ICHCA International Limited

INTERNATIONAL SAFETY PANEL BRIEFING PAMPHLET NO 13

THE LOADING AND UNLOADING OF SOLID BULK CARGOES

By John L Alexander

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ICHCA International Limited

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ICHCA International Limited - INTERNATIONAL SAFETY PANEL

The International Safety Panel is composed of safety and training officers and directors, transport consultants, representatives from leading safety and training organisations and institutions and leading authorities on the subject area from around the world.

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ISBN: 1 85330 096 9
978-1-85330-096-7

First published 1998

The Loading and Unloading of Solid Bulk Cargoes

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1 INTRODUCTION

1.1 Every year some 1.8 billion tonnes of solid bulk cargoes pass through the world's ports. Although the hazardous properties of some of the cargoes are well known, other cargoes are not dangerous cargoes in the generally accepted sense. However, this does not mean that there are no hazards associated with the loading and unloading of such solid bulk cargoes. Whether or not the cargo itself is recognised as being dangerous, there may be hazards to the port personnel who carry out the cargo handling operation, to people nearby, or to the crew of the ship while it is in the port or at sea.

1.2 In recent years there has been increasing concern at the number of bulk carriers that have been lost at sea and the associated loss of life. In opening the 68th session of the International Maritime Organization's (IMO) Maritime Safety Committee (MSC) at the end of May 1997, the Secretary General, Mr William O'Neil, reported that 99 bulk carriers had been lost together with more than 600 lives since 1990.

1.3 The IMO Code of Practice for the Safe Loading and Unloading of Bulk Carriers (the BLU Code) was approved by MSC and adopted by the 20th Assembly of IMO in November 1997. The Assembly urged IMO member Governments to implement the Code at the earliest possible opportunity and to introduce relevant port byelaws. The Code emphasises the need for co-operation between ship and cargo terminal personnel to ensure the safety of all who can be affected by their actions. This is more likely to be achieved if those involved with the handling of solid bulk cargoes are aware of at least the main hazards associated with the cargoes and the possible consequences of the hazards to themselves and others.

1.4 The BLU Code complements the IMO Code of Safe Practice for Solid Bulk Cargoes (the BC Code), which was first published in 1965, and includes guidance on the stowage and shipment of sold bulk cargoes. The BC Code is included in the Supplement volume of the IMO International Dangerous Goods Code (the IMDG Code) as well as being published as a separate document. The BLU Code does not cover the carriage of grain, which is dealt with separately in the IMO International Code for the Safe Carriage of Grain (the Grain Code)

1.5 This booklet is intended only as a short introduction to the subject. More detailed information is available in the BLU Code and other publications, such as the references listed in Appendix 1. Although a number of people in the transport chain are involved with the transport of solid bulk cargo by sea, including ship owners, charterers and agents, the booklet is intended primarily to assist stevedores, terminal operators and others who are directly involved in cargo handling operations at ports. The booklet deals only with the loading and unloading of solid bulk cargoes that can be poured into the holds of bulk carriers. It is not intended to cover the loading and unloading of rigid bulk cargoes, such as steel, timber or logs, which are carried in the holds of bulk carriers without any intermediate form of containment. However, many of the general principles, including the need for good ship/shore liaison and co-operation, will also apply to the working of rigid bulk cargoes.

1.6 A number of incidents associated with the loading and unloading of bulk carriers are described in Appendix 2.

1.7 The production of this booklet has only been possible with the co-operation and assistance of a number of persons in the shipping and ports industries, not least the members of the ICHCA Safety Panel. The contributions of all concerned are gratefully acknowledged.

2 TYPES OF SOLD BULK CARRIERS

2.1 Bulk carriers are ships which are generally built with a single deck, topside tanks and hopper side tanks in cargo spaces and are intended primarily to carry dry cargo in bulk, or are ore carriers or combination carriers.

2.2 A number of terms are used to describe solid bulk carriers.

2.3 The most common terms relating to size are:

- *Mini bulk carriers.* Bulk carriers of less than about 12,000 tonnes. These are often used in the coastal and short sea trades.
- *Small handy-sized bulk carriers.* Bulk carriers in the range 15,000 to 25,000 tonnes.
- *Handy-sized bulk carriers.* Bulk carriers in the range 25,000 to 50,000 tonnes. Those in the range 35,000 to 50,000 tonnes are sometimes known as handymax bulk carriers.
- *Panamax bulk carriers*. As implied by the name, the maximum size of these bulk carriers is the maximum that can pass through the Panama Canal. The term is generally used to refer to bulk carriers in the range 50,000 to 80,000 tonnes.
- *Cape-sized bulk carriers.* Bulk carriers in the range 100,000 to 180,000 tonnes.
- *Very large bulk carriers* (VLBCs). Bulk carriers over 180,000 tonnes.

2.4 Other terms commonly used are:

- *Combination carriers*. Bulk carriers that may carry solid or liquid bulk cargoes on different voyages but not both on the same voyage. These may be ore/bulk/oil bulk carriers (OBOs) or ore/oil bulk carriers, (OOs).
- Geared bulk carriers*.* Bulk carriers that have their own shipboard cranes, which can be used to load or unload the cargo when necessary.
- *Self-unloading bulk carriers*. Bulk carriers that are fitted with equipment to continuously discharge their cargo directly to the shore by means of an inbuilt conveyor system. This may be fed by a scraper system working across the top of the cargo in each hold or from conveyors beneath the hopper shaped bottoms of the holds.

3 TYPES OF SOLID BULK CARGOES

3.1 A solid bulk cargo is defined by IMO as meaning any material, other than a liquid or gas, consisting of a combination of particles, granules or any larger pieces of material, generally uniform in composition, which is loaded directly into the cargo spaces of a ship without any intermediate form of containment.

3.2 Many different types of materials and products are carried by sea as solid bulk cargoes. These range from natural minerals and ores, including coal, rock phosphate, iron ore and iron ore concentrates, through manufactured products and scrap metal, to ammonium nitrate and other fertilisers, grain, pulses, sugar and other agricultural products. The largest quantities carried are coal, mineral ores and concentrates, grain and other agricultural bulk products.

