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MARITIME CASUALTY TABULATION
(1972)

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JANUARY 1975

FINAL REPORT

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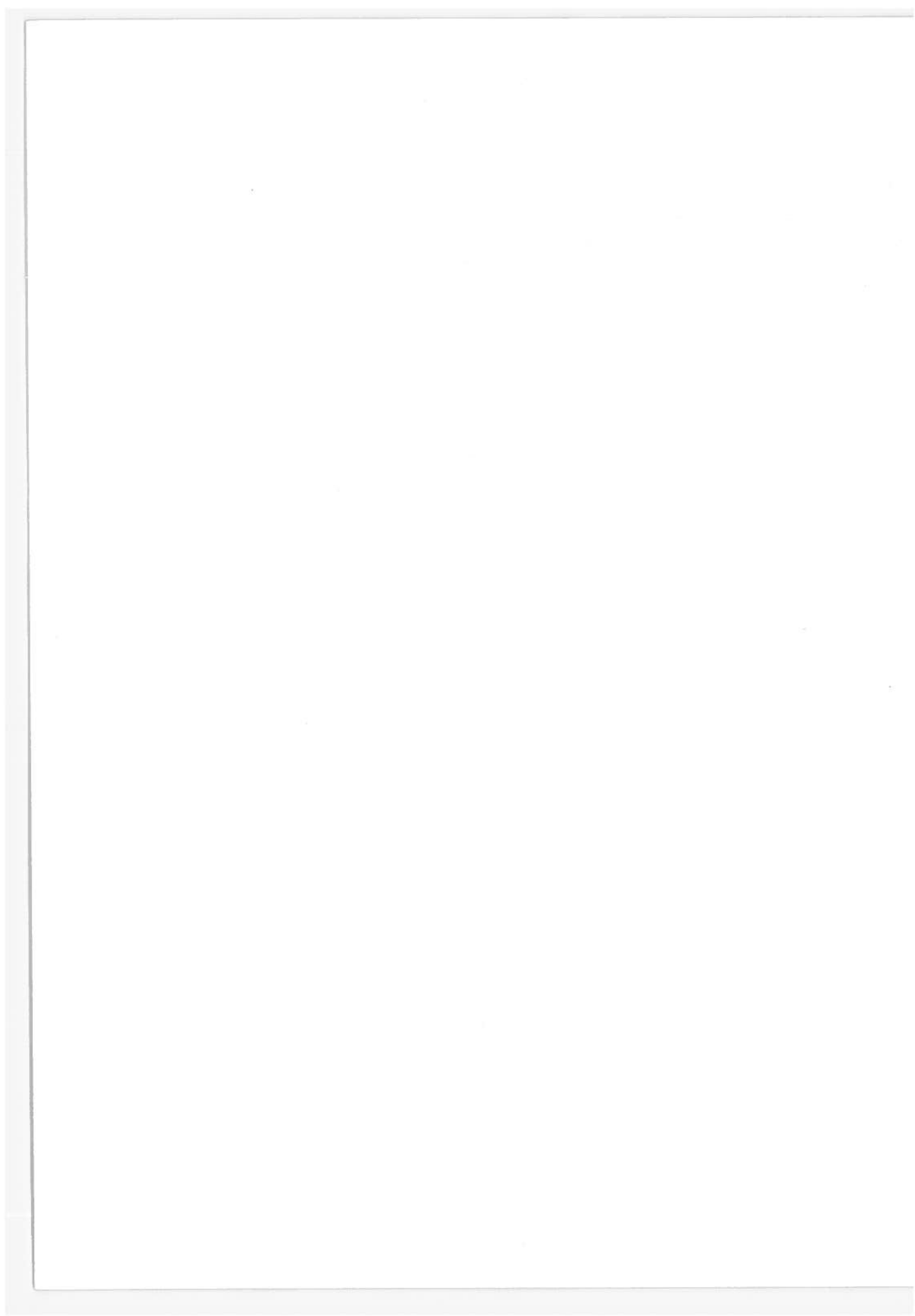
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16. Abstract <p>This report creates a data base of the maritime casualties during 1972 which would have been candidates for a distress channel in a satellite communications service.</p> <p>There are 1546 casualties recorded in this report for the calendar year 1972; of these casualties 796 were large ocean crossing vessels. The ocean crossing casualty list includes 54 vessels sunk, 158 collisions, 289 emergencies, 118 run aground and 177 suffering weather damage. These 796 vessels represent 13% of the total casualties, 500 gross ton or over, occurring during this time period. This percentage could use a satellite communication service for distress alerting and search and rescue. The remaining 87% of the casualties happened close to shore, in harbors, on lakes, canals or rivers and would use conventional communication service.</p>					
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PREFACE

The casualty tabulation described in this report was performed in the context of an overall program at the Transportation Systems Center supporting system definition, design and development of a satellite communications service for the maritime community. This program was sponsored by the United States Coast Guard, Office of Research and Development. The program supports Government activities designed to promote maritime safety through improved communication service.

