

ANNEX 3 Historical Data Analysis

1 Scope of Historical Data Analysis

The scope of the study is to deal with safety bulk carriers. Its scope should be as wide as possible because FSA is a holistic approach in nature but it should be limited in order to pursue efficiency of the study. Therefore, accidents particular to bulk carriers should be considered. So accidents of bulk carriers have been classified into two categories:

- a) Casualties to be dealt with, because there are particular to bulk carriers, and
- b) Casualties not to be dealt with, because there are not particular to bulk carriers.

Table 1.1 shows the results of categorization.

Table 1.1 Categorization of Casualties

a) Casualties to be dealt with in this study	b) Casualties not to be dealt with in this study
<ul style="list-style-type: none"> • Fire and explosion in cargo hold and fore end spaces • Flooded • List and capsize • Founder • Damage and breakdown of construction and facilities in cargo holds and fore end spaces 	<ul style="list-style-type: none"> • Personnel accident • Fire and explosion in machinery and accommodation spaces • Collision and contact • Ground and strand

2. High Level Historical Data Investigation

At first, number of casualties on bulk carriers is analyzed from LMIS casualty database (1975-1996) by National Maritime Research Institute of Japan. The results are summarized in Table 2.1, Table 2.2, Table 2.3 and Table 2.4.

Table 2.1 Casualty statistics of ships other than passenger ships

Category	Number of casualties		Number of loss and/or missing lives	
	Number	(%)	Number	No. per casualty
Casualties on ships other than passenger ships or bulk carriers	19483	100.0	10321	0.53
Casualties which first event was structural failure	3272	16.8	437	0.13
Casualties which first event was structural failure with loss and/or missing life	56	0.29	437	7.8
Casualties which first event was structural failure (crack) with loss and/or missing life	5	0.026	104	20.8
Casualties which first event was structural failure in rough sea with loss and/or missing life	6	0.031	11	1.83

Table 2.2 Casualty statistics of bulk carriers

Category	Number of casualties		Number of loss and/or missing lives	
	Number	(%)	Number	No. per casualty
Casualties on bulk carriers	2916	100.0	1890	0.65
Casualties which first event was structural failure	566	19.4	313	0.55
Casualties which first event was structural failure with loss and/or missing life	17	0.58	313	18.4
Casualties which first event was structural failure (crack) with loss and/or missing life	7	0.24	183	26.1
Casualties which first event was structural failure in rough sea with loss and/or missing life	3	1.03	36	12.0

Table 2.3 Casualties on bulk carriers of which first event was structural failure with loss and/or missing life

Number of casualty	Lost and missing lives	1st event	2nd event
6	156	Cracked (85)	Foundered (includes sank) (12)
3	65	Damaged (86)	Foundered (includes sank) (12)
2	23	Broke in two/three (82)	Foundered (includes sank) (12)
1	1	Damage-heavy weather (87)	
1	27	Cracked (85)	Missing (20)
1	5	Broke (81)	Broke in two/three (82)
1	33	Damage-heavy weather (87)	Presumed to have foundered (13)
1	2	Damage-heavy weather (87)	Flooded (03)
1	1	Broke (81)	Collision (40)
Total 17	Total 313	NOTE: No. in parenthesis is ID number of the event.	

Table 2.4 Casualties on bulk carriers with loss and/or missing life

Number of casualty	Lost and missing lives	1st event	2nd event
15	27	Explosion (30)	Fire (31)
14	266	Foundered (includes sank) (12)	
14	29	Fire (31)	
10	106	Collision (40)	Foundered (includes sank)(12)
9	246	Missing (20)	
6	156	Cracked (85)	Foundered (includes sank)(12)
6	90	Took water (27)	Foundered (includes sank)(12)
6	21	Explosion (30)	
6	16	Fire (31)	Fire (31)
5	28	Listed (97)	Foundered (includes sank)(12)
4	103	Overdue/reported missing (21)	

4	11	Capsized (11)	
4	6	Struck by projectile (70)	Fire (31)
3	65	Damaged (86)	Foundered (includes sank)(12)
3	5	Fire (31)	Explosion (30)
2	59	Presumed to have foundered (13)	
2	44	Capsized (11)	Foundered (includes sank)(12)
2	30	Trouble/difficulty (95)	Foundered (includes sank)(12)
2	25	94shifted	Foundered (includes sank)(12)
2	23	Broke in two/three (82)	Foundered (includes sank)(12)
2	2	Struck by projectile (70)	
1	69	Gave way (05)	Presumed to have foundered (13)
1	44	Unknown (99)	
1	40	Explosion (30)	Foundered (includes sank)(12)
1	33	Defect (89)	Foundered (includes sank)(12)
1	33	Damage-heavy weather (87)	Presumed to have foundered (13)
1	32	Took water (27)	Missing (20)
1	27	Cracked (85)	20missing
1	27	Lost (item) (08)	Foundered (includes sank)(12)
1	26	Sprang leak(s) (26)	Presumed to have foundered (13)
1	25	Failure (02)	Stranded (wrecked)(includes grounded) (61)
1	24	Lost (item) (08)	Broke (81)
1	24	Flooded (03)	Presumed to have foundered (13)
1	23	Collision (40)	Fire (31)
1	17	Failure (02)	Foundered (includes sank)(12)
1	10	Spark (gas cutting) (33)	Fire (31)
1	9	Struck by projectile (70)	Stranded (wrecked)(includes grounded) (61)
1	8	Wedged under (63)	
1	7	Contact-struck by (51)	
1	5	Fire (31)	Listed (97)
1	5	Broke (81)	Broke in two/three (82)
1	5	Struck by projectile (70)	Flooded (03)
1	5	Explosion (30)	Part submerged (15)
1	4	Spark (electric) (32)	Fire (31)
1	3	Took water □27□	Presumed to have foundered (13)
1	3	Struck by projectile (70)	Beached (deliberately) (60)
1	3	Struck by projectile (70)	Foundered (includes sank)(12)
1	3	Shifted (94)	Capsized (11)
1	3	Contact/struck (50)	Capsized (11)
1	3	Collision (40)	Capsized (11)
1	2	Fire (31)	Break down (80)
1	2	Damage-heavy weather (87)	Flooded (03)
1	1	Touched bottom (64)	Foundered (includes sank)(12)
1	1	Fire (31)	Beached (deliberately) (60)
1	1	Damage-heavy weather (87)	

1	1	Overflowed (93)	Explosion (30)
1	1	Collision (40)	
1	1	Broke (81)	Collision (40)
1	1	Collision (40)	Failure (02)
1	1	Trouble/difficulty (95)	
Total 160	Total 1890	NOTE: No. in parenthesis is ID number of the event.	

At the same time, Nippon Kaiji Kyokai known as ClassNK investigated on bulk carrier casualties during the period from 1990 to 1997 referring published news sources such as Lloyd's List. The list of casualties is attached as Table 1 in Appendix I.

According to these results and discussion among the research committee (RR74BC-SWG), two main key words, i.e., 'structural failure' and 'flooding', was obtained as main contributors to bulk carrier casualties resulting in total loss with fatalities.

275 casualties on bulk carriers, causes of which were structural failure or water ingress, were picked up from LMIS Casualty database in a period from 1979 to July 1997. Then, those data were classified in terms of number of fatalities, size of bulk carriers, etc. Unclear or unknown parts of casualty data were filled by expert judgment. FN curve of casualties on bulk carriers were derived and shown in Figure-2.

The casualty data were further classified by location of structural failure, i.e., part (forecastle(F), No.1, No.2 and other cargo hold(H1, H2 and Ht), engine room part(E) and aft-end part(A), etc.), sub-part (double bottom(DB), double side space(DS), bilge hopper tank(BHT), topside tank(TT), cargo hold(CH), for-peak tank(FPT), etc.) and detail of structure (side shell panel(SSP), bottom shell panel(BSP), floor(FLR), girder(G), slopping plate(SP), hatch cover(HC), transverse bulkhead(TBHD) inner bottom plate(IBP), etc.). Top-ten of structural failure identified in casualty data is shown in Table-3 ("U" means unknown).

Table-3 Detail of location of structural failure

Number of cases	Initial Part	Initial Sub Part	Initial Detail
33	U	U	U
23	Ht	CH	SSP
11	H1	CH	SSP
10	Ht	U	U
6	F	FPT	SSP
5	U	U	SSP
5	H1	U	U
4	Ht	CH	U
4	H1	CH	HC
4	Ht	DB	IBP

3. Detailed Investigation on Historical Data

3.1 Method of Historical Data Analysis

In relation with the accident scenarios concerned, the following 5 accident categories in the LMIS casualty database (August 2000 version) were selected as the data source for investigation:

- ✓ Foundered;
- ✓ Missing;
- ✓ Miscellaneous;
- ✓ Hull/machinery_structural;
- and
- ✓ Hull/machinery_unknown.

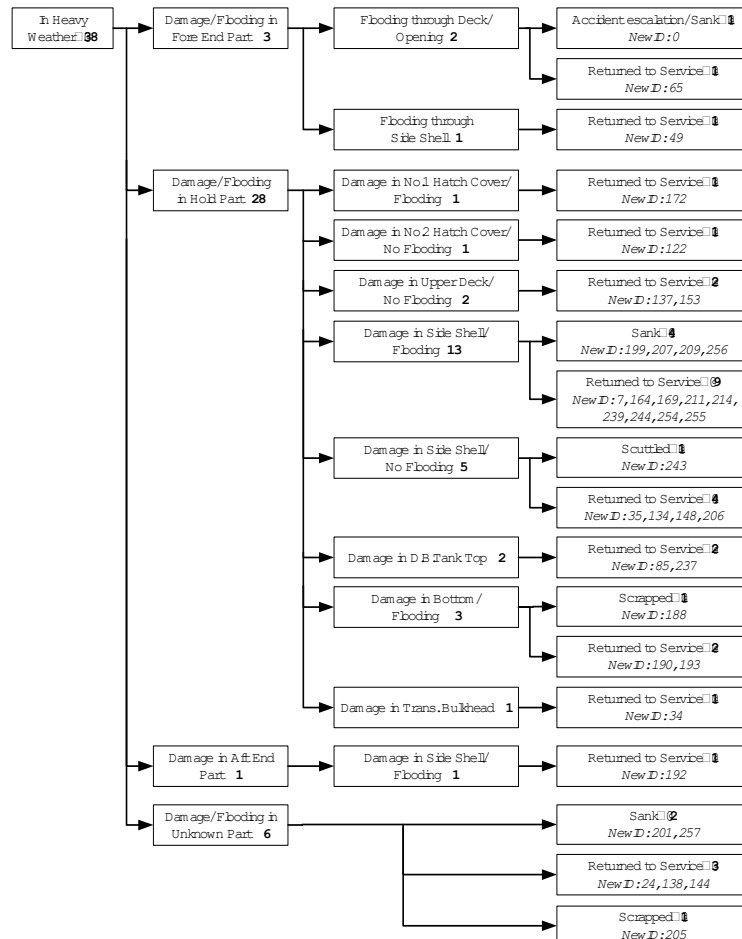
All the casualty records in these categories were carefully examined one by one whether they should be included into the basic data source of this study. As a result, while total 360 casualty data were chosen from the historical data from 1978 to 2000/8 for this investigation, other casualty data such as collision, fire & explosion, etc were excluded from the study, as they were not considered such accidents as specifically related to bulk carriers. During the investigation, other data sources such as internal class survey reports and databases of Nippon Kaiji Kyokai (ClassNK) were also referred on necessity.

3.2 Overview of Casualty Data

Detailed investigation on historical data has been carried out using the August 2000 version of LMIS casualty database. It was found that 2067 of lives were lost during the period from 1978 to August 2000 by casualties of typical bulk carriers whose deadweight is not less than 10,000 DWT by any causes.

According to high level historical data investigation, structural failure and flooding were focused. Accidents under consideration are segmented into the following 4 accident scenario groups:

- ✓ Scenario-1: Progressive flooding after the following initial failures/flooding;
 - Scenario-1-1: Flooding due to structural failure such as side shell failure;
 - Scenario-1-2: Flooding into Fore Peak from failure of deck fittings; (and)
 - Scenario-1-3: Flooding due to hatch cover failure or its securing failure
- ✓ Scenario-2: Structural failure without water ingress in heavy weather;
- ✓ Scenario-3: Structural failure during loading operation; and
- ✓ Scenario-4: Accident due to cargo shift at sea.



It was found that 1,126 of lives were lost since 1978 to August 2000, on the analysis of historical casualty data. The itemization of these fatalities by accident scenario or scenario groups is shown in Figure 3.1. It accounts for about 54% of 2067 fatalities by any causes.