3.3 In 1996 the quantities of a number of solid bulk cargoes that were shipped worldwide were:

Cargo	**Quantity in Millions of tonnes**	
Coal	422	
Metal ores and concentrates	418	
including iron ore		398
Agricultural bulk cargoes		278
including grain		190
Fertilisers and fertiliser raw Materials	109	

3.4 Many of the more common solid bulk cargoes carried by sea are listed in Appendices A, B and C of the BC Code. Appendix A lists solid bulk materials that may liquefy when transported by sea. Appendix B lists materials that are carried in bulk and are known to possess chemical hazards that could give rise to a dangerous situation on board ship. Some of these materials are also classified as dangerous goods in The IMDG Code. In these cases the individual IMDG schedules include a reference to the BC Code. Appendix C of the BC Code lists materials carried in bulk which are not liable to liquefy and do not possess chemical hazards.

4 HAZARDS ASSOCIATED WITH SOLID BULK CARGOES

4.1 The hazards associated with the transport of solid bulk cargoes may be considered under three headings:

- *Inherent dangerous properties*. These are the well-recognised dangerous properties of the cargo covered by the nine classes of the United Nations classification of dangerous goods listed in the IMDG Code.
- *Other relevant properties*. These may include the likelihood of the cargo to decompose or react with atmospheric moisture or oxygen to produce toxic or flammable gases or to reduce the oxygen content in a hold or accessway below the respirable level. Other relevant properties include the ability to liquefy and the angle of repose. These properties can affect the behaviour of the cargo during a voyage and so the stability and ultimately the safety of a ship and those aboard her.
- *Operational hazards*. These are hazards that arise from incorrect procedures or lack of communication. They may include incorrect loading leading to over-stressing of the ship and failure to notify relevant information, for example that the cargo has been fumigated.

4.2 Although this division of hazards can be made, it is not rigid and some hazards may be included under all three headings.

4.3 The most common hazards associated with the loading and unloading of solid bulk cargoes are discussed in more detail in sections 5 to 11.

5 THE SHIP

5.1 Hull stresses

5.1.1 The hull of a ship may simplistically be considered to be a long beam which is designed to be able to withstand some flexing. This flexing needs to be kept within the design limits. It will be minimised if all the ship's holds are empty or are uniformly filled but will be maximised if only the fore and aft holds are filled so that the ship is hogged or if only the centre holds are filled and the ship sags. If individual holds or port and starboard ballast tanks are loaded asymmetrically, twisting forces on the hull will result which could also lead to over-stressing. Localised over-stressing may also occur due to block loading of holds, temporary conditions during cargo loading or unloading, or the loading of excessive quantities of high-density cargo into a hold. If the ship is over-stressed it may result in failure of the hull and loss of the ship and those who are sailing aboard her. More detailed plain language information on the possible causes of over-stressing and their prevention can be found in the International Association of Classification Societies' booklets 'Bulk Carriers: Guidance and Information on Bulk Cargo Loading and Discharging to Reduce the Likelihood of Over-stressing the Hull Structure' and 'Bulk Carriers: Handle with Care'.

5.1.2 The over-stressing of their hulls is believed to have been a significant factor in the loss of a number of solid bulk carriers in recent decades. Although the safety of a ship is primarily the responsibility of the master, it can be seriously affected by the manner in which cargo is handled in ports. It is therefore essential that terminals discuss and agree cargo handling methods, sequences and rates with the master of a ship before cargo handling begins.

5.1.3 Following IMO's twentieth Assembly in November 1997, the new Chapter XII of the International Convention for the Safety of Life at Sea (SOLAS) is expected to come into force on 1 July 1999. Chapter XII will apply to bulk carriers of 150 m or more in length. It will apply to all bulk carriers built after 1 July 1999 which are designed to carry solid bulk cargoes with a density of 1000 kg/m^3 or more and to those bulk carriers built before that date which are carrying solid bulk cargoes with a density of 1780 kg/ m^3 or more.

5.1.4 Chapter XII will require bulk carriers built before 1 July 1999 and which are carrying a solid bulk cargo with a density of 1780 kg/ m$^{3\ \text{to}}$ have undergone an enhanced programme of inspection by a date depending on their age on 1 July 1999. In each case the date will be whichever of the following two dates comes first:

- if the bulk carrier is 20 years old or more, by the date of the next intermediate or full periodical survey,
- if the bulk carrier is 15 years old or more but less than 20 years old, by the date of the next periodical survey or 1 July 2002,
- if the bulk carrier is less than 15 years old, by the date of the first periodical survey after the ship is 15 years old or the date it reaches 17 years old.

A bulk carrier which is 10 years old or more on 1 July 1999 and which is carrying a solid bulk cargo with a density of 1780 kg/ m^3 or more after that date will be required to have satisfactorily undergone an enhanced periodical survey or a survey of all its cargo holds to the same extent as ships of 15 years old or more on that date.

5.1.5 Other requirements of chapter XII will relate to bulk carriers designed to carry solid bulk cargoes with a density of 1000 kg/ m^3 or more which are built on or after 1 July 1999 and to bulk carriers built before that date carrying solid bulk cargo with a density of 1780 kg/ m^3 or more.

5.1.6 A solid equilateral triangle marked amidships 300mm below the decline on both sides of a bulk carrier built before 1 July 1999 will indicate that there are restrictions on the distribution of the cargo between the holds or on the maximum deadweight of the ship when carrying solid bulk cargo with a density of 1780 kg/ m^3 or more.

5.1.7 Whilst considering the stresses that may be imposed on a ship in connection with the handling of cargo, sight should not be lost of the damage that can be done to a ship by the equipment that is used to handle the cargo, particularly in unloading ports. Considerable damage can be done to hatch covers, hatch coamings, tank tops, frames and coatings of holds by grabs, bulldozers or similar vehicles, and mechanical vibrators when they are used in holds. Grabs can weigh as much as 35 tonnes when empty. Vehicles may be used in holds to trim cargo. Mechanical vibrators may be used to free cargo from between frames and from bulkheads.

5.2 Contributory factors

5.2.1 A Number of factors relating to the stowage of solid bulk cargoes may be relevant to the potential over-stressing of the hull of a ship and so later to the safety of mariners when the ship is at sea.

5.2.2 Terminal staff should be aware of these factors and their significance in order to understand the possible consequences of their actions when loading or unloading solid bulk cargo from a bulk carrier.

5.3 Angle of Repose

5.3.1 The angle of repose is the maximum angle between a horizontal plane and the side of a cone of a free flowing granular material. If such material is stowed above its angle of repose it will be unstable and likely to move under the influence of vibration or the motion of a ship. This could cause the ship to list and ultimately lead to instability. Appendix D.2 of the BC Code sets out the test procedures to determine the angle of repose.