The maritime casualties of the year 1972 were separated into 1) those casualties which happened at a location where satellite communication would provide the most reliable service, and 2) those close to shore (within 30 nautical miles), using VHF, HF or other conventional service. In addition, a distinction was made between ships that cross the ocean and those that do not. These separations and distinctions are included in the casualty tabulation and form the data base for satellite experiments.

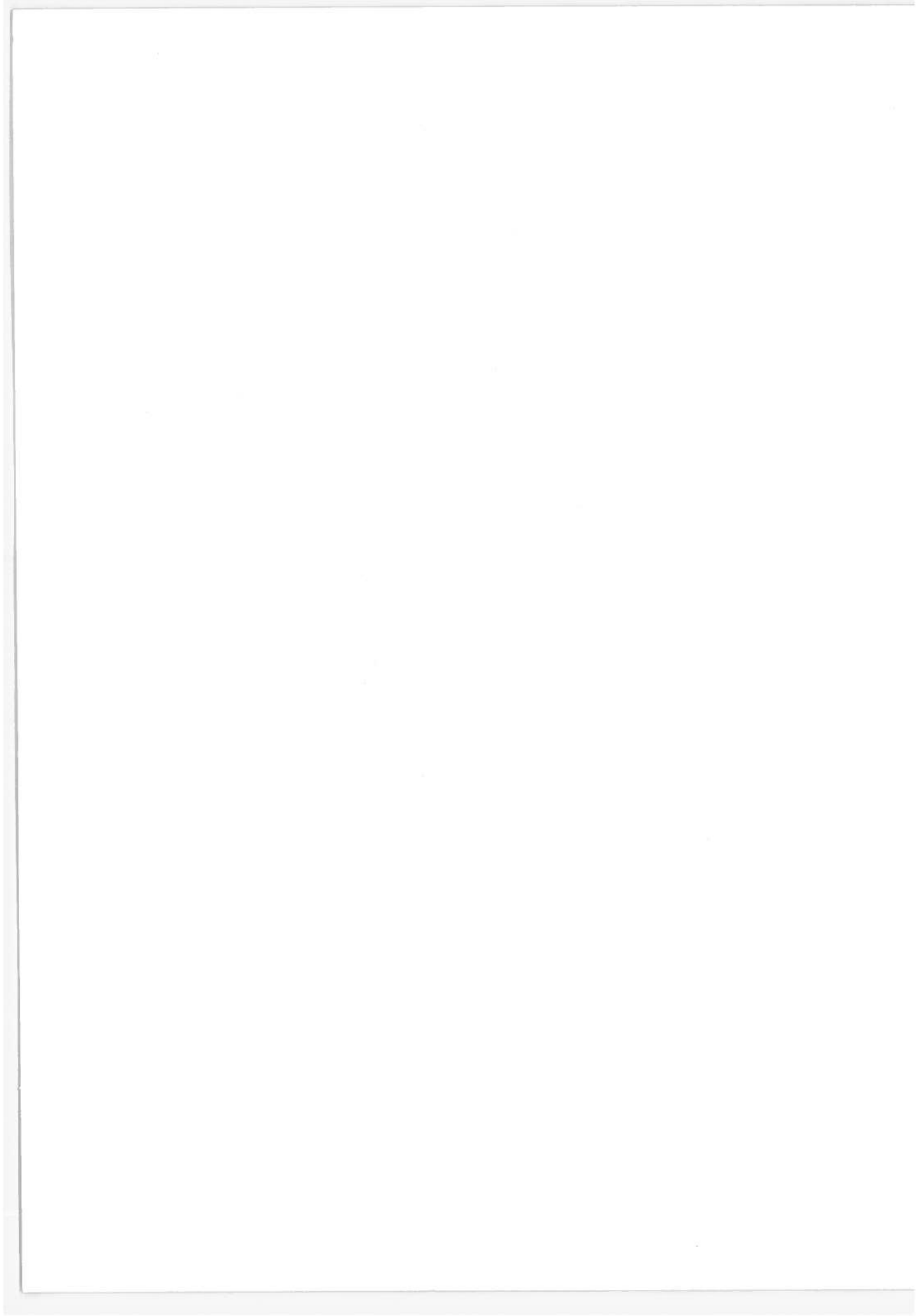


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1. INTRODUCTION

The application of satellite technology to the communication requirements of the maritime industry has received a good deal of attention in the past few years. The need for reliable, high quality communications is primarily economic. Improved communications can be the key to increased efficiency of shipping operations. Another very important need for reliable communications are the safety functions, distress alerting and search and rescue.

