

.1 The discharge rate for undiluted product shown in the following table forms the basis for calculating the discharge rate for slops in accordance with section 1 of this addendum.

N.B. Table to be developed for a given ship, taking into account:

- that the table should indicate the rates of discharge at 7 knots, at the maximum speed of the ship fully loaded, and at all speeds in between at intervals of not more than one knot;
- the provision of single- or double-discharge outlets.

3 METHOD FOR DETERMINING THE COMPOSITE CONCENTRATION IN A SLOP TANK

.1 Outside special areas

- Using the residue tables, determine the quantity of each substance present in the slop tank.
- Add the quantities of Category C substances present and divide this sum by ten.
- Add the quantities of Category B substances which are present.
- Add these two amounts.
- C_S is determined by dividing the last figure by the volume of the residue/water mixture in the slop tank. This volume is normally obtained from ullage tables.

.2 Inside special areas

- Using the residue tables determine the quantity of each Category C substance* present in the slop tank.
- Add these figures.
- C_S is obtained by dividing the figure obtained by the volume of the residue/water mixture in the slop tank. This volume is normally obtained from ullage tables.

* Only measurable quantities of Category C substances should be present in the slop tank since prewash slops containing Category B substances must be discharged to shore reception facilities or discharged into the sea outside a special area.

ASSEMBLY

THIRTEENTH SESSION

7 – 18 November 1983

RESOLUTIONS AND OTHER DECISIONS

ERRATA

Page v

Add to the entry for resolution A.539(13):

Annex 3: Recommendation on Minimum Requirements for Certification of Officers in Charge of a Navigational Watch on Fishing Vessels of 24 Metres in Length and Over Operating in Unlimited Waters

Annex 4: Recommendation on Minimum Requirements for Certification of Skippers on Fishing Vessels of 24 Metres in Length and Over Operating in Limited Waters

Annex 5: Recommendation on Minimum Requirements for Certification of Officers in Charge of a Navigational Watch on Fishing Vessels of 24 Metres in Length and Over Operating in Limited Waters

Page vii

In the column ***Agenda item***, for the decision adopted on 16 November on Maritime rescue, replace "10(b)" with "10(b) & 25", and for the decision adopted on 17 November on Relations with inter-governmental organizations, replace "17" with "27".

Page 41

In the fourth line of 2.1.1 replace "Aluminium 6.0 ± 9.5 mm" with "Aluminium 6.0 ± 0.5 mm".

Page 52

In the first line of 3.1.4.3.2 and the fourth line of 3.1.7.2, replace "100 mm^2" with "100 mm × 100 mm".

Page 105

In the second line of 5.16.2.1 replace "+35 ± 3°" with "+35 ± 3°C".

Page 194

In the second line of 2.9.5 replace "10 $1/m^2$/per minute" with "10 l/m^2 per minute".

Page 279

In the heading of 2.1.2 add "Q_{RES}***(sucpt)***" after "***point***".

Page 289

Replace "FIG A4 RESIDUE TABLE" with "FIG A3 RESIDUE TABLE".

Page 312

Alongside the compatibility chart add "+ = compatible
– = not compatible".

Page 367

Below the heading "**RELATIONS WITH INTER-GOVERNMENTAL ORGANIZATIONS**" replace "***Agenda item 17***" with "***Agenda item 27***".

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