Focus on IMO

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IMO and the safety of bulk carriers

Introduction

Bulk cargo carriers are often described as the "workhorses" of the world merchant fleet. There are about 5,500 of them operating in the world today, forming about 33% of the world fleet in tonnage terms. They include some of the world's biggest ships (only some crude oil carriers are bigger) and without them world trade and industry would be paralysed.

Yet, for all their importance to modern life, bulk carriers are among the most anonymous of ships. They usually operate between terminals situated well away from cities and traditional port areas and are rarely noticed by the general public. When they are seen they are often mistaken for oil tankers, with which they share some similarities in appearance. And when they sink - which they did all too often in the early 1990s - they usually do so unnoticed by the world at large, far away from the television cameras and leaving little unsightly pollution to worry the environmentalists.

From 1990 to mid-May 1997, total 99 bulk carriers were lost, with the death of 654 people.

During the 1990s, IMO adopted a series of measures to improve bulk carrier safety, culminating in November 1997, when an IMO conference adopted important new regulations designed to prevent bulk carriers sinking after an accident. They entered into force on 1 July 1999.

The new regulations represented an important step forward in improving bulk carrier safety. But even before they came into force, IMO was once again looking into the intrinsic safety of bulk carriers following the presentation of a survey report into the sinking of the bulk carrier **Derbyshire**. The **Derbyshire** sank with the loss of all on board in 1980, but it was more than a decade before the wreck was located and a comprehensive underwater survey carried out in an attempt to find out why the ship had sunk. The report on the

delegation to IMO, contains a series of **Derbyshire**, presented by the United Kingdom recommendations relating to the design and construction of bulk carriers, which the IMO is now considering.

This paper examines the development of bulk carriers, their contribution to the world economy and the safety problems they face.

The development of bulk carriers

The bulk carrier was first developed to carry dry cargoes, which are shipped in large quantities and do not need to be carried in packaged form. The principal bulk cargoes are grains, such as wheat, coal, iron ore, bauxite, phosphate and nitrate.

The advantage of carrying such cargoes in bulk is that packaging costs can be greatly reduced and loading and unloading operations can be speeded up. Before the Second World War, however, there was no real demand for special bulk carriers. Seaborne trade of all mineral ores only amounted to 25 million tons in 1937 and this could be carried in conventional tramp ships (freight vessels).

By the 1950s, however, movements of bulk cargoes were increasing. Very often ores and other commodities were found far away from where they were needed and the most convenient and cheapest way of shifting them was by sea. Companies in the United States, Europe and increasingly in Japan began to build ships designed exclusively for the carriage of cargoes in bulk.

As demand increased and shipbuilding technology advanced so these ships tended to become bigger in size and carrying capacity. This afforded the same economies of scale that were to make the Very Large Crude Carrier (VLCC) so attractive to oil tanker operators in the 1970s. Doubling the amount of steel used in constructing a ship enabled the amount of carrying capacity to be cubed, yet the size of the crew required did not increase greatly and other costs, such as fuel, also rose relatively slowly, especially since speed was not vital to bulk transport.

The modern bulk carrier has evolved gradually but since the 1960s the standard design has been a single hull ship with a double bottom, large cargo holds with hopper tanks and topside tanks covered by hatches. As with crude oil tankers the engine room, navigating bridge and accommodation areas are nearly always located at the stern of the ship.

By the 1970s bulk carriers of more than 200,000 dwt were operating and rivalled VLCCs as the largest ships afloat. There are several other similarities between bulk carriers and tankers, which help to explain the frequency with which they are mistaken for each other. The simplest way of telling a bulk carrier from an oil tanker is that the holds of the bulk carrier are covered by hatches raised above the deck level, while the deck of the tanker is covered by fuel pipes. A bulk carrier of 36,000 dwt may have five cargo holds while one of 250,000 dwt may have as many as nine.

By the 1970s ships were being built which could carry oil, ore or other types of dry bulk cargoes. This was done to increase operational flexibility. One of the problems with the bulk trades (as with oil transportation) is that ships normally carry cargo one way but return in ballast because there is nothing to take back. However, oil/bulk/ore (OBO) ships have never become as popular as dedicated bulk or oil carriers, partly because their complexity increases building and operating costs.

Today, bulk carriers transport a high percentage of world trade - and in most cases they do so safely. According to the International Association of Dry Cargo Shipowners (Intercargo), in 1990-1994, 99.90% of dry bulk cargoes were delivered safely. In the case of iron ore the figure was 99.71% and for both grain and coal reliability was 99.97%.

The amount of cargo carried is enormous. In 1996, according to Intercargo, 1,092 million tonnes of iron ore, coal, grain, bauxite and phosphates were carried by sea. A further 703 million tonnes of products such as steel, cement, pig iron, fertilizer and sugar were also carried by bulk carriers.

The work of IMO

Because shipping is such an international industry, it is generally accepted that safety and other issues have to be dealt with at an international level. This is true of bulk carriers as well as other ship types and since it came into existence in 1959, the organization chiefly responsible for their safety has been the International Maritime Organization, the United Nations specialized agency concerned with shipping safety and the prevention of pollution from ships.

IMO is a highly technical organization whose main tasks are summed up in the phrase “safer shipping and cleaner oceans”.

It carries out this mandate primarily by developing conventions, codes and recommendations that are intended to be applied universally. The most important of these instruments have certainly achieved this target: several of the most important have been ratified by well over 120 countries and apply to more than 98% of the world fleet of merchant shipping. In practice, it is impossible to operate a ship on an international voyage, which is not built and equipped to IMO requirements (although the way they are implemented can vary enormously).

As far as safety is concerned, IMO has developed treaties dealing with the safety of life at sea, the prevention of collisions, the improvement of radiocommunications at sea, load lines and tonnage matters, the training and certification of seafarers, the creation of an international system for search and rescue and other matters.

The most important of all the Conventions adopted by IMO is the International Convention for the Safety of Life at Sea (SOLAS). The first SOLAS Convention was adopted in 1914 (as a direct result of the Titanic disaster) and revised versions were adopted in 1929 and 1948. IMO adopted a new version in 1960 and the current version - although much amended - was adopted in 1974 and is known as SOLAS 1974.

In the 1960s, specialised bulk carriers were still in the early stages of their development, although the carriage of cargoes in bulk had been going on for many decades. When IMO developed the 1960 and 1974 SOLAS Conventions, it concentrated on two main areas in relation to bulk carriers and their cargoes - the safety of the cargo and of the structure of the ship.

Improving cargo safety

Many different products are carried on ships in bulk. Grains, such as wheat, maize, millet and rye have been transported by sea for centuries - the wheat trade between north Africa and Italy was a major economic feature of the Roman Empire, for example. Since the last century, the grain trade has grown in importance and much of it is carried by sea, often on long trans-Atlantic or trans-Pacific voyages.

According to the International Grains Council, in 1996-1997 (July/June) total wheat trade amounted to 91.3 million metric tons, with the biggest exporters being the United States (26.5 million tons), Australia (17.4 million tons) and Canada (17.0 million tons) and the biggest importers being Iran (6.7 million tons), Egypt (6.2 million tons) and Japan (5.3 million tons). In addition, 88.8 million tons of coarse grains including (maize, millet, rye) were shipped in 1996-1997, the largest exporters being United States (53.1 million tons), Argentina (10.6 million tons) and European Union (8.1 million tons) and the largest importers being Japan (20.3 million tons), South Korea (9.2 million tons) and Saudi Arabia (6.3 million tons).

Total grains shipped in the year 1996-1997 were therefore 180.1 million tons -- or just over 3,600 panamax-sized (50,000-dwt) shiploads.

Originally grain was transported in sacks, but by the middle of the 20th century the normal procedure was to carry it in bulk. It could be stored, loaded and unloaded easily and the time taken to deliver it from producer to customer was greatly reduced, as were the costs involved. However, there were problems.

Grain has a tendency to settle during the course of a voyage, as air is forced out when the individual grains sink ("sinkage"). This leads to a gap developing between the top of the cargo and the hatch cover. This in turn enables the cargo to move from side to side as the ship rolls and pitches. This movement can cause the ship to list and, although initially the ship's movement will tend to right this, eventually the list can become more severe. In the worst cases, the ship can capsize.