To define the requirements of the distress function the Department of Transportation, Transportation Systems Center has accumulated a data base of maritime casualties for the calendar year 1972. This data base will be used to establish a simulator experiment for search and rescue, which will result in recommendations for channel usage, accessing techniques, distress alerting methods, emergency interrupt procedures and other operational characteristics. In addition, the results will be used to recommend the development of shore station and satellite system equipment for the collecting and processing of distress calls.

There are several organizations that collect and publish the maritime casualty information. This published material, however, can not be directly used to establish these distress alerting, search and rescue requirements. These publications, such as Lloyd's Weekly Casualty Reports and the Liverpool Underwriters Association's Casualty Returns, do not differentiate between casualties which would continue to use conventional communication systems and those which would be candidates for satellite communications. For this reason the Casualty Tabulation was created. The Casualty Tabulation is based on the Lloyd's of London Weekly Casualty Reports and the Lloyd's Shipping Index. Weekly Lloyd's of London reports the marine, aircraft and major catastrophies. The listed marine casualties include all vessels, such as yachts, fishing ships, coasters and ocean crossing vessels. The list includes all the casualties, regardless of where they happen, whether in harbors, on rivers, lakes, canals or on the high seas.

The categories of casualties include collisions, sinkings, groundings, weather damage and miscellaneous emergencies such as fire, explosions, and loss of power. All of the above are reported in the Lloyd's Weekly Casualty Report. The Lloyd's Shipping Index records the movements and latest reports received at Lloyd's of all merchant vessels, except coasters, yachts and fishing vessels, and any vessels trading between the United Kingdom and ports on the continent, between the Skaw and Loire, between North Cape and Loire, and between Dunkirk and any port in the Mediterranean.

For a satellite experiment to be valid, the data base must be divided between those casualties that happen at a position where satellite communications would provide the most reliable service and those that would be close to shore (within 30 nautical miles) and could thus use VHF, HF or other conventional service. To further classify the casualties, a distinction must be made between ships that cross the ocean and those that do not. These separations and distinctions are made in the Casualty Tabulation.

There were 1546 casualties recorded in the tabulation for the calendar year 1972. Of these casualties, 796 vessels were large ocean crossing craft listed in Lloyd's Shipping Index. The list includes 54 vessels that sank, 158 in collisions, 289 in emergencies, 118 aground, and 177 suffering weather damage. All 1546 casualties would be candidates for satellite communication service, since they were away from harbors, rivers, etc., when they were involved in the casualty. In particular, the 796 larger vessels by their size would be more likely to be outfitted for satellite service. For a comparison, the total number of vessels 500 gross ton and over reported by the Liverpool Underwriters as being in a casualty in 1972 is 6046 vessels. The 796 vessels listed in the tabulation as ocean crossing represents 13% of this total. The impact of these casualties on the design of a satellite communications service will be determined by simulation and experiments. The simulation will be validated by the data base.

2. OBJECTIVES

The objective of the Casualty Tabulation is to create a data base of the maritime casualties which would have been candidates for a distress channel in a satellite communications service.

3. SUMMARY

As mentioned in Section 1, 1546 casualties were recorded in the Casualty Tabulation for the calendar year 1972; of these, 796 were ocean crossing vessels. In the same time period Liverpool Underwriters recorded 6046 casualties of 500 gross ton or over. The 796 vessels of the Casualty Tabulation thus represent 13+1% of the total casualties. This group would use a satellite communication service for distress alerting and search and rescue. The remainder of the casualties, 87+1%, happened close to shore, in harbors on lakes, canals or rivers and would use conventional communication service.

Each day the Underwriters report, on the average, 17 casualties of 500 gross tons or over. The Tabulation records an average of 4 daily casualties, and 2 of these 4 are large ocean crossing vessels.

Forty to 60 percent of the casualties listed in the Tabulation occur in the five confluence areas: the English Channel, the General Mediterranean, the approaches to the Northeastern United States, the United States Gulf Coast and the Japan area. The remainder are distributed throughout the major traffic routes.