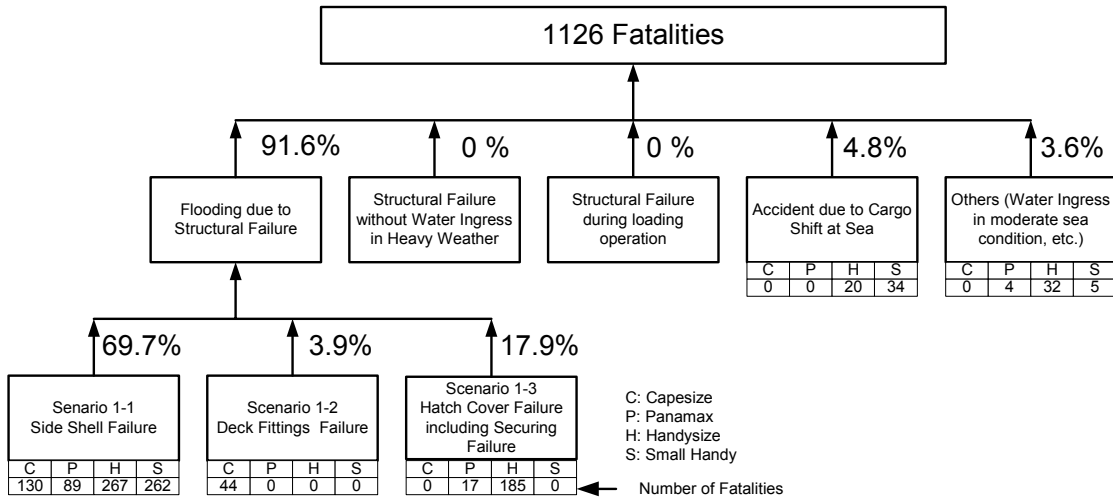


Figure 3.1 Itemization of Fatalities by casualty scenario or scenario groups

This figure shows that the accident scenario group No.1 is most significant, in case of considering the fatalities on the bulk carrier casualties related to structural failure and flooding. As the result of the analysis, 208 casualties are categorized into scenario 1-1 and about half of them (95 casualties) are resulted in total loss. This consequence corresponds to many fatalities. Although there are 9 cases that could be identified as casualties caused by deck fittings failure, the one resulted in total loss is only one case. There are 20 casualties caused by the damage of the hatch cover including securing devices, and 8 cases of them are resulted in total loss.

3.2 Population of typical bulk carriers

In analyzing the historical casualty data, they were grouped into 4 groups by their sizes: i.e. *Cape-size* bulk carrier, *Panamax* bulk carrier, *Handy-size* bulk carrier and *Small-handy* bulk carrier. In order to determine the generic size used in the analysis, these bulk carrier groups are classified as shown in Table 3.1. Table 3.2 shows the bulk carrier fleet of not less than 20,000 dwt in ship-year. As the existing bulk carrier fleets at August 2000 are 4,354 for 20,000 dwt+ and 4,842 for 10,000 dwt+, the bulk carrier fleet (BCF) in ship-year not less than 10,000 dwt 1978/1-2000/8 is estimated as follows;

$$BCF_{10,000+} = BCF_{20,000+} \times \frac{BCF(at2000)_{10,000+}}{BCF(at2000)_{20,000+}} = 80,816 \times \frac{4,842}{4,354} \approx 89,900 \text{ ship-year}$$

On the other hand, the bulk carrier fleet of each group at August 2000 is summarized in Table 3.3 and the historical change of bulk carrier fleet profile since 1970 (according to Fearnley’s “the World Bulk Fleet”) is shown in Figure 1.1.

Equations of fitting curve of fleet ratio of each dwt range in Figure 3.2 are obtained as shown in Table 3.4.

Table 3.1 Classification of bulk carrier in size

	Lf (m)	GT	Dwt (ton)	(Ref. Dwt*)
(Mini)	100~130	5,000~14,000	10,000~23,000	10,000~35,000
Small-handy	130~150			
Handy-size	150~200	14,000~30,000	23,000~55,000	35,000~50,000
Panamax	200~230	30,000~45,000	55,000~80,000	50,000~80,000
Cape-size	230~270	45,000+	80,000+	80,000+
(Very large)	270+			

Note: The figures in the column of (Ref. Dwt*) are cited from the report of "Bulk Carrier Report, An analysis of vessel losses and fatalities statistics for 1999 and ten years of losses 1990-1999" by INTERCARGO for the reference purpose.

Table 3.2 Bulk carrier fleet of 20,000 dwt+ 1978/1-2000/8 (ship-year)

Year	Ship-year	Year	Ship-year	Year	Ship-year	Year	Ship-year
*1978	2,500	1984	3,547	1990	3,618	1996	4,186
*1979	2,500	1985	3,743	1991	3,650	*1997	4,200
1980	2,705	1986	3,743	1992	3,685	*1998	4,200
1981	2,875	1987	3,556	1993	3,730	*1999	4,300
1982	3,092	1988	3,454	1994	3,853	*2000	2,900
1983	3,251	1989	3,521	1995	4,007	Total	80,816

Data source: Lloyd's statistics

*marked : assumed

Table 3.3 Bulk carrier fleet at August 2000

Type of bulk carrier	Fleet Aug.2000	Ratio
Small-handy	703	14.5%
Handy-size	2,599	53.7%
Panamax	966	19.9%
Cape-size	574	11.9%
Total	4,842	100%

Data source: Lloyd's statistics

Therefore, using the following formulas in Table 3.5, annual fleet profile of bulk carriers as shown in Table 3.6 is assumed in order to use as basic data in the analysis hereinafter.

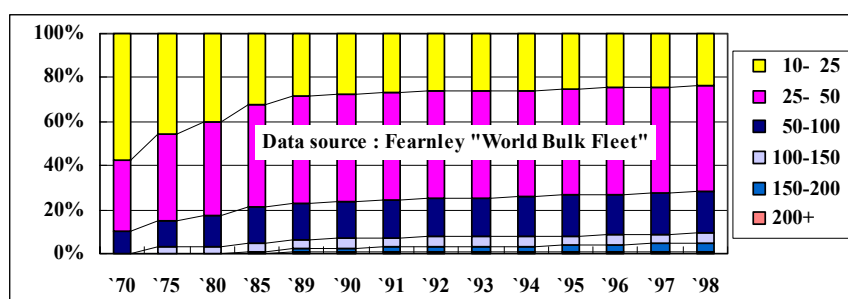


Figure 3.2 Historical change of bulk carrier fleet profile

Table 3.4 Equation of fitting curve of fleet ratio

Description	Dwt range	Expression of fitting equation (%)
<i>BCF</i> _{100K+} Fearnley	>100,000	$3.039 * 10^{-3} * y - 0.20605$
<i>BCF</i> _{50K-100K} Fearnley	50,000~100,000	$2.981 * 10^{-3} * y - 0.10037$
<i>BCF</i> _{25K-50K} Fearnley	25,000~50,000	$2.786 * 10^{-6} * y^3 - 9.891 * 10^{-4} * y^2 + 0.1124 * y - 3.652$
<i>BCF</i> _{10K-25K+} Fearnley	10,000~25,000	$-4.565 * 10^{-6} * y^3 + 1.493 * 10^{-3} * y^2 + 0.1653 * y - 6.387$

Note: here, $y = \text{year} - 1900$

Table 3.5 Assumed formula of fleet profile of bulk carriers

	Dwt range	Description	Expression of assumed formula (%)
<i>Cape-size</i>	>80,000	BCF_{80K+}	$BCF_{100K+ \text{ Fearnley}} + (BCF_{80K+/at2000} - BCF_{100K+ \text{ Fearnley}/at2000})$
<i>Panamax</i>	55,000~80,000	$BCF_{55K-80K}$	$BCF_{50K-100K \text{ Fearnley}} + (BCF_{55K-80K/at2000} - BCF_{50K-100K \text{ Fearnley}/at2000})$
<i>Handy-size</i>	23,000~55,000	$BCF_{23K-55K}$	$BCF_{25K-50K \text{ Fearnley}} + (BCF_{23K-55K/at2000} - BCF_{25K-50K \text{ Fearnley}/at2000})$
<i>Small-handy</i>	10,000~23,000	$BCF_{10K-23K}$	$100 - (BCF_{23K-55K} + BCF_{55K-80K} + BCF_{80K+})$

Table 3.6 Annual fleet profile of bulk carriers by ship type

Year	Annual fleet profile (%)					Annual fleet profile (ship-year)				
	Cape-size	Pana-max	Handy-size	Small-handy	Total	Cape-size	Pana-max	Handy-size	Small-handy	Total
1978	5.2%	13.3%	47.4%	34.0%	100.0%	145	371	1,318	946	2,780
1979	5.5%	13.6%	48.3%	32.6%	100.0%	154	379	1,342	906	2,781
1980	5.8%	13.9%	49.1%	31.2%	100.0%	175	419	1,476	938	3,008
1981	6.1%	14.2%	49.8%	29.9%	100.0%	196	455	1,592	954	3,197
1982	6.4%	14.5%	50.5%	28.6%	100.0%	221	500	1,735	983	3,439
1983	6.7%	14.8%	51.1%	27.4%	100.0%	244	536	1,846	990	3,616
1984	7.0%	15.1%	51.6%	26.2%	100.0%	278	597	2,036	1,035	3,946
1985	7.3%	15.4%	52.1%	25.1%	100.0%	306	642	2,169	1,046	4,163
1986	7.6%	15.7%	52.5%	24.1%	100.0%	318	654	2,187	1,003	4,162
1987	8.0%	16.0%	52.9%	23.1%	100.0%	315	634	2,093	914	3,956
1988	8.3%	16.3%	53.2%	22.2%	100.0%	317	627	2,045	852	3,841
1989	8.6%	16.6%	53.5%	21.3%	100.0%	335	651	2,096	834	3,916
1990	8.9%	16.9%	53.7%	20.5%	100.0%	357	681	2,163	824	4,025
1991	9.2%	17.2%	53.9%	19.7%	100.0%	372	699	2,189	799	4,059
1992	9.5%	17.5%	54.1%	19.0%	100.0%	388	718	2,216	777	4,099
1993	9.8%	17.8%	54.2%	18.3%	100.0%	406	739	2,246	757	4,148
1994	10.1%	18.1%	54.2%	17.6%	100.0%	432	776	2,323	754	4,285
1995	10.4%	18.4%	54.2%	17.0%	100.0%	463	820	2,416	757	4,456
1996	10.7%	18.7%	54.2%	16.4%	100.0%	498	871	2,522	765	4,656
1997	11.0%	19.0%	54.1%	15.9%	100.0%	513	888	2,528	742	4,671
1998	11.3%	19.3%	54.0%	15.4%	100.0%	528	901	2,523	719	4,671
1999	11.6%	19.6%	53.9%	14.9%	100.0%	555	937	2,576	714	4,782
2000	11.9%	19.9%	53.7%	14.5%	100.0%	384	642	1,732	468	3,226
Grand total	8.8%	16.8%	52.7%	21.7%	-	7,900	15,137	47,369	19,477	89,883

3.3 Breakdown of Casualties by their Causes and Consequences of Accident

Table 3.7 shows the results of the investigation on location of water ingress, severity of accident and fatality in these 360 casualties. The results were derived from not only LMIS database but also other data sources and results of expert judgment.

In Table 3.7, the following markings are made on each casualty IDs in order that anybody can easily identify and trace these casualty data, as necessity:

- Bold letter represents serious casualties such as total loss cases and fatal cases;
- Total loss cases are represented by under line; and
- Fatal cases are represented with *Italic letter with shadow*.

Table 3.7 Breakdown of casualties segmented in accident scenario 1-1

Location of water ingress	Total loss			Casualty excluding total loss			Casualty including total loss			Casualty ID (see Tables in Appendix 6.1)				
	Number of casualty	Number of fatal case	Number of fatality	Number of casualty	Number of fatal case	Number of fatality	Number of casualty	Number of fatal case	Number of fatality	Cape-size	Panamax	Handy-size	Small-handly	
No.1 cargo hold	No.1	10	7	149	20	1	3	30	8	152	1, 10, 13, <u>16</u>	<u>24, 26, 34, 35</u>	48, 49, 50, 54, 55, 56, 71, 77, <u>82</u> , 83, 86, <u>97</u> , 111, 115, O19	<u>122, 126</u> , 132, <u>134</u> , 135, <u>136</u> , 145
	Nos.1 & 2	9	1	20	2	0	0	11	1	20	2	<u>27, 31, 38</u>	<u>52, 63, 89, 116, 117</u>	<u>95</u> , 130
	Nos.1 & 7	0	0	0	1	0	0	1	0	0			81	
	Nos.1, 2 & 3	2	2	30	1	0	0	3	2	30	5		100	<u>98</u>
	Nos.1, 2, 3 & 8	1	0	0	0	0	0	1	0	0	9			
	Nos.1-6	1	0	0	0	0	0	1	0	0		<u>33</u>		
Total	23	10	199	24	1	3	47	11	202					
No.2	No.2	5	0	0	9	0	0	14	0	0	<u>84</u>	23	47, <u>51, 59</u> , 75, 78, 80, 118	96, 120, <u>127</u> , <u>131</u> , 150
	Nos.2 & 3	1	0	0	1	0	0	2	0	0	12	<u>25</u>		
	Nos.2 & 4	1	1	33	0	0	0	1	1	33	<u>22</u>			
	Nos.2, 3 & 6	0	0	0	1	0	0	1	0	0			62	
Total	7	1	33	11	0	0	18	1	33					
Other cargo holds	No.3	5	0	0	4	1	1	9	1	1	<u>14, 21</u>	36	79, <u>104</u>	<u>119</u> , 129, <u>143</u> , <u>149</u>
	No.4	4	1	18	5	0	0	7	1	18	<u>108</u>	<u>37, 39, 110</u>	H5	141, <u>146</u>
	No.5	4	2	67	7	0	0	11	2	67	7, 15, 103		42, <u>43, 61, 76, 85, 92</u>	128, 142
	No.6	0	0	0	2	0	0	2	0	0		41	114	
	No.7	1	0	0	4	0	0	5	0	0	4	30	<u>46, 67, 68</u>	
	No.8	0	0	0	3	0	0	3	0	0	8, 18		44	
	Nos.3 & 4	0	0	0	1	0	0	1	0	0				AS03
	Nos.4 & 5	2	0	0	0	0	0	2	0	0			<u>87</u>	<u>144</u>
	Nos.4 & 7	0	0	0	1	0	0	1	0	0			53	
	Nos.5 & 6	1	0	0	0	0	0	1	0	0			<u>73</u>	
	Nos.3, 4 & 5	1	1	3	0	0	0	1	1	3			<u>58</u>	
	Nos.4, 5 & 6	1	0	0	0	0	0	1	0	0				<u>133</u>
	Nos.5, 6 & 7	1	0	0	0	0	0	1	0	0		<u>28</u>		
Nos.3, 5, 6 & 7	0	0	0	0	0	0	0	0	0					
Total	20	4	88	25	1	1	45	5	89					
Total known holds	50	15	320	60	2	4	110	17	324					
Unknown cargo holds	27	16	367	9	0	0	36	16	367	<u>3, 6, 11, 17, 19, 20</u>	<u>29, 32, 40, 109</u>	45, 57, <u>60, 64, 65, 66, 70, 72, 88, 90, 91, 101, 102, 105, 106, 112, 113, 121, 125</u>	<u>93, 123, 124, 137, 140, 147, 148</u>	
Total cargo holds	77	31	687	69	2	4	146	33	691					
Other spaces	Fore end	4	3	37	6	0	0	10	3	37		O12, O14	O28, O29, <u>O33</u> , O34, O40, <u>O59</u>	<u>O53, O56</u>
	Engine room	7	0	0	17	0	0	24	0	0	O1, <u>O4</u>	O7, O8, O10, O11, O13	O17, O18, O20, O21, O22, <u>O27</u> , O32, O37, O38, <u>O39, O42, O50</u> , O52, O58	O45, <u>O55, O57</u>
	Pump room	0	0	0	2	0	0	2	0	0	O3, O5			
	Aft peak	0	0	0	2	0	0	2	0	0			O43	O47
	Fuel oil tanks	0	0	0	2	0	0	2	0	0		O9	O24	
	Ballast tanks	1	0	0	15	0	0	16	0	0	O2, O6, O51		O16, O25, O26, O30, O31, O35, O36, O41, O48, O49	O44, O46, <u>O54</u>
Total	12	3	37	44	0	0	56	3	37					
Presumed water ingress (detail unknown)	6	3	57	0	0	0	6	3	57			<u>74</u>	<u>94, 99, 107, 138, 139</u>	
Grand Total	95	37	781	113	2	4	208	39	785					