This problem was well known and the 1960 SOLAS Convention devoted an entire chapter (Chapter VI) to measures designed to prevent it from occurring. These regulations were more advantageous from an economic point of view than those adopted in SOLAS 1948 (which required a more extensive use of increasingly expensive temporary fittings and/or bagged grain) and many countries quickly put them into effect, even though the Convention itself did not enter into force until 1965.

Experience soon showed, however, that the new regulations still had some deficiencies as far as safety was concerned, and during a period of four years, six ships loaded under the 1960 SOLAS rules were lost at sea.

IMO began looking at this problem early in 1963 and asked masters of ships to contribute information to a broad study. Further studies and tests showed that some of the principles on which the 1960 regulations were based were invalid -- in particular, it was shown that the 1960 Convention had underestimated the amount of "sinkage" which occurs in grain cargoes loaded in bulk. This made the basic requirements of the Convention unattainable.

As a result, the IMO Assembly in 1969 adopted new grain regulations (resolution A.184 (), which became generally known as the 1969 Equivalent Grain Regulations.

Governments were invited to use the new regulations immediately instead of following the requirements concerning grain contained in SOLAS 1960.

Voyage experience over a three-year period showed that the 1969 Grain Equivalents were not only safer but were also more practical and economical than the 1960 regulations and, with slight amendments, based upon operational experience, they were used as the basis of new international requirements which were subsequently incorporated into chapter VI of the 1974 SOLAS Convention.

Grain was the only bulk cargo to be given a special chapter in the 1960 SOLAS Convention, but IMO also developed an international Code of Safe Practice for Solid Bulk Cargoes (BC Code)**,** which was adopted in 1965.

The Code has been updated at regular intervals since then and is kept under continuous review by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers. The practices contained in the Code are intended as recommendations to Governments, ship operators and shipmasters. Its aim is to bring to the attention of those concerned an internationally-accepted method of dealing with the hazards to safety which may be encountered when carrying cargo in bulk.

The BC Code was amended on several occasions, but in 1991 IMO decided to amend Chapter VI of SOLAS and in the process completely re-write it. The main change made in the amendments, which entered into force on 1 January 1994, was to extend the chapter to cover other cargoes, including bulk cargoes. The new Chapter VI was retitled Carriage of Cargoes. It is a great deal shorter than the existing text, but its provisions are backed by a number of codes. The advantage of including requirements in a code rather than the convention itself is that codes can be amended much more easily.

The codes that are most relevant to the safety of bulk carriers are the revised BC Code and a new mandatory International Code for the Safe Carriage of Grain in Bulk (International Grain Code).

Like the original grain rules, the Code is designed to prevent the particular qualities of grain threatening the stability of ships when it is carried in bulk. It applies to all ships - including existing ships and those of less than 500 tgt (tons gross tonnage) - that carry grain in bulk. Part A contains special requirements and gives guidance on the stowage of grain and the use of grain fittings. Part B deals with the calculation of heeling moments and general assumptions.

Code of Safe Practice for Solid Bulk Cargoes (BC Code)

The revised BC Code deals with three basic types of cargo: those which may liquefy; materials which possess chemical hazards; and materials which fall into neither of these categories but may nevertheless pose other dangers.

The Code highlights the dangers associated with the shipment of certain types of bulk cargoes; gives guidance on various procedures which should be adopted; lists typical products which are shipped in bulk; gives advice on their properties and how they should be handled; and describes various test procedures which should be employed to determine the characteristic cargo properties.

The Code contains a number of general precautions and says it is of fundamental importance that bulk cargoes be properly distributed throughout the ship so that the structure is not overstressed and the ship has an adequate standard of stability.

Loaded conditions vary according to the density of the cargo carried. The ratio of cubic capacity to deadweight capacity of a normal ship is around 1.4 to 1.7 cubic metres per tonne and the ratio of volume of cargo to its mass is known as the stowage factor. When high density bulk cargoes with a stowage factor of about 0.56 cubic metres per ton or lower are carried, it is particularly important to pay attention to the distribution of weight in order to avoid excessive stresses on the structure of the ship.

All bulk cargoes when loaded tend to form a cone. The angle formed between the slope of the cone and the bottom of the hold will vary according to the cargo and is known as the angle of repose. Some dense cargoes, such as iron ore, form a steep cone while others - such as grain - have a much shallower angle. Cargoes with a low angle of repose are much more prone to shift during the voyage and special precautions have to be taken to ensure that cargo movement does not affect the ship's stability. On the other hand, the sheer weight of dense cargoes can affect the structure of the ship.

After dealing with general precautions, the Code then goes on to deal with cargoes having an angle of repose of 35 degrees or less and then with those where the angle of repose is greater than 35 degrees.

Cargoes with a low angle of repose are particularly liable to dry-surface movement aboard ship. To overcome this problem, the Code states that such cargoes should be trimmed reasonably level and the spaces in which they are loaded should be filled as fully as is practicable, without resulting in excessive weight on the supporting structure.

Special provisions should be made for stowing dry cargoes that flow very freely, by means of securing arrangements, such as shifting boards or bins. The Code says that the importance of trimming as a means of reducing the possibility of a shift of cargo can never be over-stressed. This is particularly true for smaller ships of less than 100 metres in length.

Trimming also helps to cut oxidation by reducing the surface area exposed to the atmosphere. It also helps to eliminate the "funnel" effect, which in certain cargoes, such as direct reduced iron (DRI) and concentrates, can cause spontaneous combustion. This occurs when voids in the cargo enable hot gases to move upwards, at the same time sucking in fresh air.

The Code then gives details of other dangers that may exist. Some cargoes, for example, are liable to oxidation which may result in the reduction of the oxygen supply, the emission of toxic fumes and self-heating. Others may emit toxic fumes without oxidation or when wet. The shipper should inform the master about any chemical hazards that may exist and the Code gives details of precautions that should be taken.

The Code gives details of the various sampling procedures and tests which should be used before transporting concentrates and similar materials and also contains a recommended test procedure to be used by laboratories.

There are seven appendices to the Code, giving information about particular cargoes. A list of cargoes which may liquefy is contained in appendix A to the Code, for example while appendix B gives an extensive list of materials possessing chemical hazards. Some of the classified materials listed also appear in the International Maritime Dangerous Goods (IMDG) Code when carried in packaged form, but others become hazardous only when they are carried in bulk - for example, because they might reduce the oxygen content of a cargo space or are prone to self-heating. Examples are woodchips, coal and direct reduced iron (DRI).

Appendix C deals with bulk cargoes which are neither liable to liquefy nor possess chemical hazards. More detailed information concerning test procedures, associated apparatus and standards which are referred to in the Code are contained in appendix D. Emergency Schedules for those materials listed in appendix B are contained in appendix E. Recommendations for entering cargo spaces, tanks, pump rooms, fuel tanks and similar enclosed compartments are shown in appendix F. Procedures for gas monitoring of coal cargoes are contained in appendix G.

In 1990 the MSC issued a circular (MSC/Circ.531) which warned against the risks of shifting cargo and requested Member Governments to implement revised recommendations for trimming cargoes which were included in the 1989 edition of the Code and are intended to minimize sliding failures.

Improving structural safety

The actions taken by IMO undoubtedly helped to solve many of the problems associated with the carriage of bulk cargoes, such as cargo shift and the consequent loss of stability. The number of accidents involving bulk carriers dropped during the 1980s and it seemed to many observers that the general problem of bulk carrier safety had been solved.

Then, in 1990 the trend was dramatically reversed: 20 bulk carriers sank with 94 lives lost and in 1991, 24 sank with 154 dead. This development was so dramatic and so unexpected that alarm bells began to ring throughout the shipping world.

It became increasingly apparent that many of the bulk carriers lost - often without trace - had suffered from severe structural damage. In some cases ships had simply broken apart like a snapped pencil. What had gone wrong? And what could be done to improve matters?

What went wrong?

The analyses of bulk carriers that have been carried out during the last few years have shown that, although there were many different causes, certain conclusions could be drawn.

1 The importance of age

There is no doubt that there is a clear link between accidents and the age of bulk carriers. All but two of the ships lost in 1990 were over 18 years old. In July 1995 the classification society Lloyd's Register of Shipping published a table giving details of accidents involving 88 bulk carriers between January 1990 and December 1994. Only three of the ships on the list were less than ten years old and nearly half were over 20.