In 1972, January and February had the most casualties reported, 25%, while October had the least. During the week ending January 22 there were 43 casualty reports; of these 19 were from ocean crossing vessels. The least number of reports were received during the week ending June 3.

The casualty reports are not evenly distributed throughout the days of the week. Tuesdays and Fridays have the most reports while Saturday and Sunday have the least.

To accurately design a satellite experiment that demonstrates distress alerting, emergency interrupt and other safety related procedures the Casualty Tabulation will supply the statistical data base. In addition, the Tabulation will be used to "size" the communication channel requirements to insure reliable communications for safety functions.

4. DATA INPUT

For each week of the calendar year 1972 the Lloyd's Weekly Casualty Report was reviewed and all casualties on the high seas were extracted for the Casualty Tabulation. These casualties were correlated with the entries in Lloyd's Shipping Index to determine which were ocean crossing vessels. For each casualty the following data was tabulated: the name of the vessels, the date and time of the casualty, the type of casualty and the location.

4.1 SHIP NAME

The casualties are listed alphabetically by name and this is used as the index for tracking the casualty through subsequent issues of the Report. Yachts, degraders, barges, cranes, and lighters are indicated in the report in parenthesis next to the name. Vessels in the fishing fleet are identified. Ships listed in the Shipping Index are merchant vessels and trade across the oceans. The Index excludes coasters, yachts, and fishing vessels, and also any trading between the United Kingdom and ports on the continent (see Section 1).

4.2 TIME

The time of the casualties are usually listed as time referenced to G.M.T.; however, many emergency conditions persist for several days. The time used in the Tabulation is the time of the transmission of the distress message, unless the condition goes from an emergency to a disaster (the ship is abandoned). In this case the time at which the ship is lost is listed in the Tabulation. Some casualty times are local time or a range of time such as "... during the evening of May 19th..." In these cases local time is tabulated and "PM" for the range.

4.3 DATE

The date used in the Tabulation is the date of the distress message or the date when the ship is lost. Ships with heavy

weather damage report their casualty when they arrive at their destinations. This is the date used in the Tabulation and it can be up to one week after the actual storm.

4.4 TYPE

The following types of casualties are tabulated: sank, collisions, aground, weather damage, and emergencies. Ships which sink for any cause - collisions, fires, or going aground - are listed in just the sank category. Vessels first listed as emergencies and a week later reported as sunk remain listed in the first category. All tabulated sinkings occur outside of harbors, rivers, or canals. For a collision to be tabulated both ships must be moving and out of the harbors, rivers, and canals. The same criteria applies to emergencies, groundings, and weather damage. The emergency category requires a judgement for each casualty. If a vessel sends a distress message, it is included; if it launches a flare, it is not. A vessel requesting a tow or tug is included in the tabulation. Explosions and fires which result in personal injury or temporary loss of power are tabulated. Situations which result in sinkings outside of harbors, rivers, waterways, or canals are listed.

4.5 LOCATION

Latitude and longitude for all casualties are listed. If the data is not in the report, the nearest landmark is used for location; for example, "Aground near Isle of Texel," or "120 miles east of Cape Henry." The exception is weather damage reports that list the origin and destination of the voyage instead of the location of the event. For these, the weather damage is assumed to happen midway between the ports.

Examples of listings are shown below:

Name of the Vessel Reporting a Casualty:

MOSES COADY.--St. Lawrence, NF., Radio June 25,--at approximately 320 A.M., G.M.T. June 24, wooden motor fishing vessel Moses Coady, VC6111 burned in approximate position lat. 45 40 N., long. 57 53 W.

Time of Casualty Report:

RAFAEL LOTITO.--Gibraltar June 27-Gibraltar Radio reports: Following intercepted at 1:20 A.M., G.M.T.: SOS to all stations from Brest-La Conquet Radio: Following received at 1 A.M., G.M.T.: Motor vessel Rafael Lotito (Santos for Antwerp) aground stones near Ushant, position lat. 48 28 N., long. 05 08 W. Getting water by bottom, listing starboard side 20 deg. Problems with power supply. Need help urgently.

Date of Casualty Report:

MATTHEW FLINDERS.--Sydney June 26 - Flanders Shipping Co., Pty., Ltd., motor vessel Matthew Flinders arrived at Sydney P.M. June 24, from Japan, having sustained heavy weather damage to 10 containers on deck. Report of ten feet of water in bow-thrust compartment. Vessel sailed P.M. June 25 for Melbourne.