Table 3.8 Breakdown of casualties by their causes and consequences of accident (BC 10,000 dwt+)

Table 3.8 Breakdown of casualties segmented in accident scenario 1-2, 1-3, 2, 3 and others													
Location of water ingress	Total loss			Casualty excluding total loss			Casualty including total loss			Casualty ID (see Tables in Appendix 6.1)			
	Number of casualty	Number of fatal case	Number of fatality	Number of casualty	Number of fatal case	Number of fatality	Number of casualty	Number of fatal case	Number of fatality	Cape-size	Panamax	Handy-size	Small-handly
<i>Flooding into Fore Peak due to failure of deck fittings, etc</i>	1	1	44	8	0	0	9	1	44	<u>H21</u>	H22, H23	H15, H24, H25, H26, O23	H27
<i>Water ingress due to hatch cover failure</i>	2	0	0	7	1	2	9	1	2	H1, H2, H29		H6, <u>H7</u> , <u>H12</u> , <u>H14</u> , 69	H28
<i>Water ingress due to hatch cover securing failure</i>	6	6	200	5	0	0	11	6	200	H3	<u>H4</u>	<u>H8</u> , <u>H9</u> , <u>H10</u> , H11, H13, H16, H17, <u>H18</u> , <u>H19</u>	
<i>Grand Total for Scenario-1</i>	104	44	1,025	133	3	6	237	47	1,031				
<i>Structural failure without water ingress in heavy weather</i>	3	0	0	49	0	0	52	0	0	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, <u>S12</u> , S13, <u>S14</u> , S15, S16, S17, S18, S19, S20	S21, S22, S23, S24, S25, S26, S27, S28	S29, S30, S31, S32, S33, S34, S35, S36, S37, S38, S39, S40, S41, S42, S43, S44, S52	S45, S46, S47, <u>S48</u> , S49, S50, S51
<i>Structural failure during loading operation</i>	3	0	0	9	0	0	12	0	0	E3, <u>E4</u>	<u>E10</u> , E47	E24, E25, E29, E30, E48	E37, E42, <u>E45</u>
<i>Accident due to cargo shift at sea</i>	7	3	54	12	0	0	19	3	54			F1, <u>F2</u> , <u>F3</u> , F4, F5, F6, F14, F15	F7, <u>F8</u> , <u>F9</u> , <u>F10</u> , <u>F11</u> , F12, <u>F13</u> , F16, F17, AS01, AS02
<i>Water ingress in moderate sea condition or through piping; then, excluded from the study</i>	8	3	41	32	0	0	40	3	41	E1, E2, E5, E6	E7, <u>E8</u> , <u>E9</u> , E11, E12, E13, E14, E15, E16, E17, E50	E18, E19, E22, E23, E26, <u>E27</u> , E28, E32, E33, E49, E51, <u>H20</u> , O15	<u>E34</u> , E35, <u>E36</u> , E38, E39, E40, E41, <u>E43</u> , <u>E44</u> , E46, E52, E53
<i>Grand Total</i>	125	50	1,120	235	3	6	360	53	1,126				

- ✓ Ships under the conditions of any one-compartment flooding keep enough freeboard in static condition, except the case of small bulk carriers with special heavy cargo such as steel products;
- ✓ In general, hull girder bending moment after one hold flooding would not exceed allowable hull girder moment after flooding used as new bulk carrier design criteria;
- ✓ In some cases, flooding into a cargo hold with heavy cargo would cause excessive stress in hull girder; and
- ✓ For example, in the Ore Alternate Loading Condition in *Panamax* BC, hogging moment amidships after foremost hold flooding would exceed allowable hogging moment for new bulk carriers after flooding. It should be noted that shifting of cargo weight from fore and aft holds to holds amidships could reduce it. So appropriate cargo shifting or ballast water operations could mitigate consequences.

4 Investigation of Casualties by Accident Scenario and Ship Type

4.1 Number of casualties by Accident Scenario and Ship Type

Table 4.1 summarizes the number of casualties by accident group and ship type. The lists of casualties in each accident groups are attached as Appendix II.

In the historical data, there are some total loss casualties, which are not clearly specified with any involvement of flooding or water ingress. However, the experts in the working group judged some of them to group into “Accident group-1: hold flooding due to structural failure”, taking the following factors into consideration.

- ✓ Age of ship at the time of casualty
- ✓ Density of the cargo which was loaded at the time of casualty

However, in spite of applying the above-mentioned expert judgment as a rule, there are 6 casualties that should be left in “Accident group-2: presumed water ingress (detail unknown)”.

Table 4.1 Number of casualties by accident group and ship type

Scenario	Accident group	Number of casualties					Sum	Note (See Appendix II)
		Cape-size	Pana-max	Handy-size	Small-handly			
1	-1	1. Flooding into cargo holds due to structural failure	25 (13)	21 (15)	67 (28)	33 (21)	146 (77)	Table 1
		2. Presumed water ingress (detail unknown)	0 (0)	0 (0)	1 (1)	5 (5)	6 (6)	
		<i>(Sub-total)</i>	25 (13)	21 (15)	68 (29)	38 (26)	152 (83)	
		3. Flooding into other compartments due to structural failure	7 (1)	8 (0)	32 (6)	9 (5)	56 (12)	Table 2
		<i>(Total for Scenario-1-1)</i>	32 (14)	29 (15)	100 (35)	47 (31)	208 (95)	
		-2	4. Flooding into Fore Peak due to failure of deck fittings, etc.	1 (1)	2 (0)	5 (0)	1 (0)	9 (1)
	-3		5. Water ingress due to hatch covers failure or their securing failure	4 (0)	1 (1)	14 (7)	1 (0)	20 (8)
			<i>(Total for Scenarios-1-2 and -1-3)</i>	5 (1)	3 (1)	19 (7)	2 (0)	29 (9)
		<i>(Total for Scenario-1-1 to -1-3)</i>	37 (15)	32 (16)	119 (42)	49 (31)	237 (104)	
	2	6. Structural failure without water ingress in heavy weather	20 (2)	8 (0)	17 (0)	7 (1)	52 (3)	Table 3
3	7. Structural failure during loading operation	2 (1)	2 (1)	5 (0)	3 (1)	12 (3)	Table 6	
4	8. Accident due to cargo shift at sea	0 (0)	0 (0)	8 (2)	11 (5)	19 (7)	Table 5	
none	9. Water ingress in moderate sea condition or through piping; then, excluded from the study	4 (0)	11 (2)	13 (2)	12 (4)	40 (8)	Table 6	
	<i>Total</i>	63 (18)	53 (19)	162 (46)	82 (42)	360 (125)		

Note: Figures in parenthesis show number of total loss included.

According to the analysis summarized in Table 4.1 above, the following findings are achieved.

- 1) On Each Accident Scenario:

- ✓ 208 casualties are found in “Scenario-1-1: Flooding due to hull structural failure such as side shell failure” and about half of them (95 casualties) are resulted in total loss;
 - ✓ On the other hand, 52 casualties in “Scenario-2: Structural failure without water ingress in heavy weather” indicate that even if hull structure is damaged in heavy weather, ships can survive unless being flooded;
 - ✓ As for “Scenario-3: Structural failure during loading operation” and “Scenario-4: Accident due to cargo shift at sea”, the probabilities of accidents are relatively low in comparison with other accident scenarios; and
 - ✓ In spite of clear statement of water ingress in 40 casualties in “Accident group-9: Water ingress in moderate sea condition or through piping”, the experts in the working group judged that it is reasonable to exclude the type of accident from the scope of this study, because of their causes and sequences.
- 2) On *Small-handy* Bulk Carrier:
- ✓ The total loss ratio of *Small-handy* bulk carrier group is about 34% of all total losses. This percentage seems relatively high in comparison with its fleet ratio of 22%; and
 - ✓ The *Small-handy* group result in high total loss ratio in every scenario except “Scenario-2: Structural failure without water ingress in heavy weather”, which resulted in no total loss casualty.
- 3) On *Cape-size* Bulk Carrier:
- ✓ The total loss ratio of *Cape-size* bulk carrier group is about 14% of all total losses. This percentage seems relatively high in comparison with its fleet ratio of 8.8%; and
 - ✓ Although the casualty ratio on “Scenario-2: Structural failure without water ingress in heavy weather” of *Cape-size* bulk carrier group also shows high figure of about 38% of all casualties, only 2 total loss cases (eventual broken up and scuttle) were reported.

Even excluding “Accident groups –2: Presumed water ingress (detail unknown)” from “Scenario-1”, total 231 casualties are relating to eventual flooding. An estimate of the frequency of casualty hence is given as:

$$f = \frac{g}{m} = \frac{231}{89,900} = 2.57 \cdot 10^{-3} \quad \text{annual frequency of casualty including total loss involving water ingress}$$

With adding 6 casualties in “Accident group-2: Presumed water ingress (detail unknown)”, 237 casualties including total loss were found as upper side frequency. An estimate of the upper side frequency of casualty hence is given as:

$$f_{upper} = \frac{g}{m} = \frac{237}{89,900} = 2.64 \cdot 10^{-3} \quad \text{annual frequency of casualty including total loss involving water ingress}$$

As there is not any significant difference between these two figures, we assume that casualties in “Accident group-2” could be categorized into “Scenario-1-1” as shown in Table 4.1.

4.2 Numbers of Fatalities by Accident Scenario and Ship Type

Table 4.2 and Table 4.3 summarize the number of fatal cases by accident group and ship type, and the number of fatalities by accident group and ship type, respectively. Lists of casualties in each accident group are also attached as Appendix II. Figures 4.1 and 4.2 are the F-N Curves of bulk carrier and PLL (Potential Loss of Life) of bulk carrier respectively. In these figures, “All BC & All casualties” comprises all accident

groups in Table 4.3 and all other casualties, which are basically excluded from this study, such as fire, collision, etc, derived from LMIS database.

According to the analysis summarized in Table 4.2, Table 4.3, Figure 4.1 and Figure 4.2, the following findings are achieved.

- 1) From Table 4.2:
 - ✓ It is found that 40% of all total loss cases in Table 4.1 is resulted in fatal cases (50 fatal cases to 125 total loss cases);
 - ✓ As for “Scenario-1: progressive flooding after the following initial failures/flooding”, about 42% of total loss cases in Table 4.1 is resulted in fatal cases (44 fatal cases to 104 total loss cases);
 - ✓ As for “Scenario-1-1”, about 39% of total loss cases in Table 4.1 is resulted in fatal cases (37 fatal cases to 95 total loss cases);
 - ✓ Therefore, as a whole, it is found that around 40 % of total loss cases are resulted in fatal cases; and
 - ✓ Although there is no particular difference of fatal case ratio among ship size, *Handy-size* shows slightly higher fatal case ratio. According to this historical data analysis, this is contributed by the high fatal case ratio in “Scenario 1-3: water ingress due to hatch covers failure or their securing failure” (5 fatal loss cases to 7 total loss cases).
- 2) From Table 4.3:
 - ✓ As for cause of accidents, it is found that about 92% of these fatalities relate to “Scenario-1: progressive flooding after the following initial failures/flooding” and that about 76% of them are in “Scenario-1-1: structural failure such as side shell failure”;
 - ✓ As for ship type, about 73% of these fatalities in “Scenario-1” are of *Handy-size* and *Small-handy* bulk carrier groups;
 - ✓ As for fatalities due to scenarios other than “Scenario-1” (8 % of total fatalities), more than half of them are relating to “Scenario-4: accident due to cargo shift at sea” and are concentrated into accidents of *Handy-size* and *Small-handy* bulk carrier groups; and
 - ✓ Therefore, it could be concluded that the most important accident scenario to fatal casualty of bulk carriers would be “Scenario-1” in which total 1,031 fatalities are counted.
- 3) From Figure 4.1 & Figure 4.2:
 - ✓ PLL of “All BC”, which relates to structural failure, is lower than PLL of “All BC & All Casualties”; and
 - ✓ *Cape-size* and *Small-handy* bulk carrier groups indicate relatively high PLL. This tendency can be seen in Figure 2.1 F-N Curves of bulk carrier.