5.4 Cargoes that may liquefy

5.4.1 A cargo that may liquefy is a cargo containing at least some fine particles and some moisture, usually water, although the cargo may not appear to be visibly wet. Such a cargo may become a slurry and behave in the same way as a liquid if it is shipped with a moisture content above its transportable moisture limit. Appendix D.1 of the BC Code sets out the test procedures for materials that may liquefy.

5.5 Moisture content

5.5.1 The moisture content of a cargo is the proportion of a representative sample consisting of a liquid, normally water or ice, expressed as a percentage of the wet mass of that sample.

5.6 Flow moisture point

5.6.1 The flow moisture point is the percentage moisture content under prescribed test conditions at which the material is saturated with liquid to such an extent that it loses its internal shear strength and behaves as a liquid under the influence of external forces such as vibration, impaction or the motion of a ship.

5.7 Transportable moisture limit

5.7.1 The transportable moisture limit of a cargo that may liquefy is the maximum moisture content of the material (expressed as a percentage) that is considered safe for carriage in ships that are not specially constructed or fitted to carry that cargo with a high moisture content. It should be noted that the transportable moisture limit of a granular material would always be less than its flow moisture point.

5.8 Stowage factor

5.8.1 The stowage factor of a solid bulk cargo is the number equal to the number of cubic metres which one tonne of the cargo will occupy. A cargo with a density of 1000 kg/ m^3 (the nominal density of water, 62.4 lb/ft^3) has a stowage factor of 1 and a cargo with a density of 1780 kg/ m^3 (the approximate density of iron ore, about 111.1 lb/ft^3) has a stowage factor of 0.56.

6 TERMINAL PROCEDURES

6.1 General

6.1.1 Although the master of a ship is primarily responsible for the safety of the ship and his crew and shore side employers for that of their employees and others who will be affected by their actions, they cannot work in isolation. In a port their activities and interests necessarily overlap and each may be affected by the activities of the other. It is essential therefore that not only are they aware of the potential consequences of following incorrect practices but also that they liaise closely, so that correct procedures are followed to ensure safe and efficient cargo handling operations.

6.1.2 In particular, the calculations by a ship's officer of shear forces and bending moments is a complex task. The calculations can only be done with the co-operation of shore staff that needs to provide relevant information. The calculations are essential for the safety of the ship at sea, by ensuring that the maximum permissible limits are not exceeded either during, or on completion of, loading cargo.

6.1.3 The interaction of stresses imposed on the hull of a ship by bulk cargo and ballast water at the different stages of cargo handling operations should also be clearly understood by terminal staff, as well as by the ship's officers. It is essential that the terminal staff appreciate the reasons why it is necessary for cargo and ballast handling rates to be harmonised. Terminal staff need to accept that if the handling rates get out of step, it may be necessary for one or the other to be adjusted or temporarily suspended at the request of either the master or the terminal supervisor.

6.1.4 At loading terminals, loading equipment should be provided with cargo weighing devices that are regularly calibrated, well maintained and are accurate to within 1% of the rated quantity required over the normal range of loading rates. The weighing devices should be suitably positioned, preferably where they can be easily read by both ship and shore personnel. Where practicable the weighing devices should be able to provide the necessary information continuously but they should at least be able to provide the information at each step of the loading plan.

6.1.5 All solid bulk cargo handling operations should be carried out in accordance with the BLU Code.

6.1.6 The terminal representative should monitor the weather conditions and provide the master with the forecast of any local adverse weather conditions.

6.2 Information exchange prior to cargo handling

6.2.1 Before cargo can be safely handled it is necessary for relevant information to be exchanged between the ship and the terminal in order to draw up an efficient loading or unloading plan.

6.2.2 The BLU Code recommends that the necessary basic information that is needed should be published in port and/or terminal information books. Appendix 1 of the Code of Practice lists the recommended contents of these books, including cargo-handling rates. The relevant book, or books, should be given to masters of ships before they arrive at the port of terminal if possible, or on arrival.

6.2.4 Before a ship is loaded with a solid bulk cargo, information about the cargo and its properties will be needed. This will include its relevant chemical or other special properties and may include its density, stowage factor, angle of repose, trimming procedures and any additional certificates that may be necessary. A recommended layout of a form for cargo information is included in the BLU Code as Appendix 5. If the declared density of the cargo is in the range from 1250 kg/m^3 to 1780 kg/m^3, the density will be required to be verified by an accredited testing organisation if the cargo is to be carried in a bulk carrier which was built before 1 July 1999 and does not fully comply with the new chapter XII of SOLAS.

6.2.4 Before the ship is loaded it should be confirmed that it is suitable for the intended cargo, holds the necessary certificates, and complies with the relevant requirements of the new Chapter XII of SOLAS. The certificates should remain valid for the expected duration of the voyage and the discharge of the ship at its destination. If the cargo is to be solid dangerous goods in bulk and the ship was built on or after 1 September 1984 (1 February 1992 if the ship is of less than 500 gross tonnes), the certificates should include a document of compliance. If the cargo is to be grain, the certificates should include a document of authorisation.

6.2.5 In order to ensure that cargo handling operations are carried out in a safe controlled manner they need to be properly planned and the procedures agreed by both the ship and the terminal. This should be done by the preparation and agreement of the loading or unloading plan and the ship/shore safety checklist by both parties.

6.2.6 The information exchanged should include the action to be taken in the event of foreseeable emergencies. This should include the agreed means of communication, any signal that may need to be given and the action to be taken on hearing it.

6.3 The Loading or Unloading Plan

6.3.1 The ship should prepare a cargo loading or unloading plan to cover all stages of the loading or unloading and deballasting or ballasting. In many cases this will involve calculating bending moments and shear forces to ensure that any permissible maxima are note exceeded at any stage of the cargo handling operations. The terminal should provide the ship with any necessary information to enable the plan to be prepared. The plan should be in a form such as that in Appendix 2 of the BLU Code. A different form may be used provided it contains all the essential information required by the Code. This is the information that is enclosed by the heavy line in the form in Appendix 2 of the Code. Appendix 2 also includes worked examples of the completed form. The completed plan should be agreed by ship and terminal representatives and copies of it kept by both parties. Loading plans should be kept for at least six months. In addition, a copy of the agreed loading or unloading plan, and any later amendments to it, should be lodged with the appropriate authority of the port state.