Location of Casualty:

AMERICAN RICE.--London, June 30.--The following message has been received from New York, dated June 28: Turbo-electric vessel American Rice, exproducer, on ballast voyage Bandar Shahpour for Tampa, lost rudder 700 miles east of Aden. Master requested tug assistance, which arranged. Vessel now being towed Bombay for survey and/or repairs.

5. DATA OUTPUTS

Four data plots are made each week from the tabulated casualties, consisting of weekly, monthly and yearly totals of the number of vessels sunk, collided, aground, damaged by weather and in a state of emergency. In addition, all the casualties are plotted on a monthly AMVER (Automated Mutual assistance Vessel Rescue) chart. From this plot the casualties in the confluence areas are extracted. The major confluence areas are the English Channel, the general Mediterranean, the approaches to the United States, and the coastal waters of Japan.

5.1 WEEKLY TABULATION

Each week the maritime casualty list is searched for accidents which would have used the communication service of a satellite system. The last tabulation for the six month period is that one dated July 4, 1972 Volume 208 number 13. It includes the accidents for the last week of June 1972. There were 24 casualties, of which 11 were ocean going vessels. All the ships (4) reporting damage caused by storms are listed in Lloyd's. Three of the 5 ships aground and 4 of the 10 emergencies were the larger ocean going type vessels. There were three collisions and two vessels sank, but none of the five were listed as ocean crossing vessels. (See Figure 1.) The last tabulation for the twelve month period is dated January 2, 1973, Volume 210 number 13. It includes accidents for the last week of December 1972. There were 22 casualties, of which 18 were ocean going vessels. All eleven vessels reporting storm damage were ocean crossing vessels. One of the three sunk, the two collisions, and four of the five emergencies were the larger ocean going type vessels. The one vessel aground was not listed in the Index.

5.2 MONTHLY TABULATION

The monthly tabulation is the total of the weekly tabulations (see Table 1). For each month the Lloyd's reference data are

NAME	DATE/TIME	CASUALTY	LOCATION
AMERICAN RICE	* June 28	EMERGENCY	700 miles east of Aden
BLISSVILLE	June 26 4 A.M.	EMERGENCY	PLACENTIA N.F.
GLENDIA	June 21	EMERGENCY	OFF PUERTO RICO
HING CHONG	* June 29	WEATHER	KOBE FOR AGABA
IRMA DELMAS	* June 17	EMERGENCY (FIRE)	ABIDJAN TO EUROPE
JESUS LASHERAS (TRAWLER)	June 29 6 A.M. GMT	SANK	LAT. 20 40 N, LONG 17-41 W
JUDITH ANN	* June 17, 18, 19	WEATHER	SAVANNAH FOR JAPAN
JUDITH R	* June	WEATHER	LISBON FOR CAPE TOWN
L.W. CHEMICAL	* June 26	EMERGENCY (POWER)	LAT 36 11N, Long 41 55 W
LORD MOUNT STEPHAN	* June 27 11:30 A.M.	EMERGENCY	OFF LAS PALMAS
MARGARETHA	June 24	AGROUND	OFF SIERRA LEONE NORTH SULINA
MATTHEW FLINDERS	* June 24	WEATHER	JAPAN FOR SIDNEY
MO NEER	June 24 8:50 P.M. GMT	EMERGENCY	LAT 34 07 N, LONG 16 05 E
MOSES COADY (FISHING)	June 24 3:20 A.M. GMT	SANK (FIRE)	LAT 45 40 N, LONG 57 53 W
MYRTEA	* June 25	AGROUND	PULO BUKOM (SINGAPORE)
PRESIDENT ADAMS	* June 28	AGROUND	CAPE LOOKOUT N.C.
RAFAEL LOTITO	* June 27 1:20 A.M. GMT	AGROUND	LAT 48 28 N, LONG 05 08 W
RAKOYO MARU	June 28 3 A.M.	COLLISION	AKASHI STRAIT
SHOEI MARU #10	" "	COLLISION	" " "
SAN JOSE (TRAWLER)	June 25	AGROUND	BRAZILIAN COAST
TRIDENT (RESEARCH)	June 27 10:15 A.M. GMT	EMERGENCY	LAT 39 35 N, LONG 57 53 W 700 m. West of NANTUCKET
TUNG MING	June 20	EMERGENCY	LAT 13 24 N, LONG 111 41 E
WAVE (FISHING)	June 27 6 P.M. GMT	EMERGENCY	LAT 44 38 N, LONG 58 50 W
YUSHO MARU	June 26 3:30 A.M.	COLLISION	HARIMA STRAIT