What makes this so worrying is that the average age of bulk carriers had been rising steadily - from under nine years old in 1980 to more than 14 by 1995. The reason for this upward trend is primarily economic. During the 1980s there was a glut of shipbuilding, mainly because the industry greatly over-estimated the way in which trade would develop. This was especially true of tankers, but it was true to some extent of bulk carriers as well and when trade increased much more slowly than had been forecast (and sometimes declined) the result was a fall in the demand for ships. Some older ships were scrapped and others laid up waiting the return of more favourable trading conditions. But throughout the period there has generally been a surplus of unwanted ships and freight rates have usually remained low. This has discouraged the construction of new tonnage and has led shipowners and builders to explore new ways of cutting costs.

This trend is potentially worrying. A survey of bulk carrier safety issued in July 1995 by the classification society Lloyd's Register (entitled Bulk Carriers - an Update) says that "an historically critical age group for bulk carrier casualties is from 14 to 18 years and that in three or more years' time a large proportion of bulk carriers in service will be in this age group unless the age distribution is changed by, for example, a substantial scrapping programme."

For straightforward economic reasons there is little sign of such a mass scrapping taking place. At the turn of the century, the great majority of the world's bulk carrier fleet have reached the danger point. More than half the world's bulk carrier fleet is already more than 15 years old and one third is more than 20 years old.

2 Corrosion and fatigue

The main reason why age is so relevant to shipping casualties is that corrosion and general fatigue increase as ships grow older. This is partly because of the stresses to which the ship is inevitably subjected by routine operations, cargo handling, weather and waves and partly to the effect of seawater on steel. Although any water tends to causes metals such as steel to rust, seawater is much more harmful than fresh water because it contains so much salt. The bulk carriers used in the Great Lakes of North America, for example, frequently survive to 50 or 60 years of age - up to three times as long as the average ocean-going ship.

Corrosion is a serious problem for anything built of metal that is exposed to the elements, but for a ship it can be fatal. Corrosion is likely to be more extensive and work more rapidly than on other structures simply because the ship is in continual contact with water, usually salt. It can also be accelerated by the effects of some cargoes, especially those carried in bulk. The interior of cargo holds can be affected by humidity resulting from the moisture contained in some bulk cargoes. Sulphuric acid can be formed from sulphur residues (which can come from coal) combining with water resulting from condensation.

There are various ways of preventing corrosion - or at least of preventing it from becoming a problem. Tanks can be painted with special coatings and can be carefully washed out. Above all, the condition of the hull and other structures can be continually checked for signs of corrosion or fatigue.

This, however, is much easier said than done. There is, in the first place, a great deal of steelwork to be checked. A bulk carrier of 254,000 deadweight tons (representing roughly the amount of cargo it can carry) might be 320 metres long, 54 metres in breadth and 26 metres deep. The total hull area to be examined could thus be in excess of 54,000 square metres and that does not include the interior bulkheads, hopper tanks, brackets and other features. All of this has to be surveyed and inspected - a daunting task that requires the use of special staging, artificial light and a considerable amount of stamina on the part of the surveyor or surveyors involved.

Certainly corrosion seems to have played a significant part in many of the bulk carrier accidents of recent years - especially the most serious losses. An Intercargo analysis of 15 total losses in 1994 showed that 40% were caused by plate failure and subsequent ingress of water. A further 6.7% of losses were never explained because the ships involved disappeared. More than 70% of these losses occurred in heavy weather.

Intercargo found that of 29 fatal accidents involving bulk carriers between 1990 and 1994, 55% were due to plate failure. In terms of lives lost 81% were associated with sinkings and disappearances. In 12 cases adverse weather was a factor and in 67% of the cases, iron ore was the cargo.

Not surprisingly, the Intercargo report states: “The inescapable conclusion from this analysis is the fairly obvious one that it is plate failure, taking water and disappearance which cause the majority of fatal accidents. Thus, although during the whole period losses related to human factors account for 33% of all bulker and OBO losses, such accidents comprise only 10% of fatal accidents and involve only 7% of the total fatalities...it is structural failure, aggravated by bad weather and the carriage of iron ore which causes the majority of the really serious accidents involving loss of life.”

The frequent references to iron ore are significant because once laden bulk cargo carriers get into trouble, the consequences can be very sudden. The ships are designed to withstand bad conditions, but not to operate with several holds flooded and the combination of iron ore and a sudden inrush of seawater can result in more weight than the structure can stand.

Other investigations came to similar conclusions. The American Bureau of Shipping said in 1991: “The recent spate of casualties on conventional bulk carriers appears to be directly traceable to failure of the cargo hold structure...”

Lloyd’s Register of Shipping concluded that the prime cause of most casualties is the inability of the side structure to withstand the combination of local corrosion, fatigue cracking and operational damage.

The evidence of the disastrous consequences of uncontrolled corrosion is overwhelming - but preventing it is not so easy as it sounds, if only because of the size of the ships themselves and the difficulties involved in assessing corrosion and plate thickness.

A report by Lloyd’s Register in the autumn of 1991 says that the owner of one ten-year old Capesize bulk carrier estimated that the wastage rate of hold frames due to corrosion amounted to 0.5mm per year - and 1mm in some places. Some frames had suffered metal wastage of 20%. During one voyage from South America to Japan a bracket which was in good condition when the ship left became completely detached, leaving a 1.4mm crack. It was not detected because “the rust scale adhering to the surface of the hold structures presented a smooth and regular surface to the eye on visual inspection, making it difficult to detect any cracking.” Since the side plates of a bulk carrier may only be 20mm to 29mm thick the loss of a few millimetres can be disastrous.

3 Operational factors

Like many of the other studies carried out, the Lloyd's Register report said that structural failures were due to a combination of factors. Corrosion was important - but so was physical damage suffered during operations.

Bulk carriers are designed to withstand heavy seas. The massive structures of the largest ships will bend with the action of the sea. When the centre of the hull is higher than the bow and stern the action is known as "hogging": the reverse is called "sagging".

But the design assumes that the hull is sound. Corrosion or other damage can lead to weaknesses developing that invalidate the calculations of the naval architect and imperil the whole ship. Loading patterns can make the effect worse. Dense cargoes such as iron ore are often carried in alternate holds in order to raise the ship's centre of gravity and moderate its roll motions. But this places greater stress on frames and girders and, because holds carrying iron ore are not completely filled, there can be greater side frame deflection. The overall result is increased stress on inner hull components, according to Lloyd's Register. This might be perfectly acceptable in a new ship - but not in a ship that has suffered from 20 years of hard service and neglect.

Design features originally chosen for operational reasons may also have safety implications. Many bulk carriers are fitted with very large hatch openings to facilitate cargo loading and unloading. Yet these openings may represent points of weakness in the hull since they reduce the torsional resistance of the hull.

Cargo handling methods have also been criticized. These have changed considerably in recent years, with the emphasis being to load and unload the ship as quickly as possible so that the berth can be cleared for the next ship. In some loading terminals iron ore can be loaded at up to 16,000 tons an hour by means of conveyor belts often several kilometres long. Stopping the loading process for some reason cannot be done simply by pressing a button - it has to be very carefully planned and can take several minutes to carry out.

In these circumstances it is not surprising that bulk carriers can sometimes be overloaded. The International Association of Classification Societies (IACS) says that there is no evidence that high loading rates causes physical damage to the interior of cargo holds (assuming that they are in good condition to begin with) but "high cargo loading rates under an uncontrolled process could result in inadvertent overloading which could cause local or global damage." Dramatic proof of what can happen if something goes wrong during loading came in 1994 when a bulk carrier broke in half while being loaded at a port in South America.

A study carried out by IACS members showed that a 5% overload placed in various holds could increase the stillwater bending moment by up to 15% and the sheer force by up to 5% while a 10% overload could increase the still water bending moment by up to 40% and the sheer force by up to 20%. A 10% overload, according to IACS (in reply to questions submitted by the Nautical Institute) could be caused by a five to eight minute delay in stopping a conveyor belt with a capacity of 16,000 tons an hour.

At the other end of the voyage, other problems can be waiting. Bulk cargoes are removed from the hold by means of huge grabs, which can weigh up to 36 tons. The last tons of cargo, which may be caught up in frame webs and other parts of the hold, are often removed by bulldozers and hydraulic hammers fitted to the extending arms of tractors. There is always a danger that the hull - especially if it is suffering from corrosion or fatigue - may inadvertently be damaged in the process.