6.3.2 Once the loading or unloading plan has been agreed, it is important that the cargo handling operations are carried out in accordance with the plan and that any deviation from it that may be found later to be necessary is agreed in advance by both parties. In particular the cargo handling rates and ballast pumping rates should be kept within the agreed limits to avoid over-stressing the hull. It should be accepted by both the master and the terminal that at the request of the other it may be necessary to suspend or modify the rate of cargo handling operations in order to keep the stresses on the ship within permissible limits.

6.4 The ship/shore safety checklist

6.4.1 Before cargo-handling operations begin a ship/shore safety check list should be completed jointly by the master and the terminal representative. This will formally confirm that appropriate consideration has been given to the most important matters that may affect the safety of the cargo handling operation. The checklist at Appendix 3 of the BLU Code contains 21 items. Any additional items that may be considered necessary may supplement these. The checklist is accompanied by helpful guidelines for its completion in Appendix 4 of the Code.

6.4.2 The ship and terminal staff should complete the checklist jointly. This will help them to be aware of any potential problems and, if the problems cannot be eliminated, to plan for them in advance.

6.4.3 Many problems arise from difficulties in communication. In addition to ensuring that communications equipment is clear and efficient, it is essential that agreement be reached on a common language that can be used for clear, unambiguous operational instructions between the ship and shore.

6.4.4 When all questions on the checklist have been satisfactorily completed, authorised representatives of the ship and shore should sign the checklist. Copies should be retained by both parties

6.5 General loading and unloading procedures

6.5.1 The loading or unloading operation should be carried out in the sequence agreed and set out in the loading or unloading plan. Any deviation that may become necessary should be agreed by the ship and terminal before it takes place. Cargo handling operations on opposite sides of the ship or of individual holds should be closely matched to avoid twisting the ship.

6.5.2 At all times the cargo handling and ballast pumping rates should be kept within the agreed rates specified in the loading or unloading plan.

6.5.3 The cargo handling operation should be monitored throughout and effective communication between the ship and terminal maintained at all times.

6.5.4 The ship and terminal representatives should be aware of the requirements for trimming the cargo.

6.5.5 Personnel on the ship and terminal should be alert at all times to hazards to themselves and others that may arise during cargo handling operations. Hazards may include the fall of cargo from grabs, conveyors and other cargo handling equipment, slipping on cargo spillage, dust, and any chemical hazards of the cargo. People should never stand below cargo handling operations and whenever practicable there should be no access to the working side of the main deck during cargo handling operations. Those involved in the operations should wear safety helmets, safety footwear and high visibility clothing as appropriate. Spillages of cargo should be cleared up regularly to maintain safe means of access at all times.

6.5.6 No hot work should be carried out on the ship at any time while it is at the berth without the permission of the master and the terminal representative. Permission from the port authority or other local authority may also be necessary.

6.6 Loading procedures

6.6.1 Care should be taken to ensure that excessive stresses are not imposed on the tank top of a hold and associated structure of a ship. This is particularly likely with high density cargo and cargo loaded by large grabs. Special care should be taken at the beginning of the loading of each hold. Damage may well result if high free-fall drops, particularly of large lumps, are permitted. In addition, large clouds of dust are likely to be produced.

6.6.2 The quantity of cargo that has been loaded into a hold and the rate of loading should be checked periodically to ensure that the loading plan is being followed in order to avoid over-stressing the ship.

6.6.3 Both the ship's officer and the terminal representative in control of the loading operation should be aware of the quantity of cargo that may be on the conveyor belts of the loading system if a stop signal is given by the ship. This may be particularly relevant during the final pour into a hold and any trimming operations carried out by the loading system.

6.6.4 Care should be taken to ensure that ballast water being discharged does not flood the quay or adjacent craft.

6.6.5 The terminal representative should advise the master of any change to the agreed loading rate.

6.6.6 On completion of each pour the terminal representative should advise the master of the weight loaded and confirm that loading will continue in accordance with the agreed cargo loading plan.

6.6.7 When required, the loaded cargo should be trimmed in accordance with the BC Code. Conveyor system run-off should be allowed for when trimming operations are carried out. If trimming involves the use of heavy equipment in the hold, particular care should be taken to avoid damage to it and to the ship.

6.6.8 Topping off of the cargo in a hold may be needed. Before this is done, it may be necessary for a further draught survey to be made and for bending moment and stress calculations to be carried out by the ship's officers. It is essential that the terminal allow sufficient time for these important operations to be carried out. If it is not, the ship may be overloaded and the master refuse to sail until remedial action has been taken.

6.7 Unloading procedures

6.7.1 The quantity of cargo that has been unloaded should be checked periodically to ensure that the unloading plan is being followed in order to avoid over-stressing the ship.

6.7.2 The terminal representative should advise the master of any change to the agreed unloading rate.

6.7.3 The master of the ship should inform the terminal representative of any obstacles in the holds that may be encountered during unloading. These may include tank covers or container fittings on the tank top of a multi purpose ship.

6.7.4 If grabs are used for unloading, care should be taken to avoid damage to the ship. The coamings, frames, bulkheads and tank top are the areas most frequently damaged. Particular care needs to be taken to avoid damage to the tank top by the grab during the later stages of unloading.

6.7.5 Trimming of cargo residues from between frames and corrugated bulkheads into the square of the hatch of the hold is usually necessary. Often this will be carried out by bulldozers or similar equipment lowered into the hold. Such equipment needs to be used with care as it is capable of causing severe damage to the ship and in particular to frames, access ladders, other fittings and to any protective coatings in a hold. Sounding pipes and other equipment that pass through a hold are also vulnerable. Pneumatic hammers are sometimes used to free cargo residues and are also capable of causing considerable damage to a ship.

6.7.6 Cargo residues should only be left in holds with the agreement of the master, for example when the ship is to carry a further cargo of the same commodity. Increasing problems are being experienced by ships in disposing of residues of cargoes left in holds without causing pollution.

6.7.7 The terminal representative should advise the master when unloading is considered to have been completed from each hold.

6.7.8 Any inadvertent damage to the ship or cargo handling equipment should be reported to the master and to the terminal representative as soon as it is practicable. Damage reports should be signed both by the master and a responsible terminal representative.

7 CARGOES HAZARDOUS ONLY IN BULK

7.1 A number of the materials that are listed in Appendix B of the BC Code do not present significant hazards when transported in packaged form but present hazards requiring special precautions to be taken when they are transported in bulk. These precautions are included in the individual schedules in Appendix B of the BC Code. Similar precautions are also likely to be required in connection with any bulk storage of the materials at ports. The materials, which are referred to as 'materials hazardous only in bulk' (MHB), are listed in section 24.1.6 of the General Introduction to the IMDG Code. They include coal, unslaked lime, petroleum coke, woodchips and sawdust.