Then, the maximum base risk contribution PLL of “Scenario-1”, from the water ingress scenarios as deduced from historical data hence, is estimated to:

$$PLL_{\text{water_ingress}} = \frac{1,031}{89,900} = 1.15 \cdot 10^{-2} \quad \text{fatality per ship year}$$

Table 4.2 Number of fatal cases by accident group and ship type

Scenario	Accident group	Number of casualties				Sum	Note (See Appendix 1)		
		Cape-size	Pana-max	Handy-size	Small-handly				
1	-1	1. Flooding into cargo holds due to structural failure	5 (5)	4 (4)	15 (13)	9 (9)	33 (31)	Table 1	
		2. Presumed water ingress (detail unknown)	0 (0)	0 (0)	1 (1)	2 (2)	3 (3)		
		<i>(Sub-total)</i>	5 (5)	4 (4)	16 (14)	11 (11)	36 (34)		
			3. Flooding into other compartments due to structural failure	0 (0)	0 (0)	1 (1)	2 (2)	3 (3)	Table 2
			<i>(Total for Scenario-1-1)</i>	5 (5)	4 (4)	17 (15)	13 (13)	39 (37)	
	-2	-3	4. Flooding into Fore Peak due to failure of deck fittings, etc.	1 (1)	0 (0)	0 (0)	0 (0)	1 (1)	Table 4
			5. Water ingress due to hatch covers failure or their securing failure	0 (0)	1 (1)	6 (5)	0 (0)	7 (6)	
			<i>(Total for Scenarios-1-2 and -1-3)</i>	1 (1)	1 (1)	6 (5)	0 (0)	8 (7)	
			<i>(Total for Scenario-1-1 to -1-3)</i>	6 (6)	5 (5)	23 (20)	13 (13)	47 (44)	
2		6. Structural failure without water ingress in heavy weather	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	Table 3	
3		7. Structural failure during loading operation	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	Table 6	
4		8. Accident due to cargo shift at sea	0 (0)	0 (0)	1 (1)	2 (2)	3 (3)	Table 5	
none		9. Water ingress in moderate sea condition or through piping; then, excluded from the study	0 (0)	1 (1)	1 (1)	1 (1)	3 (3)	Table 6	
		<i>Total</i>	6 (6)	6 (6)	25 (22)	16 (16)	53 (50)		

Note: Figures in parenthesis show number of total loss included.

Figure 4.3 Number of fatalities by accident group and ship type

Scenario	Accident group	Number of fatalities				Sum	Note (See Appendix II)
		Cape-size	Pana-max	Handy-size	Small-handy		
1	-1	130 (130)	89 (89)	261 (257)	211 (211)	691 (687)	Table 1
	1. Flooding into cargo holds due to structural failure						
	2. Presumed water ingress (detail unknown)	0 (0)	0 (0)	6 (6)	51 (51)	57 (57)	
		(Sub-total)	130 (130)	89 (89)	267 (263)	262 (262)	748 (744)
	3. Flooding into other compartments due to structural failure	0 (0)	0 (0)	6 (6)	31 (31)	37 (37)	Table 2
	(Total for Scenario-1-1)	130 (130)	89 (89)	273 (269)	293 (293)	785 (781)	
-2	4. Flooding into Fore Peak due to failure of deck fittings, etc.	44 (44)	0 (0)	0 (0)	0 (0)	44 (44)	Table 4
-3	5. Water Ingress due to hatch covers failure or their securing failure	0 (0)	17 (17)	185 (183)	0 (0)	202 (200)	
	(Total for Scenarios-1-2 and -1-3)	44 (44)	17 (17)	185 (183)	0 (0)	246 (244)	
	(Total for Scenario-1-1 to -1-3)	174 (174)	106 (106)	458 (452)	293 (293)	1,031 (1,025)	
2	6. Structural failure without water ingress in heavy weather	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	Table 3
3	7. Structural failure during loading operation	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	Table 6
4	8. Accident due to cargo shift at sea	0 (0)	0 (0)	20 (20)	34 (34)	54 (54)	Table 5
none	9. Water ingress in moderate sea condition or through piping; then, excluded from the study	0 (0)	4 (4)	32 (32)	5 (5)	41 (41)	Table 6
	Total	174 (174)	110 (110)	510 (504)	332 (332)	1,126 (1,120)	

Note: Figures in parenthesis show number of fatalities in case of total loss of ship.

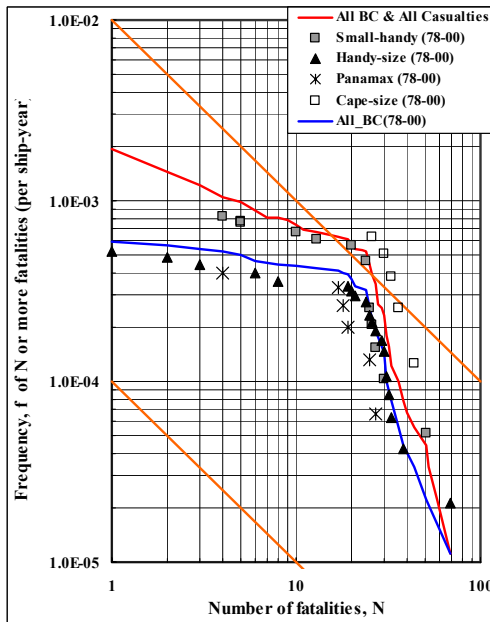


Figure 4.1 F-N curves of bulk carrier

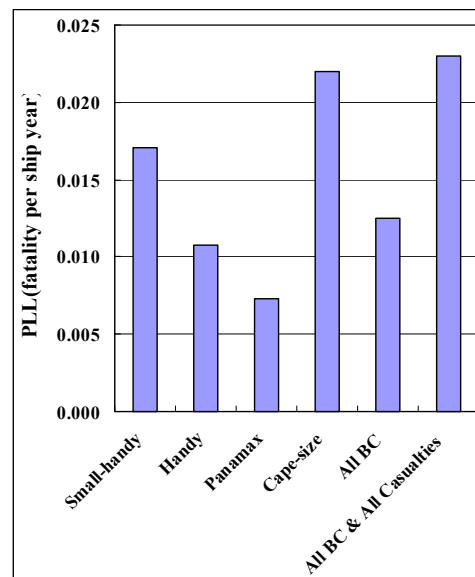


Figure 4.2 PLL of bulk carrier

**APPENDIX I: BULK CARRIER CASUALTY DATA RELATED TO STRUCTURAL FAILURE
(1990-1997)**

1. Followings are casualty data on bulk carriers, in which hull structural failure may have been a contributory factor, kept in NK obtained from a various news sources such as Lloyd's List during the period from 1990 to 1997. The data is limited to bulk carrier those deadweight are not less than 20,000 MT.

Table 1 List of casualties of bulk carriers related to hull structural failure (1990-1997)

(Note: Deadweight of bulk carriers in this table is not less than 20,000MT)

ID	Name	Age	Date of casualty	DWT.	Cargo	Total loss	Remark
1	CHARLIE	15	Jan-90	20,246	Grain	Yes	Missing off Newfoundland in Jan. '90.
2	MINERAL STAR	17	Jan-90	66,350	Coal		Side shell in No. 1 C/H lost in Jan. '90. Flooding in E/R & No. 2 C/H in Apr '90.
3	ORIENT PIONEER	19	Jan-90	108,503	Iron ore	Yes	Flooding in cargo holds through fractured duct keel and twisted upper deck. Foundered in Jan. '90.
4	AL TALUDI	20	Feb-90	41,330	Ballast		Fracture in No. 1 C/H in Feb. '90.
5	WALTER LEONHARDT	24	Feb-90	44,015	Phosphate	Yes	Damage in No. 2 C/H causing flooding. Foundered in Feb. '90.
6	TRIBULUS	9	Feb-90	129,160	Iron ore		Side shell in No. 8 cargo hold lost in Feb. '90.
7	ADEMONTASA	22	Apr-90	55,118	Barytes		2m fracture in butt weld in No. 6 C/H in Apr. '90.
8	SILIMNA	12	May-90	69,165	Iron ore	Yes	Fractures in Nos. 2 & 3 cargo holds. Sank in May '90.
9	TAO YUAN HAI	13	May-90	122,750	Iron ore	Yes	Nos. 3, 5, 6 & 7 holds flooded. Deck in No. 7 hold buckled. Sank in May '90.
10	AMAZON	9	Jun-90	140,832	Coal		Damage to side shell in No. 2 hold in June '90.
11	CORAZON	18	Jul-90	28,757	Cement	Yes	Bow lost and keel fractured. No. 2 C/H flooded. Foundered in July '90.
12	PETINGO	23	Jul-90	80,580	Iron ore	Yes	Foundered. No. 3 C/H flooded in July '90.
13	PYTHIA	17	Oct-90	120,143	Iron ore		No. 3 C/H flooded through wasted side shell in Oct. '90.
14	MEI GUI HAI	21	Nov-90	37,326	Rice		Fractures in Nos. 2, 3 & 6 C/H in Nov. '90.
15	JULIANA	19	Nov-90	65,455	Ballast		12m fracture in No. 5 C/H in Nov. '90.
16	ELOUNDA DAY	17	Dec-90	38,350	Potash	Yes	Developed cracks in No. 2 hold and took water in heavy weather in lat. 41 25N, long. 150 22W, on Dec 8 '90. Abandoned and sank in lat. 36 09N, long. 154 10W on Dec. 23 '90.
17	ALEXITA	18	Dec-90	120,608	Iron ore		Bulkhead frames loosed in Dec. '90.
18	CONTINENTAL LOTUS	24	Jan-91	54,202	Iron ore	Yes	Developed cracks in side shell plating. No. 5 hold flooded and sank 200 miles east of Malta in Jan. '91. Four crew rescued. 12 missing and

							26 dead.
19	ROLLON	18	Jan-91	67,826	Iron ore		Damage to frames in No. 1 C/H in Jan. '91.
20	PANKAR INDOMINITABLE	19	Jan-91	77,992	?		Fracture and detached frames in heavy weather in two cargo holds in Jan '91.
21	PROTEKTOR	24	Jan-91	80,185	Iron ore	Yes	Presumed sank during severe storm 220 miles south-east of Newfoundland after taking water in Nos. 2 & 4 holds in Jan. '91. All 33 crew missing.
22	SINGA SAGA	14	Feb-91	26,586	Ballast		Sustained hull damage in heavy weather. Hull cracked/holed in No. 3 hold in lat. 45 43N, long. 20 52W in Feb. '91.
23	SHOU AN HAI	17	Feb-91	119,500	?		Frames in No. 6 C/H detached in Feb. '91.
24	STARFISH	21	Apr-91	56,277	Iron ore	Yes	Developed crack in No. 4 hold. Sank in lat. 20 13S, long. 57 06E in Apr. '91. Crew rescued.
25	VASSO	24	Apr-91	68,490	Iron ore	Yes	Developed crack in hull plating in No. 1 hold and took water 152 miles south of Durban on Apr. 4 '91. Abandoned and sank same day.
26	MINERAL DIAMOND	9	Apr-91	141,028	Iron ore	Yes	Missing. 1500 miles west of Fremantle in Apr. '91
27	MANILA TRANSPORTER	14	Jul-91	115,960	Iron ore	Yes	Took water in No. 3 hold due to crack in port side in lat. 29 43.7S, long. 64 19.8E. Subsequently abandoned and sank in July '91.
28	KING WILLIAM	17	Jul-91	79,304	?		Took water in engine room due to hurricane in lat. 37 29N, long. 72 12.5W in Aug. '91.
29	BLOOMING ORCHARD	21	Jul-91	140,044	Iron ore		Developed list after ingress of water through crack in starboard side plating in lat. 03 03N, long. 78 28E in Aug. '91.
30	SUN SET	21	Aug-91	20,932	Steel billets, etc	Yes	Encountered heavy weather on Jul 30 '91, took water and sank in lat. 12 36N, long. 53 22E, off Socotra Island in Aug. '91.
31	NEO PALMIRA	14	Aug-91	38,962	?		Developed cracking of hull frames after leaving Jakarta in Aug. '91 due to heavy weather.
32	MELETE	16	Aug-91	72,063	Iron ore	Yes	Sank in rough sea 450 miles south of Reunion in lat. 27 41S, long. 54 11E in Aug. '91. Reported to have been heading for repair of crack in No. 1 hold. Of crew of 27, two rescued.
33	ERATO	23	Oct-91	29,098	Phosphate	Yes	Sank in lat. 37 35N, long. 08 07E in Oct. '91. 19 crew rescued, one dead and five missing.
34	ENTRUST FAITH	18	Dec-91	63,533	Iron ore	Yes	Sustained shell plating damage in No. 1 hold port side due to bad weather and caused ingress of water. Crew abandoned. Vessel sank in lat.