Part of the problem is that modern loading and unloading techniques were developed long after the ships they are intended to load were built. The need for speed may have compounded the problem in some cases. An article in the August 1995 edition of the BIMCO Bulletin, the magazine of the Baltic and International Maritime Council, says: "There has been a growing body of evidence that terminals, which were often owned by the cargo owners or charterers of the ship, were putting pressure upon the ships to amend their loading plans or to load cargo to suit them, with little consideration about the overall safety of the ship."

4 A question of attitude

The idea that commercial considerations could threaten safety has been noted by other sectors of the shipping industry. A study by Lloyd's Register discovered that "operational damage was accepted as the norm by the operators of bulkers and OBOs; second, there was little awareness as to the significance of this damage and its likely consequences on the capability of the ship under adverse operating conditions."

This might be put down to simple thoughtlessness, but that excuse cannot be made for shipowners who purposely move their vessels from one trade to another - to escape increasingly vigilant port State control inspections. That is what happened when Australia, alarmed by a number of accidents involving elderly bulk carriers visiting its ports, tightened its port control procedures.

The result was a rapid switch of tonnage from the Pacific to the Atlantic where inspections were apparently not as rigorous. According to Lloyd's List "in the first nine months of 1989 there were nine voyages with Capesize vessels aged 20 years or more in the transAtlantic trades. In the corresponding 1993 period that figure had increased to 152."

It is difficult to avoid the conclusion that the owners of at least some of the ships concerned moved them because they knew that the ships were in such bad condition that they would not be allowed to operate in Australia - or even leave port - without being repaired. The owners were presumably quite content to allow the crews to risk their lives on ships which they knew were unseaworthy.

It is not surprising in the circumstances that, when Lloyd's Register of Shipping began to investigate bulk carrier losses in 1991 it found that "one of the biggest problems facing LR ...is the general attitude of the industry. It is thought by some in the industry that cracking in these structures is inevitable due to the harsh nature of the cargoes and the rigorous operational procedures throughout their service life."

5 High tensile steel

Most of the concern about the condition of bulk carriers has focused on old ships, especially those aged more than 20 years. But young ships are not immune to neglect and corrosion and there is also evidence that changes in the steel used on some relatively young bulk carriers could present even more serious problems than those experienced by earlier designs.

The majority of ships operating today are built of mild steel. But since the early-1980s increasing use has been made of high-tensile (HT) steel, especially in the construction of bulk carriers. HT steel has been used in shipbuilding since 1907 but its recent popularity is due to the fact that plates can be thinner without losing any strength. Whereas a normal side plate will be 24-29mm thick, this can be reduced to 20mm by using HT steel. The weight saving - which might amount to several thousand tons - cuts building costs and also enables the ship to carry more cargo.

However, for these savings a price has to be paid. One is the simple fact that HT steel corrodes just as quickly as mild steel. Since HT plates are thinner than those of mild steel, corrosion is likely to reach the danger point more quickly. A second problem is that HTS-built ships are more prone to structural problems caused by the way in which load is transmitted through the ships' structural components and the inter-dependency of the structural response.

A paper submitted to IMO by IACS in 1992 said that the most common example where failure had occurred on HTS-built bulk carriers was at side longitudinal connections to web frames. According to Lloyd's Shipping Economist in September 1995, HTS-built ships are also prone to a phenomenon known as "springing": because the ships are flexible they tend to vibrate with short sea waves. The article says: "Classification society rules have always been based on empirical evidence from previous generations of ships, but the increased use of HTS changed the characteristics of vessels and therefore represented a step into the unknown."

It is clear from the above that HTS ships need at least as much care and maintenance as those build of mild steel, especially as they too are frequently subject to greater stresses in cargo loading and unloading than was originally envisaged. Many shipping experts believe that whereas mild steel bulk carriers usually begin to experience major problems at the age of 20, those built of HTS will do so much earlier. Since most of those built in the early 1980s are already in their late-teens, the danger is that there could be another rise in bulk carrier casualties, unless action is taken to prevent it.

What IMO has done

The sudden increase in bulk carrier losses in 1990 and 1991 caused considerable alarm in the shipping industry. Several classification societies launched major research programmes and the Secretary-General of IMO, Mr William A. O'Neil felt that the situation called for immediate action. He therefore took the unprecedented step of presenting the IMO Assembly with a draft resolution on this subject in October 1991. The move was unusual because IMO, like any other United Nations agency, is an inter-Governmental organization and the normal procedure is for major policy initiatives to come from Member States or organizations which have been granted consultative status with IMO. But Mr O'Neil felt that the situation was too serious and too urgent to rely on normal procedures.

Resolution A.713(17) ("Safety of Ships Carrying Dry Bulk Cargoes") was duly adopted. It contains interim measures designed to improve the safety of ships carrying solid bulk cargoes.

The preamble expressed concern at the continuing loss of bulk cargo carriers and the heavy loss of life incurred. The resolution noted that the nature of cargo and ballast operations can subject bulk carriers to severe patterns of bending and sheer forces and also to significant wear. It referred to the dangers posed by some bulk cargoes through their high density and tendency to shift.

It called on the MSC to develop as soon as possible requirements for the design, construction and operational maintenance and survey of ships carrying solid bulk cargoes and to specify appropriate precautionary measures. IACS was requested to develop survey and maintenance requirements for ships carrying solid bulk cargoes as soon as possible and to submit them to the MSC. In the meantime, governments, classification societies, shipowners and shipmasters were urged to take immediate action to implement the interim measures, contained in an annex. These measures are particularly concerned with the condition of the ship's structure and the detection of any corrosion.

The importance of not overstressing the ship's structure during cargo operations was emphasized and governments were advised to pay particular attention to the structural integrity and seaworthiness of ships when port State control procedures are carried out under SOLAS.

Owners were encouraged to fit vessels with equipment to monitor the stresses on the ship's structure during the voyage and during cargo operations. They were also encouraged to install equipment required by the Global Maritime Distress and Safety System (GMDSS), which entered into force on 1 February 1992 but which did not become mandatory for most existing ships until 1999.

The impact of this resolution and action initiated by major classification societies was immediately beneficial. The number of bulk carrier losses dropped to just two within the next year. What is most significant about this improvement is that the resolution did not introduce any new measures but simply stressed the importance of implementing existing standards. From this it is possible to conclude that at least some of the casualties that occurred in 1990 and 1991 were due not to defects in the regulations covering bulk carrier safety but to the ineffective way in which they were implemented.

Improving implementation

Poor implementation of regulations is a problem that concerns all forms of shipping and is one that IMO has been treating with even greater urgency.

Successful implementation depends upon a number of factors, but to be really effective it requires everybody involved doing their job efficiently and with the necessary commitment and dedication.

Those involved in implementation are:

- flag States - the Governments which have ratified conventions and thereby promised to put them into force
- port States - which have authority under conventions to check that foreign ships visiting their ports comply with IMO requirements
- shipowners - who own the ships and have the greatest responsibility - and opportunity - for ensuring that they are maintained in good condition.
- seafarers - whose training and skill are vital to shipping safety and who stand to suffer most if something goes wrong.

Some of the actions taken by IMO recently to improve implementation have been particularly important.

- The Organization established a Sub-Committee on Flag State Implementation, which spotlights some of the problems Governments have in enforcing IMO conventions and provides guidance in overcoming them.
- IMO has encouraged the establishment of regional port State control systems. Regional systems are especially useful in improving port State control because ships normally visit more than one country in a particular region. Regional co-operation in inspecting and surveying ships ensures that few sub-standard ships avoid the net - and that ships in good condition are not inspected unnecessarily.
- In 1989 IMO adopted guidelines on management for the safe operation of ships and for pollution prevention. These were replaced by an International Safety Management Code (ISM Code) which became mandatory in 1998 through a new chapter IX of SOLAS.
- The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) was completely revised in 1995 and the revised convention became effective in February 1997. Not only do the revisions bring the Convention up to date, they also introduce strict new controls which will enable IMO to validate the training and certification procedures of Parties to the Convention.

These actions are expected to lead to improvements in the safety of all ships, but in April 1992 the MSC instructed various sub-committees to develop further requirements specifically for bulk carriers.

The Sub-Committee on Ship Design and Equipment (DE) began work on measures to do with constructional safety, especially the hull integrity of large ships. The Sub-Committee felt that it would be useful to install a monitoring system that would provide information to the master of the ship while the ship was under way and during loading and unloading operations. Such a system might prevent the accident from happening in the first place.