8 DUSTY CARGOES

8.1 Dust sources

8.1.1 Whenever pieces of solid bulk cargo move against each other, abrasion is likely to result in the formation of dust. The production of at least some dust is therefore almost inevitable when solid bulk cargoes are handled. This dust is most likely to enter the atmosphere when cargo drops from one height to another. Examples of when this may occur include the dropping of cargo into a hold from a grab, from the back of a truck when it is tipped, from one conveyor to another or when a wall of residual material collapses from a bulkhead or between the frames in the hold of a ship or from the side of a hopper.

8.2 Health hazards from dust

8.2.1 Some dust is clearly hazardous as it is produced by materials that are known to be toxic. Other dusts, particularly dust associated with agricultural products, may be hazardous because of other matter, which may be included with the parent product. Such matter may include dirt of many types, insects or insect parts, pesticide residues, fungi and bacteria that may be harmful to the health of persons exposed to them.

8.2.2 Even though a dust may not be itself toxic, it can tend to clog airways and is therefore still a health hazard. Personal exposure to all dust should be minimised so far as is reasonably practicable. Unless there is an indication of the need for a lower value, it is generally accepted that in the absence of a specific exposure limit for a particular dust, the occupational personal exposure to dust should be kept below a level of 10 mg/m^3 total inhalable dust and 5 mg/m^3 respirable dust, time weighted average over a period of eight hours. In practice dust levels associated with the handling of solid bulk cargoes may be many times this figure. Levels of almost 500 mg/m^3 have been measured in the holds of ships.

8.3 Environmental hazards from dust

8.3.1 Dust may pollute both the aquatic and the atmospheric environment and increasing public concern and attention is being paid to both. The most effective controls in both cases are those applied at source. One source of water pollution may be the sweeping or washing of spilt cargo or cargo residues from the decks of ships or quays.

8.3.2 Most ports now have emergency plans to deal with spillages. Originally these tended to deal only with oil spills but in ports where solid bulk cargoes are handled consideration should also be given to whether emergency plans also need to cover spillages of solid bulk cargo that may affect the aquatic environment.

8.3.3 The exposure levels of general dust quoted in paragraph 8.2.2 are occupational exposure levels. Exposure levels for the general public need to be considerably lower and even small levels of dust can be a major nuisance to local residents. Increasingly local authorities are imposing more stringent controls on the sources of dust causing a nuisance to the public. This is particularly so in the case of older ports that have been surrounded by residential developments over the years during which time large scale cargo handling has tended to move down stream to newer, more isolated ports. In older ports, small ships are often discharged by grabs, which may give rise to dust.

8.4 Control of dust

8.4.1 Whilst users of materials often have the option of substituting less dusty or hazardous materials, this option is seldom available to those in the transport chain who generally have to handle the materials that arrive at their premises or are specified by their customers.

8.4.2 Many solid bulk cargoes are stockpiled in the open air, so are exposed to rain and therefore can be damped down by water sprays when necessary. This may be to prevent dispersion by wind during dry weather or to control the generation of dust when necessary at particular locations, e.g. at transfer points. However, this option is not available for many solid bulk cargoes that have to be kept dry to prevent deterioration or damage.

8.4.3 Ideally, all dusty materials should be handled in closed systems to prevent the escape of dust and protect the material from the weather if necessary. Enclosed solid bulk cargo handling systems are widely available and becoming more flexible. Such systems are not only available for large scale handling operations but also increasingly for small-scale operations. Systems may include mobile equipment that can be moved from quay to quay. However where full enclosure of the plant is not practicable, considerable reductions in dust levels are possible by identifying the operations most likely to generate dust and enclosing them as far as practicable. If the dust is potentially flammable, enclosures should include appropriate precautions in connection with the possible generation of static electricity and other explosion hazards.

8.4.4 Little dust, apart from potential stripping due to wind, is likely to be produced by cargo travelling along a conveyor until the conveyor discharges onto another conveyor or other piece of equipment. The dust generated at the transfer point can be minimised by keeping the distance of fall as small as possible and enclosing the transfer point.

8.4.5 Similarly, dust generated can be minimised by enclosing loading spouts or legs and adjusting them during loading to keep the open discharge close to the cargo already in the hold, thereby limiting the unenclosed fall of the cargo.

8.4.6 Tipping solid bulk cargo directly from a truck into the hold of a ship should be avoided. Not only will this be likely to generate a considerable quantity of dust, but it is also likely to load only the near side of the ship and result in the need to trim the cargo in the hold. It is preferable to discharge into the enclosed feed hopper of an inclined conveyor leading to an enclosed spout that can be guided to load the hold evenly. This will reduce the dust generated and avoid, or at least minimise the need to trim the hold later. Points at which trucks discharge solid bulk cargo into silos for later loading into ships, or are loaded from silos, should also be enclosed as far as practicable to prevent the escape of dust.

8.4.7 In addition to enclosing transfer points as far as practicable, dust levels can be further reduced by the provision of local exhaust extraction at transfer points and around loading spouts. It is however important that any such equipment is not only properly designed and installed but that any dust collectors are regularly emptied and the equipment is well maintained.

8.4.8 Although solid bulk cargoes are increasingly handled by enclosed systems, much is still handled by means of grabs. The amount of dust produced by grabbing operations can be considerably reduced by the correct choice of grab for the cargo being handled, including the use of properly constructed closed or covered grabs. The proper maintenance of grabs is very important. Too often, considerable quantities of dust escape from badly maintained jaws of grab.

8.4.9 Once again dust can be reduced by minimising the distance that cargo falls from a grab when it is opened. This is a matter directly under the control of management and operators. If the grab discharges into a hopper the design of the hopper can include an extraction system to control dust. This however will be ineffective unless the grab is opened in the designed location in the mouth of the hopper. Dust from hoppers can also be reduced by the incorporation of water spray or baffle systems where appropriate.

8.4.10 Dust control equipment will only work efficiently if it is properly maintained and cleaned regularly in accordance with the manufacturer's instructions. When working on dust control equipment that has operated in connection with potentially flammable dust, special attention should be paid to the possible explosion risks and particular care taken before any hot work is carried out.

8.4.11 If cargo is only unloaded from the centre of a hold, high walls of cargo can be formed around the area being worked. In due course, these may either collapse of their own accord or need to be knocked down. In either case when they fall they are liable to release considerable quantities of dust. So far as practicable, cargo should be unloaded evenly across a hold to minimise the distance of fall of surrounding cargo and the dust generated by it.