							37 16N, long. 25 31W in Dec. '91.
35	MARMARA S	21	Dec-91	121,522	Iron ore		Ran aground due to ingress of water into No. 3 cargo hold in Dec. '91.
36	CAPTAIN VENIAMIS	23	Jan-92	25,575	Fertilizer		Had ingress of water in forepeak and ballast tanks due heavy weather and beached in lat. 34 35 30N, long. 125 52 00E in Jan. '92.
37	I. VAN	26	Jan-92	28,393	?		Developed cracks in forepeak tank, Nos. 5 & 6 double bottom tanks in Jan. '92.
38	KARADENIZS	23	Apr-92	115,280	Iron ore	Yes	Caught in heavy swell off Gibraltar, abandoned by crew due to ingress of water and sank in Apr. '92. All crew safely rescued.
39	GREAT EAGLE	24	May-92	65,230	Ore	Yes	Reported flooded, with shell plates cracked and sank in lat. 14 33.5S, long. 65 31E in May '92. All crew safely rescued.
40	TRAVE ORE	20	Aug-92	108,200	Iron ore		Had structural damages in lat. 64 44N, long. 06 27E in Aug. '92. Sustained buckled bulkhead, separating Nos. 8 & 9 holds and fractured on main deck. Damages caused by grabs along with internal corrosion.
41	LIKA	16	Dec-92	122,547	Iron ore		Sprang leak approximately 30 miles west of Bomlo in lat. 59 56N, long. 04 19.8E, in heavy weather in Dec. '92. Took water in Nos. 1 & 2 holds and proceeded to Hervikfjorden. Sustained cracks on port side of bow section.
42	GOLD BOND CONVEYOR	19	Mar-93	26,459	Gypsum	Yes	Sank after taking water in stormy seas 110 miles southeast of Cape Sable Island in lat. 41 36N, long. 65 11W in Mar. '93. Crew of 33 abandoned vessel into life rafts. 1 body recovered, 32 missing.
43	NAGOS	24	May-93	74,596	Coal	Yes	Took water in holds in high winds and heavy seas and sank about 70 miles south of Port Elizabeth in lat. 35 15S, long. 24 01E in May '93. 16 crew rescued by helicopter. Remaining 17 missing.
44	ARTI	19	Jul-93	29,336	Steel		Internals inside No. 4 cargo hold on starboard side adrift and buckled in lat. 11 48N, long. 90 30E in July '93. Proceeded to Port Blair, arriving next day.
45	RIVER PLATE	19	Jul-93	131,260	Iron ore	Yes	Taking water in heavy seas west of Cape Town in lat. 34 22.9S, long. 15 33.25E, in July '93. Holed in port side and severe damage to shell plating near No. 5 cargo hold. Sank.
46	SAN MARCO	25	Nov-93	57,850	Phosphate		Holed in No. 1 hold about 150 miles west of Cape Town and put into Cape Town as port

							refuge in Nov. '93.
47	CHRISTINAKI	21	Feb-94	26,510	Scrap	Yes	Taking water in No. 1 hold hatch during fierce storm about 240 miles off Irish coast in lat. 48 48N, long. 13 37.28W, on Feb. 3 '94. Sank shortly after. 27 crew missing.
48	KAMARI	21	Feb-94	127,283	Iron ore	Yes	Severe damage to hull frames and holds leaking due to bad weather in Atlantic on Feb. 25 '94. Put into River Plate anchorage for repairs same day. Escorted to Rio grande Roads Apr. 12 before eventually sinking 75 miles southeast of Rio Grande Jun. 6.
49	DIAMOND SEA	18	Mar-94	139,346	-		Heavy weather damage while on passage from Rotterdam on Mar. 6 '94. Reportedly holed in side with extensive internal damage.
50	SHIN KAKOGAWA MARU	13	Jun-94	124,292	Iron ore		Hull cracked in heavy weather and taking water in No. 1 hold in lat. 34 00S, long. 27 05E, on Jun. 6 '94. Severe damage to structure near No. 7 hold.
51	APOLLO SEA	21	Jun-94	131,260	Iron ore	Yes	Sank in heavy weather shortly after leaving Saldanha Bay about 30 miles northwest of Robben Island on Jun. 20 '94. 36 crew missing.
52	WELLBORN	23	Aug-94	26,450	Manganese ore		Arrived with cracked shell plating due to bad weather, on Aug. 5 '94. Oil spillage occurred. Broke into two pieces.
53	NIKITAS ROUSSOS	18	Aug-94	72,203	Soya beans		Taking water in engine-room about 200 miles south of Tenerife on Aug. 29 '94.
54	GOLDEN CHARIOT	22	Nov-94	22,076	Grain	Yes	Abandoned by crew of 25 when vessel sank in lat. 08 44N, long. 53 44W, on Nov. 15 '94.
55	PANTAZIS L	20	Nov-94	27,436	Copper		Taking water in heavy weather 30 miles from south-east of Saint Pierre Island on Nov. 23 '94. Proceeded to port with No. 3 hold cracked and flooded.
56	M.N. EFES	21	Dec-94	74,099	Ballast		Heavy weather damage to bulkhead while on passage from Chent to port Cartier on Dec. 24 '94. Compromised total loss.
57	MOUNT OLYMPUS	17	Dec-95	54,612	?		Reported in lat. 36 07N, long. 50 03W, Dec. 1 '95 with water in hold, broken deck and water in two ballast tanks, assistance required, may abandon, weather gale to severe gale.
58	CANADIAN HARVEST	17	Dec-95	31,413	-	Yes	Broke in two in heavy weather 112 miles northeast of Stable Island, in lat. 44 25 48N, long. 57 09 18W, while being towed to scrap yard Dec. 3, '95.
59	MEMED	17	Dec-95	23,198	Steel	Yes	Reported taking water in cargo holds 3, 4 and 5

	ABASHIDZE				bars/soda ash		and sinking in lat. 11 15N, long. 110 18E, Dec. 23, '95. Crew abandoned ship.
60	AMPHION	19	Jan-96	26,515	?	Yes	Taking water in Nos. 1 and 2 holds in bad weather with 15m seas in lat. 45 40N, long. 41 14W Jan. 10, '96. Crew attempted to keep vessel afloat by pumping water out but forced to abandon Jan. 11. Vessel low in water, sinking in lat. 46 02N, long. 43 56.
61	MERYEMANA	24	Feb-96	27,071	?		Reported with serious ingress of water off South Falls, Dover Strait in lat. 51 10.6N, long. 01 41.6E, Feb. 13, '96; taken in tow by tug and later anchored off Dover western entrance; ballast pumps heavily damaged; to drydock after temporary repairs; Ghent.
62	SEAFaITH	23	Feb-96	68,275	Iron ore	Yes	Sank in bad weather about 60km north of Taiwan, in about; lat. 26 03N. long. 122 25.51E, Feb. 17, '96. Eleven of the 30 crew rescued by vessel AKASHI.
63	POS CHALLENGER	4	Apr-96	75,277	Ballast		Bulkhead collapsed on tank top during ballasting in Callao area on or around Apr. 8 '96. Hatch cover severely buckled and deformed. Repairs in hand. Sailed 12 May.
64	JOLLITY	21	Nov-96	22,623	?		Reported with water ingress in lat. 17 47N, long. 119 20E, Nov. 13, '96; engine room flooded; taken in tow Nov. 15, '96 by salvage tug Salvage Challenger; bound Hong Kong.
65	LEROS STRENGTH	20	Feb-97	21,673	Apatite	Yes	Sank in heavy seas about 30 miles west of Stavanger in lat. 58 54.4N, long. 38.8E, Feb. 8, '97. Master had reported leakage to the bow causing navigating problems. 20 crew missing. Oil spillage occurred. Murmansk for Poland.
66	ALBION TWO	21	Mar-97	29,676	-	Yes	Reported overdue Mar. 5, '97. Following a search which lasted several days, wreckage of vessels positively identified in lat. 48 18.8N, long. 06 08.7W at depth of 130 meters; Gdynia for Kingston (Jm).
67	ASKANIA NOVA	13	Jul-97	52,450	Soybeans		Taking water in engine-room in lat. 37 13S, long. 52 22E, Jul. 26, '97: water ingress brought under control with use of pumps: taken in tow same day.
68	OAK	16	Dec-97	21,951	?		Cargo shifted in lat. 53 16N, long. 24 59W, Dec. 31 '97; engine subsequently blacked out.

**APPENDIX B: IDENTIFIED SERIOUS CASUALTIES FROM LMIS CASUALTY DATABASE
(August 2000 Version)**

1. Identified serious casualties, including total loss, from the LMIS casualty database in the period from 1978 to 2000 is summarized in the following tables:

Table B1	Identified or presumed cases involving cargo hold flooding due to structural failure excluding stranding, collision, etc
Table B2	Identified cases involving other compartment flooding due to structural failure excluding stranding, collision, etc
Table B3	Serious casualty due to structural failure without water ingress
Table B4	Identified cases involving water ingress due to hatch cover failure or miscellaneous closing device failure
Table B5	Identified cases involving total loss or serious casualty due to cargo shift
Table B6	Exceptional cases such casualty during as out of voyage, e.g. valve/piping failure, accident whilst loading/discharging/ballasting, etc.
Table B7	Total loss casualty due to water ingress caused by collision, contact, etc

*** Note:**

- 1) Description in **italic character** in Note is referred from the data source other than the LMIS casualty database.
- 2) Cell and line surrounded by **bold frame** shows the difference from MSC74/INF.JPN2 and indicates that those cells or lines, or description in them are either, modified, added, inserted or moved from another table, at this investigation.

Table B1 Identified or presumed cases involving cargo hold flooding due to structural failure excluding stranding, collision, etc.

(Ref. ID with asterisk like 148* indicates the case where involvement of cargo hold flooding is presumed with expert judgement)

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
# <i>Small-handy</i>								
Evelpidis Era	10451 (GT)	19780116	No.3 hold flooded & sank Rock salt loaded	1	0	16	?	149
Arendal Bay	11848	19991227	No.2 hold flooded Unknown cargo loaded	0	0	25	?	150
Anderson	12051	19930917	Foundered (detail unknown) Iron loaded	1	24	18	3	148*
Luchana	14524	19860115	Unknown hold flooded Broke in two & sank Iron ore loaded	1	4	22	5	147
William Shakespeare	15328	19960628	No.4 hold flooded & foundered Steel loaded	1	0	18	?	146
Asia Eeho	15993	19830122	No.1 hold flooded Unknown voyage	0	0	16	4	145
Char Ye	16211	19840810	Nos.4 & 5 holds flooded & foundered Unknown cargo loaded	1	0	8	5	144
World Fuji	16511	19801227	No.3 hold flooded Subsequently broken up Coal loaded	1	0	16	4	143
Apiliotis	16600	19820607	No.5 hold flooded Unknown cargo loaded	0	0	19	5	142
Sincerity	16626	19900309	No.4 hold flooded Unknown voyage	0	0	14	4	141
Al Hadi	16659	19960816	Unknown hold flooded Foundered whilst anchored Sulphur loaded	1	0	28	?	140
Queen Jane	16711	19871023	Not since heard of (detail unknown) Log/fertilizer loaded	1	24	19	4	139*

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Winners Bee	16769	19850609	Foundered (detail unknown) Unknown voyage	1	0	16	4	138*
Asean Carrier	16873	19980802	Unknown 2 holds flooded & presumed to have foundered Bagged cement loaded	1	0	29	?	137
Huron	16895	19890504	No.1 hold flooded & foundered Timber/steel/scrap loaded	1	13	17	3	136
Ais Mamas	16957	20000101	No.1 hold flooded Logs loaded	0	0	24	?	135
Petchomphoo	17214	19910818	No.1 hold flooded & presumed to have foundered Steel loaded	1	24	22	4	134
Tanfory	17659	19850304	Nos.4, 5 & 6 holds flooded & presumed to have foundered Salt loaded	1	0	23	6	133
Clipper Alliance	17666	19930524	No.1 hold flooded Steel coils loaded	0	0	16	4	132
Jin Yang No. 11	17705	19800709	<i>No.2 hold flooded & sank</i> Steel products loaded	1	0	22	?	131
Don Juan	18037	19880315	Nos.1, 2 & 4 holds flooded Rice in bags loaded	0	0	13	4	130
Kinko Maru	18534	19820108	No.3 hold flooded Trucks loaded	0	0	12	4	129
Kimolos	18731	19810103	No.5 hold flooded Chrome ore loaded	0	0	22	5	128
Kalliopi A.	19034	19841126	No.2 hold flooded & sank Unknown voyage	1	0	15	5	127
Alborada	19112	19870724	<i>No.1 hold flooded & sank</i> Coal loaded	1	30	18	4	126
Kronos	19329	19890226	Not since heard of (detail unknown) Steel loaded	1	20	16	4	124*
Rio Bravo	19378	19810324	Unknown hold flooded & foundered Steel Scrap loaded	1	0	21	?	123
Osool	19427	19980721	No.1 hold & E/R flooded & foundered Steel loaded	1	0	24	?	122
Maureen B.	19776	19820109	No.2 hold flooded Copper concentrates loaded	0	0	20	7	120
Mitsos	19978	19790201	No.3 hold flooded & foundered Scrap iron loaded	1	0	19	?	119
Innovator	20009	19960209	Foundered (detail unknown) Gypsum loaded	1	0	23	?	99*
Charlie	20246	19900120	Not since heard of (detail unknown) Grain loaded	1	27	15	4	107*
Golden Pine	20349	19810102	Nos.1, 2 & 3 holds flooded & presumed to have foundered Copper concentrates loaded	1	25	13	?	98
Chios Captain	21546	19800708	No.2 hold flooded Phosphate rock loaded	0	0	10	6	96
Leros Strength	21673	19970208	<i>Nos.1 & 2 holds flooded & foundered</i> Apatite ore loaded	1	20	21	5	95
Golden Chariot	22076	19941115	Foundered (detail unknown) Grain loaded	1	0	22	5	94*
Kairali	22247	19790703	Posted missing (detail unknown) Ore loaded	1	51	13	?	93*
Rocky	7975	19850206	No.3 & 4 holds flooded Steel coils loaded	0	0	19	3	AS3
# Handy-size								
Tito Campanella	19260	19840114	Not since heard of (detail unknown) Iron plate loaded	1	24	22	6	125*
Pab	19472	19850816	Unknown hold flooded & subsequently sank Pig iron loaded	1	0	23	7	121