This recommendation was accepted by the MSC in May 1994 and issued as MSC/Circ.646. It contains guidance on the fitting of hull stress monitoring systems (HTMS) and recommends that they be fitted to bulk carriers of 20,000 dwt and above. Governments were asked to provide IMO with information on experience gained.

The Sub-Committee also considered ways of combating corrosion of seawater ballast tanks, a problem shared by both bulk carriers and oil tankers. Its proposals were adopted by the MSC in May 1994. They include a new draft regulation 14-1 in Chapter II-1 of SOLAS, which requires all dedicated seawater ballast tanks to be provided with an efficient corrosion prevention system, and the relevant guidelines. These guidelines were adopted by the MSC and then by the IMO Assembly in 1995 by resolution A.798(19). The regulation itself was included in amendments to SOLAS adopted by the 66th session of the MSC in 1995 (see below) which entered into force in 1998.

Enhanced inspections during surveys

Resolution A.713(17) emphasized the importance of regular inspections of bulk carriers, especially of older ships, and in 1993 guidelines on an enhanced programme of inspections during surveys of bulk carriers and oil tankers were adopted by the 18th Assembly by resolution A.744(18). It was originally intended that the guidelines would apply to tankers but because of concern about the loss of bulk carriers they were extended to them as well.

The guidelines were regarded as so important to safety that amendments to SOLAS to make them mandatory were adopted in May 1994 and entered into force on 1 January 1996.

The guidelines apply to existing tankers and bulk carriers of five years of age and over - meaning that the vast majority of the world tankers and bulk carriers are affected. The enhanced surveys must be carried out during the periodical, intermediate and annual surveys prescribed by the SOLAS Convention. The enhanced survey programme is mandatory for oil tankers under Regulation 13G of Annex I to the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).

The guidelines pay special attention to corrosion. Coatings and tank corrosion prevention systems must be thoroughly checked and measurements must also be carried out to check the thickness of plates. These measurements become more extensive as the ship ages. The guidelines go into considerable detail to explain the extra checks that should be carried out during enhanced surveys. One section deals with preparations for surveys and another with the documentation which should be kept on board each ship and be readily available to surveyors. This should record full reports of all surveys carried out on the ship.

Annexes to the guidelines go into still more detail and are intended to assist implementation. They specify the structural members that should be examined, for example, in areas of extensive corrosion; outline procedures for certification of companies engaged in thickness measurement of hull structures; recommend procedures for thickness measurements and close-up surveys; and give guidance on preparing the documentation required.

Guidance on planning the enhanced programme of inspections was adopted by the MSC in May 1994 and issued by means of MSC/Circ.655.

Cargo handling

The Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC) considered ways of improving the safety of loading and unloading operations. One aim was to amend Chapter VI of SOLAS so that ship masters would be provided with sufficient information on cargoes to be able to assess stress limitations. At the 32nd session in 1994, a questionnaire was developed and later sent out as MSC/Circ.611. It deals with the loading and unloading of bulk cargoes and was based on a model plan prepared by the Nautical Institute and the International Federation of Shipmasters' Associations (IFSMA).

Three other circulars were sent out by the MSC in December 1994 which were also based on work carried out by these two organizations. MSC/Circ. 665 is concerned with the duties of Chief Mate and

Officer of the Watch at bulk cargo loading and discharge ports. It contains checklists which are designed to ensure that loading and unloading is carried out safely. The circular was superseded in June 1995 by MSC/Circ. 690, which contains an improved model ship/shore safety checklist.

MSC/Circ. 666 contains a cargo operation form, which is intended to ensure proper planning and calculation prior to the commencement of cargo operations. MSC/Circ. 667 contains general advice on bulk carrier safety. It stresses, for example, the importance of reducing corrosion within holds and ballast tanks by maintaining paint coatings and gives guidance on where corrosion is most likely to occur.

Other organizations were also working to improve bulk carrier safety, including the leading classification societies, most of whom are members of the International Association of Classification Societies (IACS), which also has consultative status with IMO. In 1994 IACS submitted to IMO copies of its manual on guidelines for surveys, assessment and repair of hull structures of bulk carriers. It focuses on the IACS member societies' survey procedures.

Keeping up the pressure

In May 1994, the MSC reviewed the work carried out so far in improving bulk carrier safety. It concurred with the Secretary-General's appraisal that the measures taken so far had resulted in a comprehensive set of standards. However, during 1994 the number of casualties to bulk carriers again increased, incurring considerable loss of life. The Committee agreed in MSC/Circ. 646 that these accidents "suggested that it is not the lack of standards that leads to such tragedies but rather their inadequate implementation and enforcement."

The circular invited flag States to implement all bulk carrier safety measures adopted by IMO and to use port State control to ensure compliance of foreign ships calling at their ports. IMO Member Governments were also invited to draw the attention of shipowners and operators, shipmasters, classification societies, loading and unloading terminal operators and other parties concerned to the need for increased safety in bulk carrier operations.

The Secretary-General, Mr. O'Neil, was also trying to ensure that the safety of bulk carriers remained an important issue. In September 1994 he attended a Ministerial Conference on Port State Control in Copenhagen and pointed out that the rate of accidents involving bulk carriers seemed to be increasing and yet public concern appeared to be minimal. He said: "The fact that the world as a whole does not seem to care about the loss of ships and the deaths of seafarers should not deter us. We can claim with justice that we have tried to make shipping safer - but we have to recognize that we have not done enough and that if we do not do more safety at sea will get worse.

"During the next few years, many bulk carriers built in the 1980s of high-tensile steel will be reaching an age when corrosion becomes a major threat. But because plates made of high-tensile steel are thinner than those made of conventional steel corrosion is an even greater danger. Will we be prepared to sit back and congratulate ourselves on what we have achieved while more ships sink and more seafarers die?"

A paper submitted to IMO by Intercargo in October 1994 also showed that the casualty rate could deteriorate very quickly. In the first seven months of 1994 there were seven major casualties involving bulk carriers, four of them due to plate failure or disappearance. Intercargo proposed a series of measures designed to improve safety in both the short and the long term, based on guidance on control of stresses during loading and unloading, advice on mitigating stress conditions at sea, such as from corrosion or shifting cargoes, emphasising enhanced surveys, looking at design factors for new ships and looking at the human factor such as proper training of crew.

Meanwhile, the United States Maritime Administration (MARAD) had in 1993 submitted a paper to the MSC which carried the results of a damaged stability and strength analysis on a typical 1980s built 63,000 dwt bulk carrier carrying iron ore, in an attempt to look at the reasons why so many bulk carriers had sunk.

The findings of the U.S. study showed that if one hold was flooded following water ingress for any reason, the ship would remain afloat. But when flooding spread to two compartments, particularly the two forward-most holds, the ship would rapidly sink. The report concluded: "In the light of this study, a most plausible scenario for bulk carriers reported missing is flooding of a single cargo hold due to a local failure of hull plating and frames, followed by progressive flooding through poorly maintained transverse bulkheads."

When the MSC met for its 64th session in December 1994 it was in the knowledge that no matter how much had been done in recent years to make the carriage of bulk cargoes safer, a great deal more remained to be accomplished. The Committee established a correspondence group co-ordinated by Australia which would consider the whole issue of bulk carrier safety, concentrating on six key areas:

- survivability standards (led by Italy)
- design and construction standards (IACS)
- operational standards (Canada)
- survey requirements (United States)
- ship/shore interface (International Chamber of Shipping) and
- management and training (Norway).

The correspondence group's report to the MSC's 65th session in May 1995 made a number of proposals for improving the chances of a bulk carrier surviving in the open seas. Their importance was emphasized by the group's statement that, over the period 1990-1994, 77 bulk carriers were lost with a total of 532 lives. Ships of 15 years of age and over represented most of the losses while 44% were lost or had the potential to be lost through structural damage and/or heavy weather.