8.4.12 An unfortunate factor of the economics of the transport industry is that any dust extracted during handling at a port is part of the cargo and the property of the customer, so is normally added back to the cargo. This means that it causes further problems to everyone else who has to handle the cargo along the transport chain. Clearly this is a matter that would benefit from some new thinking within the industry.

8.4.13 Although it is possible to reduce dust emissions at a number of points, it is not possible to eliminate them all. From time to time, it will continue to be necessary for some persons to work in areas where there are high concentrations of dust. In some cases it is feasible to enclose operators and supply them with clean filtered air. This is possible in the case of control cabins on loading and unloading arms or cabs of plant used for trimming in holds. Where persons need to be mobile, helmets providing filtered air should be used. In all cases where people have to work in places where they may be exposed to dust levels that are in excess of the appropriate occupational exposure limit, it is essential that they are provided with, and wear, the correct type of respiratory protective equipment. All dust control and respiratory protective equipment should be maintained in accordance with the manufacturer's instructions. In particular, any filters should be regularly cleaned or replaced.

9 `TOXIC AND CORROSIVE CARGOES

9.1 General

9.1.1 Toxic, or poisonous, and corrosive cargoes are all cargoes which are hazardous to health. This may be by contact, for example quicklime, by swallowing (ingestion) or breathing in (inhalation).

9.1.2 Whilst exposure of people to such cargoes should be avoided whenever practicable, some exposure may be unavoidable during cargo handling operations. Any necessary exposure should be minimised in accordance with national health and safety legislation. Whilst exposure to toxic materials should preferably be minimised by engineering controls, this will not always be practicable for all solid bulk cargo handling operations. In such situations personal protective equipment should be provided and worn as appropriate.

9.1.3 Considerable care should be taken in the selection of personal protective equipment. It should be remembered that some equipment is only suitable for use against low concentrations of toxic materials and will not provide adequate protection against high concentrations. Not only should personal protective equipment be technically suitable for use in connection with the hazardous material concerned but it should also be practical. If those responsible for the purchase of such equipment and ensuring it is used had to wear it for just one working shift, they would appreciate just how important the 'wearability' or comfort of such equipment is.

9.1.4 Suitable arrangements should be provided for the storage of personal protective equipment when it is not in use. This should be separate from accommodation for non-working clothing in order to prevent cross contamination.

9.1.5 In the same way as any other equipment, personal protective equipment should be maintained. This may be by simple cleaning or by replacement of components in accordance with the manufacturer's instructions. It should be remembered that the useful life of some components, such as filters, is limited and may depend on the concentration of hazardous material to which they are exposed, the higher the concentration, the shorter the life.

9.1.6 The importance of personal hygiene when working with toxic or corrosive materials should never be overlooked. Smoking and eating in the working area should be forbidden and good washing facilities should be available. It is essential that hands be always washed before food is eaten.

9.1.7 The IMO Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas, the International Labour Office Convention 152 on the Occupational Safety and Health in Dock Work and national legislation based on them are relevant to all cargo handling operations involving dangerous cargoes.

9.2 Cargo products

9.2.1 Some solid bulk cargoes that are non hazardous of themselves, may be liable to give rise to hazardous substances. These are usually gases and may be the result of decomposition or bacteriological action. Such products may only be produced slowly but can build up to dangerous levels in unventilated holds overnight or by the end of a voyage. In such cases it is particularly important that proper procedures are followed before there is entry into cargo holds or accessways (see section 11). Examples of bulk cargoes that may give rise to toxic products include coal, bark, fishmeal and even some types of wet fish.

9.3 Fumigation

9.3.1 Some cargoes, particularly grain, may be fumigated in the holds of ships. This is a hazardous operation that should only be carried out by competent, qualified operators. Fumigation on board ships should be carried out strictly in accordance with IMO's Recommendations on the Safe Use of Pesticides in Ships and any relevant national legislation. The IMO Recommendations are included as section 6 of the Supplement volume of the IMDG Code. In particular, it is especially important that if fumigation of the cargo has continued in transit, the master of the ship should notify the appropriate authorities at the destination port, and at any intermediate ports of call, at least 24 hours before arrival that fumigation is in progress. It is not uncommon to find that fumigation is still continuing on arrival, usually because excessive amounts of fumigant have been used. Appropriate personal protective equipment should always be worn when handling fumigants or fumigant residues.

9.4 Asphyxiation

9.4.1 Asphyxiation may occur due to the lack of oxygen in the atmosphere or the cutting off of the supply of oxygen to a person.

9.4.2 Many people have been killed on board ships after entering unventilated confined spaces which had a reduced oxygen content. The most insidious cause of reduced oxygen levels is the rusting of the structure of the ship itself. Another common cause is the oxidation of the cargo using oxygen from the atmosphere in the hold. Cargoes particularly prone to oxidation include pig iron, wood chips and bark. Oxygen depletion in holds (see section 11) and other confined spaces is a particularly insidious hazard and all people who enter these spaces need to be continually alert to it.

9.4.3 The most common material to cause asphyxiation is water but people can also be 'drowned' in dry materials such as grain and other free-flowing granular materials into which a person can sink. As far as practicable entry onto such cargo into which a person can sink should be avoided. Where it is necessary the person concerned should be attached to a life-line and under the immediate supervision of a person who can start rescue procedures while further help is summoned.

10 FLAMMABLE CARGOES

10.1 General

10.1.1 Some solid bulk cargoes are flammable and a number, such as sulphur, can be ignited during cargo handling operations. Common sources of ignition include sparks produced by a steel blade or bucket striking another metal object such as a frame in a hold of a ship or an elevator enclosure. Dust clouds of particles of flammable cargoes may be explosive. Some cargoes, including coal, may be liable to self-heat.

10.1.2 In addition to solid bulk cargoes, which are themselves flammable, some cargoes, such as coal and charcoal, are liable to self-heating and even spontaneous combustion. The risk of this may be increased by the cargo being wet or by bacteriological action. Wetting or bacteriological action may also lead to the evolution of flammable decomposition products.

10.1.3 If there is a likelihood of a build up of flammable gases in a hold it is essential that the hold is fully ventilated before any electrical equipment, other than appropriately explosion protected electrical equipment, is switched on. This may mean the ventilation of the hold by natural ventilation rather than by the use of non explosion-protected ventilation equipment.