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Thomas K.	20829	19840128	No.1 hold flooded & subsequently sank Scrap iron loaded	1	8	23	4	97
Tina	22669	19870211	No.5 hold & E/R flooded & foundered Scrap iron loaded	1	0	13	5	92
Ontario	26119	19930901	No.1 hold flooded Unknown voyage	0	0	18	5	O19
Uniwersytet Jagiellonski	52000	19890228	No.4 hold flooded No.4 hatch cover damaged Ore loaded	0	0	18	7	H5
Santa Esmeralda	23945	19990413	No.2 hold flooded Dolomite loaded	0	0	17	4	118
Maria Bacolitsa	24512	19800301	Foundered (detail unknown) Pig iron loaded	1	26	18	?	91*
Antiparos	24527	19810103	Not since heard of (detail unknown) Scrap loaded	1	31	18	?	90*
Ocean Navigator	24594	19781211	Nos.1&2 holds flooded Steel loaded	0	0	8	5	89
Sanaga	24732	19991011	Nos.1 & 2 holds flooded & presumed to have foundered Logs loaded	1	0	20	?	117
Wellborn	25651	19940805	Unknown hold flooded & broke in two Manganese ore loaded	1	0	23	5	88
Antacus	26044	19840716	Nos.4 & 5 holds flooded & foundered Steel loaded	1	0	11	5	87
Dona	26074	19891229	No.1 hold flooded Cargo unknown	0	0	22	3	86
Peony Islands	26400	19900121	No.5 hold flooded Cargo unknown	0	0	8	5	85
Magnificence Venture	26500	19850127	No.1 hold flooded Copper concentrate loaded	0	0	11	5	83
Singa Sea	26586	19880704	Broke in two & sank Copper ore loaded	1	19	12	5	102*
Well Speeder	26587	19990905	Nos.1 & 2 holds flooded & subsequently sank Cement loaded	1	0	23	?	116
Maria A	26599	19980321	No.1 hold flooded Wheat loaded	0	3	22	?	82
Nand Rati	26710	19991220	No.1 hold flooded Soya beans loaded	0	0	15	?	115
Albion Two	26976	19970218	Foundered (detail unknown) Steel loaded	1	25	21	?	106*
Lok Priti	26999	19931231	Nos.1 & 7 holds flooded Wheat loaded	0	0	12	7	81
Leon	27390	19911117	No.2 hold flooded Steel products loaded	0	0	18	7	80
Pantazis L	27434	19941123	No.3 hold flooded Copper loaded	0	0	20	6	79
Kalisti	27540	19940414	No.2 hold flooded Fluorspar fltr cake loaded	0	0	17	7	78
Ave	27571	19931222	No.1 hold flooded Concentrates loaded	0	0	21	6	77
Agios Giorgis	27624	19800107	No.5 hold flooded & sank Scrap loaded	1	29	18	?	76
Goldean Alliance	28098	19880426	No.2 hold flooded Cargo unknown	0	0	4	5	75
Erato	29098	19911021	Foundered (detail unknown) Phosphate loaded	1	6	23	7	74*
Flare	29222	19980116	Broke in two originated from crack in upper deck & sank Ballast	1	21	26	7	101*
Capirona	29389	19801205	Nos.5 & 6 holds flooded & broken up Zinc/lead concentrates loaded	1	0	29	7	73

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Federal Vibeke	30900	19941129	Unknown hold flooded Cargo unknown	0	0	13	6	72
Darya Kamal	30910	19911210	No.1 hold flooded Cargo unknown	0	0	10	6	71
Kapetan Georgis	31622	19801123	Unknown holds flooded Unknown cargo	0	0	18	7	105
Fei Cui Hai	32300	19980207	Foundered (detail unknown) Iron ore concentrate loaded	1	30	25	?	70*
Margarita	33225	19800207	No.3 hold flooded Grain loaded	0	1	14	8	104
Canadian Bulker	33399	19850116	No.1 hold flooded Corn loaded	0	0	19	?	69
C. Tahsin	33680	19820225	No.7 hold flooded Cargo unknown	0	0	14	7	68
Minories Pride	34139	19831108	No.7 hold flooded Sulphur loaded	0	0	19	7	67
On Ding	34281	19871222	Unknown hold flooded Cargo unknown	0	0	21	7	66
Federal Mackenzie	35315	19990325	No.6 hold flooded Unknown voyage	0	0	15	7	114
Xin Zhu Jiang	35660	19991221	Foundered (detail unknown) Ore loaded	1	1	23	?	113*
Star of Alexandria	35967	19890417	Unknown hold flooded Broke in two & sank Cement loaded	1	2	24	7	65
Pan Dynasty	36650	19891004	Unknown hold flooded & subsequently sank Phosphate rock loaded	1	0	21	6	64
Cumberlande	36978	19870612	Nos.1 & 2 holds flooded & foundered Manganese loaded	1	0	14	7	63
Mei Gui Hai	37236	19901106	Nos.2, 3 & 6 holds flooded Bauxite loaded	0	0	21	6	62
Karin Vatis	37765	19851115	No.5 hold flooded & subsequently sank Scrap iron loaded	1	0	12	7	61
Hennigsdorf	38070	19840919	Unknown hold flooded & sank Cargo unknown	1	0	18	7	60
Memed Abashidze	38250	19951222	Nos.3, 4 & 5 holds flooded & presumed to have foundered Steel loaded	1	3	17	?	58
Elounda Day	38250	19901218	No.2 hold flooded & subsequently foundered Potash loaded	1	0	17	7	59
On Tung	38373	19891125	Unknown hold flooded Bauxite loaded	0	0	16	7	57
Federal Schelde	38568	19870412	No.1 hold flooded Cargo unknown	0	0	10	7	56
Alam Sentosa	39110	20000625	Unknown holds flooded Coal loaded	0	0	8	?	112
Goulias	39219	19840826	No.1 hold flooded Alumina loaded	0	0	17	7	55
Al Taludi	41300	19900223	No.1 hold flooded Ballast	0	0	20	5	54
Capetan Sea	42127	19890430	Nos.4 & 7 holds flooded Manganese ore loaded	0	0	21	7	53
Vulca	42245	19891229	Nos.1&2 hold flooded & foundered Scrap iron loaded	1	0	22	7	52
Walter Leonhardt	42805	19900218	No.2 hold flooded & foundered Phosphate loaded	1	0	24	8	51
Stonepool	45027	19851201	No.1 hold flooded Ore loaded	0	0	18	7	50
China Progress	45090	20000214	No.1 hold flooded Copper Concentrate loaded	0	0	16	?	111
Ince Express	45877	19980130	No.1 hold flooded Copper concentrate loaded	0	0	13	5	49

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Korea Rainbow	46118	19870113	No.1 hold flooded Ore loaded	0	0	8	7	48
EA	49114	19890226	No.2 hold flooded Ore loaded	0	0	18	7	47
Turrís Octava	51666	19850211	Nos.1, 2 & 3 holds flooded Coal loaded	0	0	17	7	100
Theomitor	51717	19800813	No.7 hold flooded & sank Ore loaded	1	0	13	?	46
Delta Joy	52164	19960218	Unknown hold flooded Coal loaded	0	0	26	?	45
Askania Nova	52450	19970726	No.8 hold flooded Soya loaded	0	0	13	8	44
Continental Lotus	53346	19910121	No.5 hold flooded & foundered Ore loaded	1	38	24	8	43
Mount Olympus	54615	19951201	No.5 hold flooded Ballast	0	0	17	?	42

Panamax

Ademontasa	55120	19900414	No.6 hold flooded Barytes loaded	0	0	22	7	41
Hongjin	56127	19791224	Unknown hold flooded & presumed to have sunk Ballast	1	0	11	?	40
Starfish	56277	19910408	No.4 hold flooded & sank Ore loaded	1	0	21	7	39
Onomichi Maru	56341	19801230	Nos.1 & 2 holds flooded Broke in two & subsequently sank Coal loaded	1	0	14	8	38
Carnival	56494	19860306	No.3 hold flooded Wheat loaded	0	0	14	7	36
Carnival	56494	19880828	No.4 hold flooded Coal loaded	0	0	16	7	37
Vasso	57181	19910404	No.1 hold flooded & sank Ore loaded	1	0	24	8	35
San Marco	57850	19931112	No.1 hold flooded, sold & broken up Phosphate loaded	1	0	25	7	34
Academy Star	57910	19820319	No.1 to 6 holds flooded & subsequently broken up Coal loaded	1	0	14	6	33
Leader L	62322	20000323	No.4 hold flooded & foundered Salt loaded	1	18	23	7	110
Snestad	62503	19891217	Unknown hold flooded Bauxite loaded	0	0	17	7	32
Entrust Faith	63533	19911127	No.1 hold flooded & subsequently sank Ore loaded	1	0	18	7	31
Forum Trader	64438	19910228	No.7 hold flooded Ore loaded	0	0	17	7	30
Cathay Seatrade	64620	19870106	Not since heard of (detail unknown) Ore loaded	1	27	14	7	29*
Peace	64912	19990128	Unknown hold flooded & sank Scrap Iron loaded	1	0	27	?	109
Great Eagle	65230	19920531	Nos.5, 6 & 7 holds flooded & foundered Ore loaded	1	0	24	7	28
Mineral Star	66350	19900125	Nos.1 & 2 holds flooded & sold & broken up Coal loaded	1	0	17	9	27
Seafaiith	68275	19960217	Broke in two & foundered Ore loaded	1	19	13	9	26*
Silimna	69165	19900527	Nos.2 & 3 holds flooded & subsequently sank Ore loaded	1	0	12	7	25
Melete	72063	19910824	No.1 hold flooded & foundered Ore loaded	1	25	16	8	24
Docebrisa	75594	19980419	No.2 hold flooded Ore loaded	0	0	17	?	23

Cape-size

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Protektor	80185	19910111	Nos.2 & 4 holds flooded & presumed to have foundered Ore loaded	1	33	24	9	22
Petingo	80580	19900630	No.3 hold flooded & subsequently sank Ore loaded	1	0	23	9	21
Starlauro Uno	81876	19890319	Unknown hold Ore loaded	0	0	15	9	20
Yarrowonga	85180	19890109	Unknown hold flooded Ballast	0	0	18	9	19
Lafumina	89529	19790120	No.8 hold flooded Ballast	0	0	11	11	18
Alpha Star	103332	19931226	No.2 hold flooded & broken up Iron ore loaded	1	0	21	9	84
Orient Pioneer	108504	19900107	Unknown hold flooded & subsequently sank Ore loaded	1	0	19	9	17
Goldean Mariner	115721	19841217	No.5 hold flooded Ore loaded	0	0	14	9	15
Testarossa	115721	19870113	No.1 hold flooded & sank Ore loaded	1	30	17	9	16
Manila Transporter	115960	19910707	No.3 hold flooded & sank Ore loaded	1	0	15	9	14
Lika	118733	19921220	No.1 hold flooded Ore loaded	0	0	16	9	13
Iapetos	119500	19910316	No.5 hold flooded Ballast	0	0	18	9	103
Pythia	120143	19901031	Nos.2 & 3 holds flooded Ore loaded	0	0	17	9	12
Tao Yuan Hai	122734	19900523	Nos.3, 5, 6 & 7 holds flooded & presumed to have foundered Ore loaded	1	0	13	9	11
Shin-Kakogawa Maru	124292	19940606	No.1 hold flooded Ore loaded	0	0	13	9	10
Kamari	127283	19940225	Nos.1, 2, 3 & 8 holds flooded & subsequently sank Ore loaded	1	0	21	9	9
Tribulus	127907	19900205	No.8 hold flooded Ore loaded	0	0	9	9	8
River Plate	131260	19930726	No.5 hold flooded Ore loaded	0	0	19	9	7
Apollo Sea	131305	19940620	Foundered (detail unknown) Ore loaded	1	36	21	9	6*
Iolcos Victory	132597	19960914	Nos.1, 2 & 3 holds flooded & foundered Ore loaded	1	5	16	9	5
Blooming Orchard	140440	19910806	No.7 hold flooded Ore loaded	0	0	21	9	4
Mineral Diamond	141028	19910411	Not since heard of / Broke in two Ore loaded	1	26	9	9	3*
Treasure	143731	20000614	No.4 hold flooded & foundered Iron Ore loaded	1	0	17	9	108
Salvia	153256	19910209	No.1 hold flooded & subsequently sank Ore loaded	1	0	21	12	2
Berlisa	154489	19910520	No.1 hold flooded Ore loaded	0	0	16	9	1

**Table B2 Identified cases involving other compartment flooding due to structural failure
excluding stranding, collision, etc**