As a result, the MSC made a number of decisions:

- The International Organization for Standardization (ISO) was requested to prepare quality standards for use by repair workers, surveyors and superintendents and to develop international shipbuilding quality standards on such matters as building techniques, quality control and qualifications and competency.
- To improve safe operations at terminals, the Committee agreed that SOLAS Chapter VI needed to be amended by adding a footnote referring to the Code of Safe Practice for the Safe Loading and Unloading of Dry Bulk Cargoes, then under development by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC).
- It was recognized that there was a need for a bulk carrier endorsement to certificates of competency, similar to the one required for tankers, to reflect the special expertise required for bulk carrier operations.
- A new Assembly resolution on bulk carrier safety was drafted and subsequently adopted by the 19th Assembly in November 1995 as resolution A.797 (19). It urged Governments, classification societies, shipowners, ship operators, shipmasters and terminal operators to implement measures contained in an annex which gave practical guidance to port States, flag States, shipowners and classification societies on improving the way regulations are implemented.
- Special consideration was given to the safety of single hull bulk carriers carrying high-density cargoes, such as iron ore. A number of ships of this type have suffered progressive flooding in some cases involving the collapse of transverse bulkheads between holds. The Committee agreed that draft amendments to SOLAS should be developed.
- The correspondence group was asked to prepare draft amendments which would bar bulk carriers of 20,000 dwt and above from carrying high-density solid bulk cargoes such as ore unless they complied with certain conditions. These included being able to meet at least a one-compartment standard of subdivision for any cargo and in all relevant loading conditions; being able to establish that the transverse bulkheads have sufficient strength to withstand flooding of any single cargo hold; ships of ten years of age and above should have successfully undergone surveys of all holds to the minimum extent specified for the five yearly periodical survey according to the Enhanced Survey Programme; and the Safety Construction Certificate should be endorsed to show that this had been done.
- SOLAS should be amended to require the installation of loading instruments on ships of over 150 metres in length.

A number of proposals were made for existing ships, including a reduction in cargo carrying capacity, raising standards of subdivision and damage stability and preventing progressive flooding through collapsing bulkheads. A new correspondence group was formed, again coordinated by Australia, to develop draft regulations.

In May 1996, the Committee met for its 66th session and once again bulk carrier safety was an important item on the agenda, particularly since some of the proposals made by the correspondence group had important technical and financial implications for the shipping industry. These proposals were based on a three- part approach to defining the conditions under which bulk carriers of ten years of age and over would be permitted to carry high density cargoes. Its purpose was to:

- ensure that the ship could survive flooding of one hold without sinking and thus provide a second line of defence against accidents
- ensure that the hold structure is adequate to withstand such flooding in a loaded condition, and
- provide for enhanced survey of the hold structure.

The correspondence group was also directed to develop a regulation to make mandatory the fitting of loading instruments to enable ships' officers to control and monitor loading and unloading.

The correspondence group prepared draft amendments, which were further considered by a working group during the MSC's 66th session. They dealt with flooding, surveys and enhanced structural requirements for new bulk carriers, which were readily agreed in principle. However, there was less agreement on implementing changes for existing ships, which would have serious financial and technical implications.

All cargo ships (including bulk carriers) built since 1992 have been required by SOLAS to be able to withstand flooding. But while investigating the practicability of the correspondence group's three-part approach to bulk carrier safety, the International Association of Classification Societies (IACS) found -- as the U.S. study had done earlier -- that even where a ship has been designed to withstand flooding it may not be able to survive the head of water that results, especially if the ship is loaded and the seawater creates dynamic pressures in the flooded hold. The bulkhead between the flooded hold and the next one might collapse under this pressure, followed by progressive flooding and the rapid sinking of the ship.

However, the IACS representative told the MSC that further work was needed before IACS could advise IMO on the extent of the problem and on possible measures to overcome them. As a result, many delegations were reluctant to endorse proposals concerning the structural strength of existing ships until IACS had completed its work. A number of countries also suggested that the effectiveness of other solutions, such as enhanced surveys and the application of the International Safety Management (ISM) Code should be assessed before requiring extensive modifications to be made to existing ships.

In December 1996, the MSC once again had bulk carrier safety high on its agenda, but the IACS study was still not complete. However, a report submitted to IMO by IACS showed that in certain circumstances non-homogeneously loaded cargoes with a density lower than 1.78 tonnes per square metre can, if the hold is flooded, produce higher stresses in certain locations in the corrugated transverse watertight bulkheads. IACS promised that a further report, known as the IACS Ramification Study, would be ready for consideration by the MSC at its 68th session in May 1997.

During the 67th MSC session in December 1996, the bulk carrier safety Working Group met but could not agree on a number of key points, including the need for strengthening internal structures, the compulsory introduction of homogeneous loading and whether there should be a reduction in the amount of cargo which can be carried on certain ships.

When the MSC met again in May 1997 for its 68th session, IACS had completed its Ramification Study. The study confirmed what the earlier studies had indicated -- that older ships were most vulnerable to damage and that the crucial point was the bulkhead between numbers one and two holds, since 40 percent of ship casualties involved water ingress into number one hold. If the hold was strengthened the likelihood of that bulkhead collapsing under pressure -- and the ship sinking as subsequent bulkheads followed suit -- could be reduced.

Even before any agreement at IMO, the IACS Council had in December 1996 ratified a decision to require, as a condition of classification, that the transverse bulkhead between numbers one and two holds and the double bottom structure in the way of number one hold must meet new IACS standards. These standards would apply to all single-skin bulk carriers over 150 metres in length.

When the MSC met, it was against the background of two major bulk carrier losses earlier in the year - the Albion Two with 25 crew and the bulk carrier Leros Strength with the loss of 20 lives. Both ships had undergone a special survey not long before sinking, so it was clear that existing standards needed to be revised.

After an eight-day session, the MSC therefore agreed draft regulations to improve the safety of bulk carriers. Delegations agreed that a new Chapter XII to SOLAS should be written, dedicated to the safety of bulk carriers and containing the draft regulations. It was agreed that the amendments to SOLAS to add a new chapter to the SOLAS Convention would be considered in November 1997, at a conference to be held at the same time as the regular 20th session of the IMO Assembly.

The MSC also agreed proposed amendments to the Guidelines on the Enhanced Programme of Inspections during Surveys of Bulk Carriers and Oil Tankers (Resolution A.744(18)), making the Guidelines more comprehensive. In addition, the amendments add a new section covering Prompt and Thorough Repairs of Bulk Carriers Relative to Damages and Wastage in Cargo Holds. The new section states that any damage or excessive wastage beyond allowable limits "is to be promptly and thoroughly repaired".

The November 1997 SOLAS Conference

The November 1997 Conference adopted a new chapter XII to SOLAS **- Additional Safety Measures for Bulk Carriers**, which entered into force on 1 July 1999.

The new requirements cover survivability and structural requirements to prevent bulk carriers from sinking if water enters the ship for any reason. Existing ships which do not comply with the appropriate requirements will have to be reinforced - or they may have to limit either the loading pattern of the cargoes they carry or move to carrying lighter cargoes, such as grain or timber.

The regulations state that all new bulk carriers 150 metres or more in length (built after 1 July 1999) carrying cargoes with a density of 1,000 kg/m^3 and above should have sufficient strength to withstand flooding of any one cargo hold, taking into account dynamic effects resulting from presence of water in the hold and taking into account recommendations adopted by IMO.

For existing ships (built before 1 July 1999) carrying bulk cargoes with a density of 1,780 kg/m^3 and above, the transverse watertight bulkhead between the two foremost cargo holds and the double bottom of the foremost cargo hold should have sufficient strength to withstand flooding and the related dynamic effects in the foremost cargo hold.

Cargoes with a density of 1,780 kg/m^3 and above include iron ore, pig iron, steel, bauxite and cement. Less dense cargoes, but with a density of more than 1,000 kg/m^3, include grains such as wheat and rice, and timber.

Chapter XII allows surveyors to take into account restrictions on the cargo carried when considering the need for, and the extent of, strengthening of the transverse watertight bulkhead or double bottom. When restrictions on cargoes are imposed, the bulk carrier should be permanently marked with a solid triangle on its side shell.

The date of application of Chapter XII to existing bulk carriers depends on their age. Bulk carriers which are 20 years old and over on 1 July 1999 have to comply by the date of the first intermediate or periodical survey after that date, whichever is sooner. Bulk carriers aged 15-20 years must comply by the first periodical survey after 1 July 1999, but not later than 1 July 2002. Bulk carriers less than 15 years old must comply by the date of the first periodical survey after the ship reaches 15 years of age, but not later than the date on which the ship reaches 17 years of age.