10.1.4 The movement of some dry solid bulk cargoes can generate static electricity which can build up to provide a source of ignition. When cargo that can give rise to flammable dust is to be handled, it is essential that the cargo handling equipment to be used be designed to ensure that such dangerous levels of static cannot build up.

10.1.5 Dust on electrical equipment can thermally insulate the equipment leading to the build up of heat. This may raise the temperature of dust deposits on it above their auto-ignition temperature and result in a fire or explosion. Electrical equipment that is necessarily installed in potentially dusty locations should therefore be constructed to be suitable for such service.

10.1.6 Many items of plant for handling solid bulk cargoes are enclosed. This may itself lead to dangers and where necessary such plant should be provided with suitable explosion protection equipment or explosion relief venting into a safe place.

10.1.7 When dust explosions occur the major damage is often caused by the secondary explosion of dust blown up from surrounding floors, equipment and ledges in a building by the initial primary explosion. It is essential therefore that all installations associated with the loading and unloading of flammable solid bulk cargoes maintain a high degree of cleanliness to minimise the risk of secondary explosions.

10.2 Hot-work

10.2.1 Hot-work is the use of open fires, flames or other work involving the application of heat by means of tools or equipment. This includes the unintentional application of heat by the use of power tools or hot rivets, or the falling of hot particles from cutting or welding operations. These may ignite flammable materials, including gases or vapours, below or near the work.

10.2.2 Hot-work is frequently carried out in connection with maintenance or voyage repair operations but may also be carried out in connection with cargo handling operations. An example is the fitting and removal of temporary guide bars to the edges of hatch covers to prevent the falls of grabs snagging on cleats.

10.2.3 Although the master has the primary responsibility for the safety of operations on his ship, many port and/or terminal authorities have byelaws, other legal requirements, or rules relating to hot work. Hot work should therefore only be carried out on ships in a port with the permission of both the master and the relevant shore authorities. Such work usually needs to be carried out in accordance with a permit to work system that specifies the precautions to be taken.

10.2.4 Before any hot-work is carried out it is essential that all flammable material is removed from the proposed work area. If the hot work includes work on a bulkhead, the area on the opposite side of the bulkhead or any space adjacent to it, including spaces above, below or diagonal to it, which may be affected by the hot work must also be cleaned. In addition to ensuring that appropriate fire fighting equipment is available during the work, it is essential that checks are made after the work has been completed to ensure that no smouldering material remains at the work site or in any adjacent spaces. Many fires caused by smouldering residues break out several hours after those who carried out the work have left.

10.2.5 Particular care should be taken before undertaking hot work on combination carriers that have previously carried flammable liquid cargoes. Although the holds may have been certified as being gas free before loading a solid bulk cargo, residual flammable liquid may remain in pumps and pipelines. If such a pump is later used to ballast a hold in order to complete the unloading of solid bulk cargo, the residual flammable liquid will be pumped into the hold and may give rise to a flammable atmosphere above the apparently innocuous ballast water. The BLU Code requires combination carriers to give the following additional information to terminals:

- the nature of the preceding three cargoes
- the date and place at which the last oil cargo was discharged
- advice of the content of slop tanks and whether they are fully inerted and sealed
- the date, place and name of the authority that issued the last gas free certificate which includes the pipelines and pumps.

The guidelines for completing the ship/shore safety checklist in the Code include a reminder that the gas free certificate needs to relate to pipelines and pumps as well as holds.

11 ENTRY INTO HOLDS AND OTHER CONFINED SPACES

11.1 As the atmosphere in a hold may be toxic, asphyxiating or flammable it is essential that a hold is not entered until appropriate precautions have been taken. A hold should only be entered with the permission of the master or responsible ship's officer who has ensured it is safe to enter without breathing apparatus by ensuring that the hold has been thoroughly ventilated and by testing the atmosphere of the holds in appropriate areas. The tests should be carried out to ensure that there is no oxygen deficiency or harmful concentrations of hazardous gases or vapours. The BC Code includes a Maritime Safety Card listing general precautions and a safety checklist for the use of ships' officers before permitting entry into holds.

11.2 It is sometimes forgotten that hold accessways, including access trunkways, may be in direct communication with holds and so may be equally deficient in oxygen.

11.3.1 Despite the well-known hazards associated with entry into closed holds and other confined spaces on board ships, accidents continue to occur from time to time. In such circumstances it is essential that the instinctive reaction to go to the help of those involved is resisted until the alarm has been raised and anyone going to help has put on suitable breathing apparatus. All too often rescue attempts by persons not wearing breathing apparatus have delayed the rescue of the original victim and made it more difficult and resulted in increased numbers of casualties.

APPENDIX 1

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APPENDIX 2

SELECTED INCIDENTS

1 Over-stressing, overloading and damage

1.1 Between 1990 and August 1997, 99 bulk carriers were lost at sea together with 654 lives. Often there were no survivors so the exact cause of the loss is not known but it is widely believed that the factors leading to many of the losses included failure of the hull resulting from corrosion, damage and/or over-stressing.

1.2 A 22 year old 145,000 tonne OBO loading iron ore at a terminal accidentally overfilled a hold causing the ship to break her back and sink at the berth. As a result the berth, which was one of only three at the terminal, was blocked for several weeks. The overloading of the hold is believed to have been due to a communication failure.

1.3 An 80,000 tonne bulk carrier loaded iron ore in a port with limited water alongside and limited air draught under the loaders. The cargo was loaded at up to 4,000 t/hr in alternate holds. When the ship was a quarter full and a pour into No 1 hold had been in progress for some 45 minutes, the intended simultaneous deballasting was delayed by a faulty valve. The Chief Officer assisted in releasing the valve and on leaving the pipe tunnel 30 minutes later was surprised to find cargo still being loaded into No 1 hold. It was found that the loading gauge had stopped working and the shore did not know how much ore had been loaded. A rough draught survey indicated that some 2000 tonnes more than intended had been loaded into No 1 hold. As excessive negative trim and the limited air draught prevented loading No 9 hold, loading of No 7 hold was started and the aft tanks ballasted until the loader could move to No 9 hold. When the ship was fully loaded on an even keel, the additional weight in No 1 hold was counterbalanced by the cargo in No 9 hold and reduced loads in Nos 3, 5, and 7 holds but the ship had a severe hog and the calculated “at sea” bending moment was 104% of allowable. As the ship cleared the berth, the centre double bottom and wing tanks were ballasted bringing the stresses to just within sea limits but the tropical marks were still submerged. As the ship sailed in this condition, it was fortunate that the weather was favourable throughout the voyage so that a decision as to whether to be overloaded or over-stressed did not have to be made. Clearly the shore should have stopped loading when the loading gauge ceased working. The incident also underlines the need to adhere strictly to an agreed loading plan and for efficient communication between ship and shore personnel to be maintained throughout cargo handling.