*LLOYD'S SHIPPING INDEX

Figure 1. Weekly Data Sheet

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (REPORTS FROM OCEAN CROSSING VESSELS IN PARENTHESIS)

JANUARY 1972

WEEK	1	2	3	4	5	TOTAL
LLOYD'S REF.	JAN. 4	JAN. 11	JAN. 18	JAN. 25	FEB. 1	TOTAL
DATE	206	207	207	207	207	MONTHLY
VOLUME	14	1	2	3	4	
NUMBER	15(11)	8(2)	10(2)	12(2)	4(1)	49(8)
SANK	15(7)	14(10)	7(7)	3(1)	0(0)	39(25)
COLLIDED	13(9)	8(5)	7(4)	21(8)	18(11)	67(37)
EMERGENCIES	3(0)	4(3)	2(1)	12(7)	5(2)	26(13)
AGROUND	5(4)	5(3)	5(3)	14(12)	10(9)	39(31)
WEATHER DAMAGE	0(0)	0(0)	1(0)	0(0)	0(0)	1(0)
OVERDUE						
TOTAL	51(21)	39(23)	32(17)	62(30)	37(23)	221(114)

FEBRUARY 1972

WEEK	1	2	3	4	5	TOTAL
LLOYD'S REF.	FEB. 8	FEB. 15	FEB. 22	FEB. 29	MAR. 7	TOTAL
DATE	207	207	207	207	207	MONTHLY
VOLUME	5	6	7	8	9	
NUMBER	6(0)	6(0)	6(0)	6(1)	8(1)	32(2)
SANK	8(5)	4(1)	3(3)	11(7)	4(4)	30(20)
COLLIDED	14(6)	21(12)	9(7)	17(10)	9(6)	70(41)
EMERGENCIES	4(2)	6(2)	3(2)	3(1)	6(4)	22(11)
AGROUND	10(9)	10(5)	8(7)	8(7)	5(5)	41(33)
WEATHER DAMAGE	1(0)	0(0)	0(0)	0(0)	0(0)	1(0)
OVERDUE						
TOTAL	43(22)	47(20)	29(19)	45(26)	32(20)	196(107)
						TOTAL YEAR TO DATE
						81(10)
						69(45)
						137(78)
						48(24)
						80(64)
						2(0)

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (Continued)

MARCH 1972

WEEK	1	2	3	4	TOTAL MONTHLY	TOTAL YEAR TO DATE
LLOYD'S REF.	MAR. 14	MAR. 21	MAR. 28	APR. 4		
DATE	207	207	207	207		
VOLUME	10	11	12	13		
NUMBER	6(1)	8(0)	9(0)	6(0)	29(1)	110(11)
SANK	4(4)	5(2)	14(7)	0(0)	23(13)	92(58)
COLLIDED	11(7)	11(3)	9(5)	11(6)	42(21)	179(99)
EMERGENCIES	5(4)	3(0)	10(5)	0(0)	18(9)	66(33)
AGROUND	14(10)	6(5)	5(4)	4(2)	29(21)	109(85)
WEATHER DAMAGE	0(0)	0(0)	0(0)	2(0)	2(0)	4(0)
OVERDUE						
TOTAL	40(26)	33(10)	47(21)	23(8)	143(65)	560(286)

APRIL 1972

WEEK	1	2	3	4	TOTAL MONTHLY	TOTAL YEAR TO DATE
LLOYD'S REF.	APR. 11	APR. 18	APR. 25	MAY 2		
DATE	208	208	208	208		
VOLUME	1	2	3	4		
NUMBER	7(2)	10(5)	2(0)	0(0)	19(7)	129(18)
SANK	1(0)	10(5)	11(4)	4(2)	26(11)	118(69)
COLLIDED	6(2)	10(3)	3(2)	10(4)	29(11)	208(110)
EMERGENCIES	12(7)	5(2)	5(3)	3(1)	25(13)	91(46)
AGROUND	2(1)	8(8)	7(7)	7(7)	24(23)	133(108)
WEATHER DAMAGE	(0)	0(0)	0(0)	0(0)	0(0)	4(0)
OVERDUE						
TOTAL	28(12)	43(23)	28(16)	24(14)	123(65)	683(351)

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (Continued)