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
<i># Small-handy</i>								
Jelau	10113	19791014	E/R flooded & presumed to have foundered Logs loaded	1	0	5	?	O57
Porn Udom	16504	19891008	FPT flooded & presumed to have foundered Tapioca loaded	1	26	20	4	O56
Meliksah	17677	19990823	E/R flooded & subsequently sank Fertiliser loaded	1	0	22	?	O55
Rhodian Sailor	18406	19821226	FPT flooded & foundered List and holds flooded Cement in bags loaded	1	5	20	7	O53
Tai John	18742	19811230	DBT flooded & sold for breaking up Unknown voyage	1	0	20	5	O54
Sally	20003	19891110	DB flooded Unknown voyage	0	0	23	7	O44
Cara	21164	19810221	APT flooded Unknown cargo	0	0	16	6	O47
Industrial Trader	21546	19880310	BHT flooded Salt loaded	0	0	18	6	O46
Jollity	22623	19961113	E/R flooded Unknown voyage	0	0	21	?	O45
<i># Handy-size</i>								
Cape Race	23310	19851114	APT flooded Unknown voyage	0	0	14	6	O43
Eagle II	24622	19950909	E/R flooded Steel loaded	0	0	17	?	O21
Star Carrier	25110	19870622	E/R flooded & subsequently sank Scrap iron loaded	1	0	20	6	O42
Captain Veniamis	25575	19920125	FPT & DT flooded Sold for breaking up Calcium Nitrate loaded	1	0	25	7	O59
Vitocha	25864	19950604	E/R flooded Potash loaded	0	0	18	7	O20
Haris	26151	20000613	E/R flooded Rice loaded	0	0	18	?	O58
Victoria City	26289	19820829	E/R flooded Soyabeans loaded	0	0	12	5	O18
Countess	26499	20000527	E/R flooded Lam coke in bulk loaded	0	0	24	?	O52
Eli Marie	26646	19950401	BHT flooded Potash loaded	0	0	22	7	O41
Pacduchess	26680	19930108	E/R flooded Unknown voyage	0	0	18	5	O17
Macarena	26958	19810302	FPT flooded Ballast	0	0	8	7	O40
Meryem Ana	27071	19960213	E/R flooded Scrap loaded	0	0	24	?	O38
Jag Shanti	27071	19940528	E/R flooded & subsequently sank Pellets loaded	1	0	22	7	O39
Glorious	27198	19790610	E/R flooded Pellets loaded	0	0	25	7	O37
Norquest	27376	19920604	TST flooded Alumina loaded	0	0	20	5	O48
Iman	27398	19960720	E/R flooded & broken up Cement clinker loaded	1	0	24	?	O50
Mont Fort	27614	19860104	DB flooded Unknown cargo	0	0	17	7	O36
Marina Mistral	27890	19891113	BH WBT flooded Unknown voyage	0	0	21	7	O35

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
I. Van	28393	19920106	FPT & DBT flooded Unknown cargo	0	0	26	7	O34
Corazon	28757	19900731	FPT flooded & subsequently broke in two and foundered Cement loaded	1	6	18	7	O33
Zara	29171	19911030	ER flooded Ballast	0	0	14	7	O32
Holly	29255	19960426	DB flooded Unknown voyage	0	0	19	?	O16
Federal St. Laurent	30350	19890126	DB.WBT flooded Unknown voyage	0	0	11	5	O31
Hercegovina	30880	19941205	DB flooded Unknown voyage	0	0	17	7	O30
Venture Star	32587	19850326	WBT flooded Containers loaded	0	0	4	5	O49
Huandoy	34602	19861112	FPT flooded Unknown cargo	0	0	21	7	O29
Glyfada Faith	35083	19811113	FPT flooded Grain loaded	0	0	15	7	O28
Chian Mariner	35224	19980411	E/R flooded & foundered Manganese ore loaded	1	0	24	?	O27
Federal Mackenzie	35315	19920131	DB WBT flooded Unknown cargo	0	0	9	7	O26
Louis	35593	19860107	WBT flooded Gypsum loaded	0	0	25	5	O25
Federal Calumet	35887	19871021	DB FOT flooded Unknown cargo	0	0	10	7	O24
Xue Hai	46585	19831106	E/R flooded Ore loaded	0	0	6	7	O22
# Panamax								
Marcona Trader	64427	19810228	FPT flooded Coal loaded	0	0	15	7	O14
China Glory	64615	19920505	FPT flooded Unknown voyage	0	0	2	7	O12
Theanoula	72063	19910425	E/R flooded Bauxite loaded	0	0	17	8	O11
Nikitas Roussos	72203	19940828	E/R flooded Soya beans loaded	0	0	18	8	O10
Rani Padmini	76384	19971009	DB FOT flooded Unknown voyage	0	0	11	9	O9
Hermes	78079	19940622	E/R flooded Grain loaded	0	0	18	9	O8
Konpolis	78572	19890825	E/R flooded Oil loaded	0	0	11	9	O7
King William	79304	19910819	E/R flooded Unknown voyage	0	0	17	9	O13
# Cape-size								
Cape North	85180	19900122	DB.WBT flooded Iron pellets loaded	0	0	19	9	O6
Konstantinos	99089	19871203	P/R flooded Coal loaded	0	0	15	9	O5
Bos Transporter	115280	19900117	P/R flooded Unknown voyage	0	0	21	9	O3
Karadeniz S	115280	19920330	E/R flooded & subsequently broken in two and sank Ore loaded	1	0	23	9	O4
Vakis T	130370	19990428	WBT flooded Iron ore loaded	0	0	20	?	O51
EB Carrier	161798	19890825	E/R flooded Ballast	0	0	15	11	O1
Suruga Maru	215158	19980313	Ballast tank flooded Coal loaded	0	0	11	9	O2

Table B3 Serious casualty due to structural failure without water ingress

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
# Small-handy								
Hea	12078	19981111	Damage in upper deck Unknown voyage	0	0	16	?	S51
Fjordnes	12352	19870111	Damage in side shell Part loaded	0	0	4	4	S50
Medstar	17659	19800414	Unknown damage Ballast	0	0	18	6	S49
Forum Sun	19630	19851127	Unknown damage Sugar loaded	0	0	23	7	S48
Semira	21052	19801213	Unknown damage Unknown voyage	0	0	15	6	S47
Valor	22631	19960727	Unknown damage Petroleum coke loaded	0	0	24	5	S46
Wan Ling	22670	19971201	Damage in side shell iwo No.? hold DAP loaded	0	0	21	?	S45
# Handy-size								
Elka	18044 (GT)	19830818	Damage in side shell iwo No.7 hold Manganese ore loaded	0	0	19	7	S52
Georgios	23811	19911209	Unknown damage Unknown voyage	0	0	21	7	S44
Slavianka	24750	19791204	Damage in girder iwo double bottom Rape seed loaded	0	0	1	7	S43
Atlantis Two	26066	19980209	Damage in upper deck Unknown voyage	0	0	17	?	S42
Singa Saga	26586	19910224	Damage in TST boundary Ballast	0	0	14	5	S41
Kilmun	26931	19830108	Damage in side shell iwo FPT /bos'n store Wheat loaded	0	0	7	5	S40
Lok Priti	26999	19840101	Unknown damage Unknown voyage	0	0	3	7	S39
Flinders Range	27500	19800318	Damage in poop deck Unknown voyage	0	0	3	6	S38
Winter Star	28660	19981201	Damage in upper deck /side shell Unknown voyage	0	0	20	?	S37
Arti	29336	19930704	Damage in hold frames Steel loaded	0	0	23	?	S36
Star Malaysia	29486	19820308	Damage in side shell iwo TST Unknown voyage	0	0	12	5	S35
Star Singapore	29959	19830408	Damage in double bottom Unknown cargo loaded	0	0	13	5	S34
Cissus	33529	19840113	Damage in forward bottom Unknown voyage	0	0	10	5	S33
Neo Palmira	38962	19910906	Damage in hold frames Unknown cargo loaded	0	0	14	5	S32
Chennai Ookkam	43816	19821226	Unknown damage Unknown voyage	0	0	16	7	S31
Damodar Tanabe	45282	19840321	Damage in double bottom Unknown voyage	0	0	15	7	S30
Cast Beaver	51666	19800228	Damage in forward bottom Slag/pig iron/containers loaded	0	0	12	7	S29
# Panamax								
Hopeclipper	57181	19810107	Damage in side shell iwo No.6 deep tank hold Ballast	0	0	14	8	S27
Hopeclipper	57181	19840229	Unknown damage Ballast	0	0	17	8	S28
Virginia	58509	19801114	Damage in trans. bulkhead iwo No.? deep tank hold Ballast	0	0	12	7	S26
Amber Pacific	59113	19781202	Damage in trans. bulkhead iwo No.6 deep tank hold Ballast	0	0	9	8	S25

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Pan Journey	64473	19870902	Damage in double bottom Unknown voyage	0	0	12	7	S24
Juliana	65455	19901117	Damage in side shell iwo No.5 hold Ballast	0	0	19	9	S23
Cambridgeshire	71600	19810301	Damage in side shell iwo No.? hold Sulphur loaded	0	0	5	8	S22
Doddsland	76284	19870217	Unknown damage Oil loaded	0	0	2	9	S21
# Cape-size								
Navios Patriot	80873	19801023	Damage in side shell iwo No.6 deep tank hold Ballast	0	0	13	9	S20
Arnaki	81881	19951125	Damage in upper deck iwo No.1 hold Unknown voyage	0	0	21	9	S19
Seneca	84790	19861125	Unknown damage Oil loaded	0	0	11	9	S18
Arcade Sun	103637	19891225	Damage in upper deck iwo TST Oil loaded	0	0	17	9	S17
Iron Shortland	107140	19801007	Damage in trans. bulkhead iwo No.4 <i>deep tank</i> hold Ballast	0	0	1	9	S16
Iron Sirius	107477	19800318	Unknown damage Unknown cargo loaded	0	0	13	11	S15
Vallathol	114147	19901130	Unknown damage & sold and broken up Iron ore loaded	1	0	14	9	S14
Australian Pioneer	122600	19830123	Damage in tank top Iron ore loaded	0	0	7	9	S13
Aida	123768	19950228	Damage in side shell iwo No.? hold Iron ore loaded	0	0	20	?	S11
Protoklitos 4	123768	19930618	Damage in hold frames iwo No.3 hold & towed out to sea and scuttled Iron ore loaded	1	0	19	9	S12
Vakis T	130370	19970915	Damage in bow Unknown voyage	0	0	18	?	S10
Diamond Sea	139346	19940306	Damage in side shell iwo No.? hold Unknown voyage	0	0	18	9	S9
Blooming Orchard	140440	19901020	Damage in upper deck iwo TST Unknown voyage	0	0	20	9	S8
Cape Providence	146019	19990924	Damage in side shell iwo No.3 hold Iron ore loaded	0	0	12	9	S7
Georgios M	148629	19971201	Damage in side shell iwo No.? hold Unknown voyage	0	0	15	?	S6
Rokko San	150900	19900124	<i>Damage in side shell iwo No.11 deep tank hold</i> Ballast	0	0	19	12	S5
Chickasaw	152329	19921208	Damage in tank top Ballast	0	0	5	9	S4
Newforest	155759	19870425	Damage in side shell iwo No.6 hold Ballast	0	0	15	11	S3
Kowloon Bridge	169080	19861118	Damage in upper deck iwo TST Ore loaded	0	0	13	9	S2
Tyne Bridge	169428	19820311	Damage in upper deck iwo TST Ballast	0	0	10	9	S1

Table B4 Identified cases involving water ingress due to hatch cover failure or miscellaneous closing device failure

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
<i># Small-handy</i>								
Remus	11960	19781211	Hatch cover damaged No flooding Unknown cargo loaded	0	0	7	3	H28
Bani	20216	19820218	Closing device for F'cle space damaged F'cle space flooded Unknown voyage	0	0	16	7	H27
<i># Handy-size</i>								
Oinoussian Pride	41824	19880730	E/R flooded Logs loaded	0	0	2	5	O23
Marine Electric	25985	19830212	Hatch cover had been non-tight due to poor maintenance FPT holed due to anchor hit No.1 hold & FPT flooded & capsized and sank Coal loaded	1	33	39	6	H19
Christinaki	26510	19940203	Hatch cover had been open No.1 hold flooded & foundered Scrap metal loaded	1	27	21	5	H18
Bluenorth	26586	19960119	<i>Hatch covers had been non-tight due to failure of rubber gaskets and corrosion hole</i> No.1&2 holds flooded Unknown cargo	0	0	26	5	H17
Amphion	26800	19960110	<i>Closing device (ventilator) for Nos. 1 & 2 holds damaged</i> No.1 & 2 hold flooded Steel loaded	0	0	18	?	H26
Lok Pratima	26925	19960215	<i>Hatch cover had been non-tight</i> No.? holds flooded Alumina loaded	0	0	7	7	H16
Lok Priti	26999	19890124	<i>Probably, hatch covers damaged</i> No.1 & 2 hold flooded Unknown cargo	0	0	8	7	H15
Skipper I	27345	19870429	Hatch cover damaged (<i>probably No.1</i>) <i>Probably No.1 hold flooded</i> Presumed to have foundered Scrap iron loaded	1	0	14	5	H14
Montrealais	27840	19931017	<i>Pontoon hatch covers washed away (5 of 20 total, perhaps incl. No.1)</i> <i>Probably, hold flooded</i> Unknown voyage	0	0	31	5	H13
Arctic	28096	19811026	Hatch cover damaged No.2 hold flooded Unknown voyage	0	2	3	7	H12
Alberta	30820	19910307	Closing device for F'cle space damaged F'cle space flooded Unknown voyage	0	0	7	6	H25
Epta Dafnes	31510	19820913	Hatch cover had been non-tight No.2 to 7 hold flooded Cement loaded	0	0	18	7	H11
Mezada	31554	19810307	Hatch cover washed away No.1 hold flooded & foundered Potash loaded	1	24	21	?	H10
Marina di Equa	32818	19811229	Hatch cover opened No.1 hold flooded & sank Steel loaded	1	30	9	?	H9
Chandragupta	37685	19780105	Pontoon hatch cover washed away No.1 hold flooded & presumably sank Wheat loaded	1	69	15	?	H8