1.4 A bulk carrier of some 40,000 tonnes, which was to pass through the Panama Canal during her loaded voyage, was loaded with coal at a terminal. However the quantity of coal loaded was such that the ship’s loaded draught was more than that permitted by the Canal Authority. The loading terminal had no discharge facilities to rectify the situation. The ship was therefore delayed for three days awaiting the arrival of a crane barge that was able to lighten her.

1.5 A 20-year-old 127,000 tonne bulk carrier loaded 120,000 tonnes of iron ore. Shortly after sailing the ship sought shelter at an anchorage and spent two weeks carrying out repairs, which were reported to include the welding of inserts to distorted frames. Some four weeks later the ship arrived at another anchorage, still well short of her final destination. Following port state control inspection it was reported that 25% of the ship's frames were damaged and that leaks in No 2 hold were spreading to Nos 3 and 4 holds.

2 Fumigation

2.1 A cargo of 3000 tonnes of grain was fumigated by aluminium phosphide at the loading port and fumigation continued in transit. The master did not notify the discharge port before arrival six days later. The holds were ventilated by being left open for seven hours on the day of arrival. Discharge into shore silos via four suction legs started on the following morning. It is believed that a number of fumigant pellets were transferred to the silos with the grain. Some time later a man became unwell due to fumigant fumes and discharge was stopped. Another man was taken ill later and during the day a total of 39 people were taken to hospital as a precautionary measure. No cargo was worked on the following day but the holds were opened for some 18 hours. Discharge resumed on the next day but was again stopped when a further man was taken ill. The ship was temporarily evacuated and a high level of phosphine was detected in the hold. Seven more people were taken to hospital during the day.

2.2 A cargo of grain was being loaded into the hold of a ship from trucks via two mobile conveyors. A pesticide in a solvent carrier was applied to the grain on the conveyors. After only a quarter of an hour, three stevedores trimming the cargo in the hold were taken ill and taken to hospital. In this case it was the solvent carrier, rather than the pesticide, that was believed to be the cause of the illness. All three men involved had been wearing positive powered air filtering helmets but these provided no protection against the solvent vapours.

2 Asphyxiation

2.1 Two dockworkers were killed when they went down an access hatch to go into a hold of copra. Later tests indicated that the oxygen content was some 10%, well below the minimum level necessary to sustain life, let alone the normal level of 20.8% in air. A carbon dioxide level of 8% and a carbon monoxide level of 3000 parts per million were also measured.

2.2 Five stevedores entered the hold of a bulk carrier before the hatches were opened. Much of the cargo of maize in the hold had started to germinate during the voyage depleting the oxygen in the hold. All five died due to the oxygen deficiency.

2.3 Tests on the hold, accessways and void spaces on a ship carrying woodchips indicated an oxygen level of 14.5%, a carbon monoxide level of 790 parts per million and the presence of some methane. Woodchips are included in the IMDG Code and Appendix B of the BC Code as materials hazardous only in bulk, which may lead to depletion of oxygen and an increase of carbon dioxide in the cargo space. The tests followed an incident on the ship at another port some time earlier when two crewmembers were killed. A seaman on the ship went down an accessway to a hold full of logs to go to a storeroom at the bottom of the accessway for brooms to sweep the hatches clean after discharge of the deck cargo. The mate later saw the seaman lying at the bottom of the accessway and went to help him but was overcome himself. The master started the cargo hold fan and with the aid of self-contained breathing apparatus recovered the two men, but both were dead. The hold had not been ventilated since the logs had been loaded six days earlier. Subsequent tests indicated that the oxygen level might have been as low as 1.9%.

2.4 A trawler was discharging a catch of blue whiting at a port over a weekend. When the last hold was half empty on the Sunday morning, the berth was required to allow a tanker to discharge. The hold was closed and the trawler moved to another berth overnight. On the following morning the trawler was moved back to the original berth, the hatch opened and two men went into the hold to complete the discharge. Some time later it was seen that they had been overcome and another man and the manager went to their rescue in the hold and were in turn overcome. Blue whiting is known to be prone to rapid oxidation leading to depletion of the oxygen content in holds and the evolution of toxic decomposition products.

3 Explosion, including hot work

3.1 Two seamen entered a mast house in which there were access hatches to holds. The access hatches had not been secured and methane from the cargo of coal had escaped into the mast house. When one of the seamen lit a cigarette there was an explosion that killed both men.

3.2 After carrying a cargo of light crude oil, a 35,000 tonne OBO cleaned its tanks and loaded a cargo of coal. On arrival at the discharge port it was necessary to moor with the opposite side of the ship to the berth than usual. This resulted in the cleats on the hatch covers being on the berth side of the ship and being liable to foul on the falls of the unloading grab. Temporary bars were therefore welded to the edge of the nearside hatch covers to keep the falls of the grab clear of the cleats. Before discharge of the coal could be completed it was necessary to ballast Nos 2 and 6 holds to reduce the air draught of the ship. When discharge was complete shore contractors were instructed to cut off the temporary bars to allow the hatch covers to be closed and the ship to sail. Permission for the hot work was obtained from the port authority and, on condition that the hatches were closed, from the master. When the contractor was removing the bar from No 6 hold an explosion occurred in the hold that inverted the 40 tonne hatch cover and killed two men. Tests in No 2 hold later confirmed the presence of a flammable atmosphere above the ballast water. It is believed that when the tanks were cleaned and the pipelines stripped, the same one of the two cargo pumps was used for all the operations but that the other pump was used to ballast the two holds during discharge, so jumping the residual crude oil in the second pump’s associated pipeline into the two holds with the ballast water. Following this incident, section 12.15 was included in the fourth edition of the International Safety Guide for Oil Tankers and Terminals.

3.3 Fire broke out in a ship in a port during the unloading of a cargo of ammonium nitrate in paper bags. Fire fighting action was unsuccessful and the ship was abandoned. An explosion took place some 75 minutes later. The fire spread to another ship that was also carrying ammonium nitrate. Some 600 persons were killed. Although this incident involved packaged ammonium nitrate, ammonium nitrate is often carried in bulk. The incident occurred over 50 years ago but is still a salutary reminder of the hazards associated with the transport and handling of dangerous cargoes.