MAY 1972

WEEK LLOYD'S REF. DATE VOLUME NUMBER SANK COLLIDED EMERGENCIES AGROUND WEATHER DAMAGE OVERDUE TOTAL	1		2		3		4		5		TOTAL MONTHLY	TOTAL YEAR TO DATE
	MAY 9 208	5	MAY 16 208	6	MAY 23 208	7	MAY 30 208	8	JUNE 6 208	9		
	8(1)		8(0)		11(3)		4(1)		4(1)		35(6)	164(24)
	0(0)		12(7)		4(4)		7(5)		1(1)		24(17)	142(86)
	18(9)		6(4)		15(9)		8(4)		8(5)		55(31)	263(141)
	5(1)		3(1)		8(5)		5(3)		0(0)		21(10)	112(56)
	8(7)		4(4)		3(3)		1(1)		2(2)		18(17)	151(125)
	0(0)		0(0)		1(0)		0(0)		0(0)		1(0)	5(0)
TOTAL	39(18)		33(16)		42(24)		25(14)		15(9)		154(81)	837(432)

JUNE 1972

WEEK LLOYD'S REF. DATE VOLUME NUMBER SANK COLLIDED EMERGENCIES AGROUND WEATHER DAMAGE OVERDUE TOTAL	1		2		3		4		TOTAL MONTHLY	TOTAL YEAR TO DATE
	JUNE 13 208	10	JUNE 20 208	11	JUNE 27 208	12	JULY 4 208	13		
	4(0)		2(1)		7(1)		2(0)		15(2)	179(26)
	2(1)		8(3)		6(3)		3(0)		19(7)	161(93)
	8(5)		14(7)		13(9)		10(4)		45(25)	308(166)
	4(1)		3(2)		2(1)		5(3)		14(7)	126(63)
	1(1)		2(2)		2(1)		4(4)		9(8)	160(133)
	0(0)		0(0)		0(0)		0(0)		0(0)	5(0)
TOTAL	19(8)		29(15)		30(15)		24(11)		102(49)	939(481)

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (Continued)

JULY 1972

WEEK LLOYD'S REF.	1		2		3		4		5		TOTAL MONTHLY	TOTAL YEAR TO DATE
	JULY 11 209	JULY 18 209	JULY 25 209	AUG. 1 209	AUG. 8 209							
SANK	1 6(4)	2 6(2)	3 8(1)	4 8(1)	5 2(0)	30(8)	209(34)					
COLLIDED	7(1)	11(7)	10(4)	6(5)	0(0)	34(17)	195(110)					
EMERGENCIES	1(1)	16(7)	7(5)	5(4)	9(7)	38(24)	346(190)					
AGROUND	3(2)	3(1)	8(4)	9(5)	0(0)	23(12)	149(75)					
WEATHER DAMAGE	4(4)	3(1)	2(0)	3(2)	2(1)	14(8)	174(141)					
TOTAL	21(12)	39(18)	35(14)	31(17)	13(8)	139(69)*	1073(550)					

AUGUST 1972

WEEK LLOYD'S REF.	1		2		3		4		TOTAL MONTHLY	TOTAL YEAR TO DATE
	AUG. 15 209	AUG. 22 209	AUG. 29 209	SEP. 5 209						
SANK	6 6(1)	7 3(0)	8 4(2)	9 2(0)	15(3)	224(37)				
COLLIDED	4(2)	1(0)	2(1)	6(4)	13(7)	208(117)				
EMERGENCIES	5(2)	4(1)	12(7)	10(6)	31(16)	377(206)				
AGROUND	7(4)	4(3)	3(1)	7(4)	21(12)	170(87)				
WEATHER DAMAGE	1(1)	1(0)	3(2)	1(0)	6(3)	180(144)				
TOTAL	23(10)	13(4)	24(13)	26(14)	86(41)	1159(591)				

*5 overdue ships not carried

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (Continued)

SEPTEMBER 1972

WEEK	SEPTEMBER 1972				TOTAL MONTHLY	TOTAL YEAR TO DATE
	1	2	3	4		
LLOYD'S REF.						
DATE	SEP. 12	SEP. 19	SEP. 26	OCT. 3		
VOLUME	209	209	209	209		
NUMBER	10	11	12	13	14 (2)	238 (39)
SANK	2 (0)	4 (0)	3 (1)	5 (1)	22 (16)	230 (133)
COLLIDED	3 (3)	4 (2)	11 (8)	4 (3)	37 (17)	414 (223)
EMERGENCIES	7 (4)	9 (5)	9 (5)	12 (3)	24 (14)	194 (101)
AGROUND	6 (2)	6 (3)	7 (5)	5 (4)	5 (1)	185 (145)
WEATHER DAMAGE	1 (0)	1 (1)	2 (0)	1 (0)		
TOTAL	19 (9)	24 (11)	32 (19)	27 (11)	102 (50)	1261 (641)