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Al Maieed	45501	19881202	Closing device for bos'n store damaged Bos'n store flooded Unknown cargo	0	0	3	6	H24
Sandalion	46050	19801127	Hatch covers damaged No.1&2 hold flooded & sank Coal loaded	1	0	17	?	H7
Edera	46433	19790216	<i>No.1 hatch cover damaged</i> <i>No.1, 2 & 3 hold flooded</i> Ore loaded	0	0	17	7	H6

Panamax

Maratha Mariner	65085	19830920	Closing device for bos'n store damaged Bos'n store flooded Grain loaded	0	0	7	6	H23
Nagos	74543	19930526	<i>Sank...after a hold flooded when a hatch cover was washed away (Lloyd's list dated on 1993/5/28)</i> <i>Probably No.1 hold flooded</i> Coal loaded	1	17	24	8	H4
Mineral Luxembourg	75203	19820216	Closing device for bos'n store damaged Bos'n store flooded Unknown cargo	0	0	5	7	H22

Cape-size

Victory 3	97947	19850123	No.8 hatch cover washed away <i>Probably, No.8 hold flooded</i> Ballast	0	0	17	9	H3
Ostia	103095	19850329	No.2 hatch cover damaged <i>Probably cargo oil leaked</i> Oil loaded	0	0	12	9	H29
Goldstar	145057	19870729	<i>Probably, crack occurred in top plate of No.1 hatch coaming</i> <i>Probably cargo oil leaked</i> Oil loaded	0	0	15	9	H2
Winna	146368	19890130	Hatch cover damaged No.1 hold flooded Ore loaded	0	0	18	11	H1
Derbyshire	169044	19800909	<i>Fore end part incl. fore peak tank flooded</i> <i>No.1 hold progressively flooded & sank (by UK/EC assessor's report)</i> Ore loaded	1	44	4	9	H21

Table B5 Identified cases involving total loss or serious casualty due to cargo shift

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
# Small-handy								
Sevasti	15147	19890429	Cargo shifted & foundered Timber loaded	1	0	18	3	F13
Summer Sky	19469	19910130	Cargo shifted Containers/vehicles/ machinery loaded	0	0	17	4	F12
Golden Harvest	20203	19980608	Cargo shifted & presumed to have foundered Diammonium phosphate loaded	1	24	23	?	F11
Sunset	20932	19910730	Cargo shifted Holds flooded & foundered Steel products loaded	1	0	21	5	F10
Dayspring	21241	19870623	Cargo shifted Holds flooded & presumed to have foundered Lead concentrates loaded	1	0	17	6	F9
Sea Prospect	21297	19980826	<i>Cargo shifted</i> Capsized & sank Nickel ore loaded	1	10	2	5	F8
Oriental Angel	21373	19900609	Cargo shifted Nickel ore loaded	0	0	7	4	F16
Iron Prince	21735	19840326	Cargo shifted No.2 hold flooded Tin plate loaded	0	0	3	4	F7
Oak	21951	19971231	Cargo shifted Timber loaded	0	0	16	?	F17
Pollux	13451	19910411	Cargo shifted Copper concentrate loaded	0	0	7	2	AS1
Ponteceso	9306	19840223	Cargo shifted Galena loaded	0	0	4	3	AS2
# Handy-size								
Garza Star	23757	19850423	Cargo shifted Accommodation flooded Logs loaded	0	0	8	4	F6
Cape Antibes	24090	19850815	<i>Cargo shifted</i> No.4 hold flooded Container loaded	0	0	13	5	F5
Asia No.12	25504	19810701	Cargo shifted Lumber loaded	0	0	1	4	F14
Ocean Orchid	26369	19960220	Cargo shifted <i>No.5 hold flooded</i> Logs loaded	0	0	5	?	F4
Angele N	26548	19880325	Cargo shifted Timber loaded	0	0	14	5	F15
Artemis	30190	19801227	<i>Cargo shifted</i> FPT & No.1 hold flooded & sank Timber loaded	1	0	7	?	F3
Mega Taurus	30413	19881216	<i>Cargo shifted & capsized</i> Not since heard of Nickel ore loaded	1	20	8	5	F2
Esmeralda I	36800	19911010	Cargo shifted No.1 hold flooded Containers loaded	0	0	7	5	F1

Table B6 Exceptional cases such as casualty during out of voyage,
e.g. valve/piping failure, accident whilst loading / discharging / ballasting, etc

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
<i># Small-handy</i>								
M. Sycourtris	10440	19850916	E/R flooded whilst in tow Pig iron loaded	0	0	25	4	E46
Sea Queen	12126	20000422	Hull girder buckled whilst loading & broke in two	1	0	28	?	E45
Alastair Guthrie	13730	19790418	E/R flooded (valve) & sank Grain loaded	1	0	57	?	E44
D. G. Kerr	13910	19801212	Unknown compartment flooded whilst in tow for demolition & sank	1	0	64	?	E43
Beechglen	14808	19910430	Hull girder buckled whilst unloading	0	0	49	4	E42
Cidade de Sao Paulo	14960	19940228	E/R flooded in moderate sea Grain loaded	0	0	15	4	E41
Shanta Rohan	16180	19890728	WBT flooded in moderate sea Muriate of potash loaded	0	0	20	4	E52
Trans Sapphire	16665	19780801	E/R flooded (stern tube) Fertilizer loaded	0	0	26	?	E40
Anastasia	17567	19960306	E/R flooded in moderate sea Grain loaded	0	0	22	?	E53
Marvi Salvador	17966	19971118	E/R flooded whilst berthed	0	0	30	?	E39
Roubini	18494	19941203	E/R flooded in Great Lakes Mixed grain loaded	0	0	12	4	E38
Asia Grace	19457	19800227	Side shell fractured whilst loading	0	0	11	4	E37
Lung Hao	20372	19890911	Stranded and broke in two after moorings parted Subsequently sold & broken up	1	5	23	6	E36
Vonita	20800	19821109	E/R flooded (No detail) Unknown voyage	0	0	0	4	E35
Grigoroussa	22258	19980928	E/R flooded (stern tube) & broken up Unknown voyage	1	0	26	5	E34
<i># Handy-size</i>								
Philippine Victory	29496	19900416	E/R flooded Unknown cargo	0	0	20	5	O15
Dunav	25200	19801209	No.1 hatch cover was beaten by derrick boom No.1 hold flooded & has not been heard of since Steel loaded	1	32	7	?	H20
Saronis	23592	19850807	E/R, duct keel flooded whilst moored	0	0	23	7	E33
Deka Concorde	23969	19820119	Deck cracked whilst unloading (copper concentrate)	0	0	14	5	E48
Frotasul	25231	19811214	Ballast water leaked into adjacent compartment through corrosion hole	0	0	14	6	E32
Zachary	26510	19921218	Unknown hold flooded whilst discharging	0	0	19	5	E30
Orgullo	26600	19960214	No.2 hold flooded whilst discharging	0	0	20	?	E29
Golden Promise	26610	19920504	Ballast water leaked into adjacent compartment Steel products/ timber loaded	0	0	19	4	E28
Canadian Harvest	31413	19951203	Broke in two whilst in tow for demolition Presumed to have foundered	1	0	30	6	E27
Mar Atlantico	33529	19890908	Holds, E/R flooded during drydocking	0	0	19	7	E26
Rodlo	33742	19870301	Unknown damage whilst anchored	0	0	2	5	E49
Jade Pacific	34537	19950717	No.5 hold flooded whilst loading	0	0	18	5	E25
Caspian Sea	36273	19810325	No.5 hold flooded whilst loading	0	0	13	8	E24
Kiwi Arrow	38695	19910406	E/R flooded (piping) Steel loaded	0	0	10	5	E23
Arabela	38801	19840826	E/R flooded (valve) whilst discharging	0	0	5	7	E22
Michalakakis	41150	19960325	FPT flooded in moderate sea Unknown voyage	0	0	28	?	E51
Lucy	51452	19810906	E/R flooded (piping) Maize loaded	0	0	14	8	E19

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
Cast Beaver	51666	19801223	E/R flooded (stern tube) Containers loaded	0	0	12	7	E18
# Panamax								
Orient Trader	60200	19840220	E/R flooded whilst loading	0	0	1	7	E17
Orient Trader	63942	19870607	E/R flooded (valve) whilst anchored	0	0	4	7	E16
Hsing May	65000	19940714	E/R flooded whilst discharging	0	0	4	7	E15
Nand Schivchand	65075	19870806	E/R flooded (piping) Ballast	0	0	5	7	E14
World Star	69582	19930104	Steering compartment flooded (non-structural) Unknown voyage	0	0	8	7	E13
Bjorghav	73816	19780322	P/R flooded in moderate sea Oil loaded	0	0	11	11	E50
Kaptan Ziya Sonmez	74543	19900223	Coll.bulkhead cracked whilst loading (coal)	0	0	21	8	E47
TNT Capricornia	75105	19880104	P/R flooded (piping) whilst ballasting	0	0	5	4	E12
El Aalim	75485	19890131	FPT flooded whilst anchored	0	0	6	7	E11
Main Ore	75806	19840702	Trans. BHD collapse whilst departing (ore loaded) Subsequently sold for demolition	1	0	18	9	E10
Jhansi Ki Rani	76583	19870205	Foundered whilst in tow for demolition after stranding	1	4	13	9	E9
Afthoros	77727	19920501	E/R flooded (piping) whilst loading Subsequently broken up	1	0	23	9	E8
Saxonia	78130	19840109	E/R & P/R flooded (piping) whilst oil loading	0	0	11	9	E7
# Cape-size								
Thalassini Tyhi	99518	19780810	E/R flooded whilst discharging	0	0	10	9	E6
K.S. Venture	102816	19901018	E/R flooded whilst at anchor	0	0	20	7	E5
Trade Daring	134999	19941111	<i>Hull girder collapsed whilst loading</i>	1	0	22	9	E4
Giga 2	140086	19961105	<i>Trans. BHD collapse whilst ballasting</i>	0	0	15	9	E3
Golden Phoenix	150001 129017	19841010	Duct keel flooded (piping) whilst loading	0	0	1	9	E2
Saldanha	172173	19991125	E/R flooded (No detail) Ballast	0	0	4	?	E1

Table B7 Total loss casualty due to water ingress caused by collision, contact, etc

Name	DWT	Date of event	Note	Total loss indicator	Number of fatalities	Age of ship at casualty	Number of cargo holds	Ref. ID
# Small-handy								
Feddy	20509	19810210	Sank after collision (Unknown hold flooded) Steel scrap loaded	1	32	19	?	C9
Pan Nova	22464	19830909	Nos.2 & 3 holds flooded Sank after collision Wheat loaded	1	0	5	5	C16
Star K.	22639	19780719	Sank after collision (Unknown hold flooded) Ballast	1	2	17	?	C8
# Handy-size								
Arctic	26440	19960822	BHT flooded (ice damage) Unknown voyage	0	0	18	7	E31
Zeno	40300	19880303	No.1 hold flooded (cargo contact) whilst loading	0	0	6	5	E21
Oriental Viking	42842	19950309	E/R flooded (<i>pipng</i>) Unknown voyage	0	0	10	5	E20
Ocean Ace	24740	19810821	Sank after collision (No.5 hold & E/R flooded) Steel products loaded	1	1	4	?	C7
Paris	25957	19950104	Sank after collision (Unknown hold flooded) Empty	1	27	23	5	C6
Anna Spiratou	26098	19960615	Sank after collision (Unknown hold flooded) Steel billets loaded	1	26	18	?	C5
Pacbaroness	26681	19870921	Sank after collision (Unknown hold flooded) Copper concentrates loaded	1	0	11	5	C15
You Xiu	26802	19950104	Sank after collision (Unknown hold flooded) Empty	1	27	3	5	C4
Regal Sword	27905	19790618	Sank after collision (Unknown hold flooded) Scrap iron loaded	1	0	18	?	C14
Fidelity	28124	19840518	Sank after collision (Unknown hold flooded) Steel loaded	1	3	17	6	C3
Quatsino Sound	29819	19870214	Sank after collision (Unknown hold flooded) Copper ore loaded	1	0	6	5	C13
Wei Hai	31825	19940525	Sank after collision (Unknown hold flooded) Coal loaded	1	0	30	7	C12
Kumanovo	39674	19890105	Sank after collision (Unknown hold flooded) Coal loaded	1	0	23	7	C11
# Panamax								
Icl Vikraman	55881	19970926	Unknown hold flooded Broke in two & sank after collision Steel coils loaded	1	29	18	?	C2
Riviera Sky	56469	19860112	Sank after collision (Unknown hold flooded) Unknown voyage	1	0	19	7	C10
# Cape-size								
Mineral Dampier	170698	19950622	Sank after collision (Unknown hold flooded) Iron ore loaded	1	27	9	9	C1