The criteria and formulae used to assess whether a ship currently meets the new requirements, for example in terms of the thickness of the steel used for bulkhead structures, or whether reinforcement is necessary, are laid out in IMO standards adopted by the Conference.

Under the new Chapter XII, surveyors can take into account restrictions on the cargo carried in considering the need for, and the extent of, strengthening of the transverse watertight bulkhead or double bottom.

The SOLAS Conference also adopted a number of Resolutions, including:

- **Recommendation on Compliance with SOLAS Regulation XII/5**. The Resolution refers to the new requirement for bulk carriers built on or after 1 July 1999 and notes Unified Requirements issued by IACS regarding longitudinal strength, evaluation of scantlings and evaluation of allowable hold loading for single side-skin bulk carriers. The Resolution urges Governments to ensure that all bulk carriers of single side-skin construction, whether or not they are classed with classification societies which are members of IACS, to comply with the IACS Unified Requirements.
- Standards for the evaluation of scantlings of the bulkhead between the two foremost cargo holds and standards for the evaluation of allowable hold loading of the foremost cargo hold. The Resolution sets out the standards, which are mandatory under Regulation 6 of the new Chapter XII. The technical standards provide formulae for calculating when steel renewal is necessary on scantlings, and for calculating the allowable hold for a bulk carrier, taking into account loads and the shear capacity of the double bottom.
- **Recommendation on loading instruments**. The Resolution urges Governments to apply IACS Recommendation No. 48 on loading instruments when approving loading instruments as required by Regulation 11 of the new Chapter XII, and to ensure that loading instruments already fitted have been approved in accordance with the standards of recognized organizations.
- **Interpretation of the definition of "bulk carrier" as given in Chapter IX of SOLAS 1974, as amended in 1994.** The Resolution is aimed at clarifying the definition of "bulk

carrier" in Chapter IX of SOLAS, which makes mandatory the application of the International Safety Management (ISM) Code.

- **Enhanced surveys carried out prior to entry into force of the amendments**. The Resolution allows Governments to permit bulk carriers to carry heavy cargoes (with a density above 1,780 kg/m^3) if they have been subject to an enhanced survey in compliance with SOLAS regulation XI/2 before 1 January 1996.
- **Further work on the safety of bulk carriers**. The Resolution calls on the Maritime Safety Committee of IMO, as a matter of urgency, to consider further the safety of bulk carriers not already covered by the new Chapter XII (for example, those under 150 metres in length) and to develop a definition of single side-skin construction for bulk carriers.
- **Implementation of the International Safety Management (ISM) Code**. The Resolution notes that a significant number of shipping companies operating bulk carriers have not yet obtained ISM certification, according to information received by IMO, and urges Governments to redouble efforts to ensure timely and effective implementation of the ISM Code on bulk carriers.

The 20th Assembly

While the SOLAS conference was going on, the IMO Assembly was also considering the questions of bulk carrier safety. It adopted two important resolutions.

- **A.862(20) Code of Practice for the Safe Loading and Unloading of Bulk Carriers**. The Code of Practice, referred to as the BLU code, notes that a number of accidents involving bulk carriers have occurred as a result of inadequate loading and unloading and that safe practices could prevent such accidents in future. The Code contains recommendations to shipowners, masters, shippers, and operators of bulk carriers, charterers and terminal operators for the safe handling, loading and unloading of solid bulk cargoes. It includes a Ship/Shore Safety Checklist to help ship and terminal personnel recognize potential problems by taking both parties step by step through procedures and requirements, from confirming whether the depth of water at the berth is adequate to checking whether the terminal has been advised of the time required for the ship to prepare for sea on completion of cargo work.
- **A.866(20) Guidance to ships' crews and terminal personnel for bulk carrier inspections**. The Resolution highlights the principal areas on bulk carriers that are likely to be susceptible to corrosion or damage, in the form of a simple guide aimed at ships' crew and terminal operators. The Guidance notes that severe structural damage may occur to bulk carriers due to loading/unloading operations, including major damage, which could endanger the ship's safety, or minor cracks which could develop into serious defects prior to the ship's next scheduled Enhanced Survey. The Guidance therefore recommends that terminal operators and members of the ship's crew themselves regularly inspect cargo holds, ballast tanks and hatch covers to detect damage and defects at an early stage.

Beyond the new Chapter XII

The new Chapter XII to SOLAS on the safety of bulk carriers represented the culmination of a lengthy process involving Governments, shipowners and classification societies in looking at all aspects of bulk carriers, from operational issues to their design and structure.

The regulations were based on the premise that all possible aspects should be considered. It is recognized that the cost factor cannot be ignored, but the expense of changes to existing requirements should not be used as a rationale for delaying or not proceeding with the implementation of any necessary measures. Strengthening an existing bulk carrier to comply with the new requirements may cost a shipowner as much as U.S.$300,000. But with a crew of 30 seafarers, this amounts to just $10,000 per potential life saved -- without considering the costs of cargoes and the value of the ship itself.

The Resolutions adopted by the 1997 SOLAS Conference called on the MSC to review the safety of bulk carriers not already covered by the new Chapter XII (for example, those under 150 metres in length), which meant the issue remained on the MSC agenda.

The Derbyshire report

In the meantime, and even before the new chapter XII came into force, the whole issue of bulk carrier safety was again pushed to the forefront of the minds of shipping safety experts - when in May 1998, the United Kingdom delegation to the MSC presented the outcome of a report into the 1980 sinking of the bulk carrier **Derbyshire.**

The **Derbyshire** - a relatively new ship at the time - sank suddenly in a storm in the Pacific, with the loss of all on board. More than a decade later, the wreck was located and a full-scale underwater survey carried out, in an attempt to find the cause of the sinking.

The report on the sinking presented a possible accident scenario and contained a series of important recommendations relating to the design and construction of bulk carriers, in particular relating to the protection of the ship's fore end from green water, reserve buoyancy and the strength of hatch covers.

The MSC agreed to re-establish the Bulk Carrier Working Group (which had developed the regulations in SOLAS chapter XII) to look at these issues as well as those issues outstanding from the 1997 Conference, including the safety of bulk carriers under 150 metres in length, to which the new chapter does not apply and whether the chapter should apply to double skin bulk carriers, as well as those of single skin construction.

In December, 1998 at its 70th session, the Bulk Carrier Working Group reviewed the issues raised in the **Derbyshire** report and the MSC agreed to refer a number of issues to the Sub-Committee on Stability and Load Lines and on Fishing Vessel Safety (SLF), including:

1 strength of hatch covers and coamings;

2 freeboard and bow height;

3 reserve buoyancy at fore end, including forecastles;

4 structural means to reduce loads on hatch covers and forward structure; and

5 fore deck and fore end access.

These issues are being considered in the context of the ongoing review of the 1966 Load Lines Convention. The MSC invited delegations to submit proposals on other specific issues, including dealing with loss of steering ability on a bulk carrier and training and operational matters.

The MSC also invited further submissions on proposals that new bulk carriers should be required to carry a safe haven, which would float free if the ship were to sink, and that existing bulk carriers should be fitted with freefall lifeboats.

Meanwhile, the MSC agreed various interpretations and clarifications requested by the 1997 SOLAS Conference and adopted them by an MSC Resolution. These include the identification of bulk carriers for port State control purposes, the definition of bulk carrier in SOLAS Chapter IX and the application of SOLAS regulations XII/9 on Requirements for bulk carriers not being capable of complying with regulation 4.2 due to the design configuration of their cargo holds and XII/10 on Solid bulk cargo density declaration.

Formal Safety Assessment

The MSC also agreed with a United Kingdom proposal to carry out a formal safety assessment (FSA) study of bulk carriers, to aid future IMO decision-making on bulk carrier safety.

FSA is a process for assessing the risks associated with any sphere of activity, and for evaluating the costs and benefits of different options for reducing those risks. It therefore enables, in its potential application to the rule making process, an objective assessment to be made of the need for, and content of, safety regulations.

The FSA study, scheduled to be completed over a two year period by a number of IMO Member States in collaboration with observer organizations is looking at a range of measures to improve bulk carrier safety, including problem areas referred to the MSC by the SOLAS Conference of November 1997, which adopted the new Chapter XII to SOLAS on bulk carrier safety.

The FSA study is also likely to look at whether chapter XII should apply to bulk carriers under 150 metres in length and to double skin bulk carriers, as well as those of single skin construction. The study may also look at the benefits of specific safety measures, such as the need for a device to detect water ingress into cargo holds of existing bulk carriers which would assist in warning the crew of situations where one or more holds were in the process of flooding and the possible need for crew access to the foredeck in heavy weather.

FSA consists of five steps: identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes); assessment of risks (evaluation of risk factors); risk control options (devising regulatory measures to control and reduce the identified risks); cost benefit assessment (determining cost effectiveness of each risk control option); and recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control options is provided).

STCW amendments

At the same session in December 1998, the MSC adopted amendments to the Seafarers' Training, Certification and Watchkeeping (STCW) Code, aimed at improving minimum standards of competence of crews, in particular relating to cargo securing, loading and unloading on bulk carriers, since these procedures have the potential to put undue stresses on the ship's structure. The amendments, due to enter into force on 1 January 2003, concern section A-II/1 and A-II/2 under "Cargo handling and stowage at the operational and management levels".

SLF Sub-Committee

The Sub-Committee on Stability and Load Lines and on Fishing Vessels Safety (SLF) met for its 42nd session in February 1999 and reviewed the bulk carrier safety issues referred to it by the MSC.

The Sub-Committee agreed that it has been clearly demonstrated that 1966 Load Line Convention standards may be inadequate with respect to wave loads and permissible strength of hatch covers for bulk carriers and other ships types. The technical annexes of the 1966 LL Convention are currently being completely revised to bring them up to date.

The Sub-Committee agreed to closely look at the regulations concerning bulk carriers with a view to revising them where necessary and taking into account the work of the MSC Working Group on Bulk Carrier Safety. The Sub-Committee is scheduled to meet for its next session in September 2000.

MSC continues work

The MSC's Working Group on Bulk Carrier Safety, during the 71st session of the MSC in May 1999, reviewed various submissions relating to bulk carrier safety and agreed the SLF Sub-Committee should continue its work on reviewing the Load Lines Convention in relation to bulk carriers.

The Committee also agreed a basic framework for carrying out the formal safety assessment (FSA) study of bulk carriers, which is expected to take two years (to the year 2001).

The framework sets out the project objectives, namely:

1 to inform IMO's future decision-making regarding measures to improve the safety of bulk carriers;

2 to apply FSA methodology to the safety of dry bulk shipping; and

3 to secure international collaboration and agreement.

Scope and application of FSA study

The framework for the FSA study of bulk carriers states the study should apply to bulk carriers as defined in SOLAS Conference resolution 6 of November 1997, i.e."ships constructed with single deck, top-side tanks and hopper side tanks in cargo spaces and intended primarily to carry dry cargo in bulk; or ore carriers (as defined) or combination carriers (as defined)", as well as to other types of ships carrying solid bulk cargoes heavy break bulk cargoes, but not to other cargoes such as containerised or bagged cargoes .

The types of operations to be considered should cover the complete dry bulk shipping route from loading to discharge terminal (including life-saving appliances, ballast water exchange at sea and main machinery configuration), i.e.:

1 loaded passage;

2 ballast passage;

3 loading cargo;

4 discharging cargo;

5 lay up (and re-commissioning); and

6 maintenance and inspection.

The framework also the study should start by considering, at the outset, the widest range of accident categories and that it should be recognized in the study that accidents are categorised by their initiating events, but that techniques such as consequence analyses would reveal the possible outcomes.

Accidents resulting in single, or very few, deaths and those resulting in multiple deaths or the loss of the entire crew should be distinguished as a measure of the severity of an accident.

The study is to be carried out on an international collaborative basis, involving Administrations and non-governmental organizations interested in bulk carrier safety, co-ordinated by the United Kingdom.

An International Project Steering Board, comprising the organizations contributing to the study, will actively review the results of the work, and agree parameters such as measures of risk or basis of cost benefit assessments.

IACS Hazard Identification study

The Committee also referred to the FSA study group information provided by the International Association of Classification Societies (IACS) on a Hazard Identification study on the watertight integrity of the fore end of bulk carriers.

The study identified 51 hazards relating to the technical system, onboard operations, shore side operations during loading /unloading, and the management. Ten of these hazards are judged to represent an unacceptable level of risk and IACS notes they merit a more detailed assessment to determine the exact nature of the problem. These ten hazards are as follows:

IACS Hazard Identification study on the watertight integrity of the fore end of bulk carriers - Risks associated with these hazards are considered unacceptable

- Mechanical damage to cargo hold and ballast space structure during loading and unloading. **Effect:** More rapid corrosion (wastage).
- Chemical damage due to corrosive cargo and ballast sea water.

  Effect: More rapid corrosion (wastage).
- Failure of or poor maintenance planning or organisation.

  Effect: Maintenance periods not planned properly. Lack of resources for maintenance including manpower and specialist services.
- Failure to monitor maintenance performance.

  Effect: Undetected poor maintenance.
- Port authority does not follow loading plan. Inadequate control during cargo loading or discharge. Failure to prepare or prepare poor loading plan.

  Effects: Vessel exposed to beyond design criteria static loads. Excessive shear forces and/or bending moments.
- Failure to operate ship within design criteria.

  Effects: Vessel exposed to stress beyond design criteria. Structural failure of hull, hatch coamings and covers, fatigue damage.
- Excessive dynamic global loads during ballast voyage.

  Effects: Slamming damage to foreship bottom structure. Structural failure of hull; fatigue damage.
- Mechanical damage of hold bottom, side structure, transverse bulkheads, hatch corners and coamings during loading and unloading.

  Effects: Local structural damage, Hatch covers may not close properly.
- Closing devices and structural components of access hatches and doors not properly maintained during loaded and ballast voyage.

  Effect: Potential for ingress of water.
- Damage during loaded and ballast voyage to pipes and closures above deck serving stores. **Effects:** Water ingress to stores. Potential of failure of equipment and machinery located in these spaces.

Issues resolved at MSC 71 (May 1999)

The Committee agreed the following:

- MSC Resolution **on Interpretation of the provisions of SOLAS Chapter XII on additional safety measures for bulk carriers** which includes guidance on application of and interpretation of the chapter to certain bulk carriers, including "Interpretation of the term "bulk carrier of single side skin construction" and Interpretation of the requirement for certain bulk carriers to be permanently marked on the side shell with a triangle.
- MSC Circular **on Uniform method of measurement of the density of bulk cargoes**, including a performance specification for the measurement of the density of such cargoes.

Future work

The entry into force on 1 July 1999 of the new Chapter XII to SOLAS on Additional Safety Measures for Bulk Carriers was a significant step in improving bulk carrier safety and was the culmination of a lengthy process involving Governments, shipowners and classification societies in looking at all aspects of bulk carriers, from operational issues to their design and structure.

However, as has been seen, this is not the end of the story. The report on the sinking of the **Derbyshire** raised further issues to be reconsidered, while the general review of the 1966 Load Lines Convention was inevitably going to mean a review of specific safety features of bulk carriers in relation to their design.

IMO does not seek to amend regulations or create new ones excessively – but where there is a need for new regulations, this must be done.

The ongoing FSA study on bulk carriers will go some way to helping IMO in the process of deciding which regulations – or amendments - will be appropriate. Indeed, this is part of IMO policy to move to a more pro-active approach. Instead of solely responding to disasters we should try to prevent them from happening in the first place, by using statistical analysis to identify potential problems and ensuring that new measures are safe. The Bulk Carrier Working Group will use the results of the FSA study to help analyse the likelihood of disasters such as the **Derbyshire** repeating themselves, and the measures needed to prevent any reoccurrence.

The work on bulk carrier safety is also being carried out against the broader context of IMO's moves to improve implementation of existing IMO instruments and in reducing human error – still seen as the cause of most accidents at sea.

Studies show that people make mistakes because of many different factors and although seafarers are often the chief victims of maritime accidents, the mistakes that lead to them are often made on shore. That was one reason why IMO adopted the International Safety Management Code, which became mandatory for bulk carriers and certain other ships in 1998 and will be extended to remaining categories of ships in 2002.

Full implementation of the 1995 amendments to the STCW Convention will also be equally important for bulk carriers as for other ships.

It is likely we will see amendments to SOLAS chapter XII once the Bulk carrier Working Group completes its work over the next two or three years. It will then be down to Administrations, port States, flag States, shipowners and seafarers to ensure they are implemented – and to reduce the number of accidents involving bulk carriers.