OCTOBER 1972

WEEK	OCTOBER 1972				TOTAL MONTHLY	TOTAL YEAR TO DATE
	1	2	3	4		
LLOYD'S REF.						
DATE	OCT. 10	OCT. 17	OCT. 24	OCT. 31		
VOLUME	210	210	210	210		
NUMBER	1	2	3	4	9 (1)	247 (40)
SANK	3 (1)	1 (0)	4 (0)	1 (0)	9 (4)	239 (137)
COLLIDED	2 (2)	6 (2)	0 (0)	1 (0)	39 (19)	453 (242)
EMERGENCIES	7 (4)	10 (5)	9 (3)	13 (7)	10 (6)	204 (107)
AGROUND	3 (0)	1 (0)	4 (2)	2 (2)	6 (3)	191 (148)
WEATHER DAMAGE	1 (0)	2 (1)	0 (0)	3 (2)		
TOTAL	16 (9)	20 (8)	17 (5)	20 (11)	73 (33)	1334 (674)

TABLE 1. MONTHLY TABULATION OF CASUALTY REPORTS (Concluded)

NOVEMBER 1972

WEEK	1	2	3	4	5	TOTAL MONTHLY	TOTAL YEAR TO DATE
LLOYD'S REF.							
DATE	NOV. 7	NOV. 14	NOV. 21	NOV. 28	DEC. 5		
VOLUME	210	210	210	210	210		
NUMBER	5	6	7	8	9	13 (3)	260 (43)
SANK	2 (0)	1 (0)	6 (3)	1 (0)	3 (0)	14 (11)	253 (148)
COLLIDED	2 (1)	3 (3)	6 (5)	2 (2)	1 (0)	45 (22)	498 (264)
EMERGENCIES	6 (5)	9 (5)	12 (5)	6 (2)	12 (5)	14 (7)	218 (114)
AGROUND	3 (2)	6 (3)	1 (1)	2 (0)	2 (1)	9 (5)	200 (153)
WEATHER DAMAGE	2 (2)	2 (1)	1 (0)	2 (0)	2 (2)		
TOTAL	15 (10)	21 (12)	26 (14)	13 (4)	20 (8)	95 (48)	1429 (722)

DECEMBER 1972

WEEK	1	2	3	4	TOTAL MONTHLY	TOTAL YEAR TO DATE
LLOYD'S REF.						
DATE	DEC. 12	DEC. 19	DEC. 26	JAN. 2, 1973		
VOLUME	210	210	210	210		
NUMBER	10	11	12	13	24 (11)	284 (54)
SANK	6 (3)	8 (3)	7 (4)	3 (1)	16 (10)	269 (158)
COLLIDED	5 (1)	3 (3)	6 (4)	2 (2)	40 (25)	538 (289)
EMERGENCIES	12 (11)	16 (6)	7 (4)	5 (4)	9 (4)	227 (118)
AGROUND	2 (1)	3 (2)	3 (1)	1 (0)	28 (24)	228 (177)
WEATHER DAMAGE	5 (5)	6 (4)	6 (4)	11 (11)		
TOTAL	30 (21)	36 (18)	29 (17)	22 (18)	117 (74)	1546 (796)

listed by date, volume, and number, as well as the number of reports recorded in that issue (the overdue category was discontinued after June). There are two numbers for each category and the totals. The first number is the report for the week, the second number in parenthesis is the ships which were listed in the Index as an ocean crossing vessel. For example, the June listing was 102(49), which indicates 102 casualties reported, 49 of these large ships.

5.3 YEARLY TABULATIONS

The yearly tabulation is the sum of all the casualties to date. During the period from January 1972 to December 1972 there have been 1551 reports. Of this 796 were received from ocean crossing vessels.

TOTAL YEAR TO DATE

Report Category	Total Number of Reports	Ocean Crossing Vessel Reports	
Sank	284	54	
Collided	269	158	
Emergency	538	289	
Aground	227	118	
Weather Damage	228	177	
Total	1546	796	
Overdue	5		

Report Month	Total Reports	Ocean Crossing	Adjusted	
January	221	114	176*	92*
February	196	107	156*	84*
March	143	65	143	65
April	123	65	123	65
May	154	81	124*	64*
June	102	49	102	49
Six Month Total	939	481	824	419

* In some of the months there are five reporting periods instead of four; the adjusted values are 4/5's of the reports in those months.

For the second six-month period the values are:

Report Month	Total Reports	Ocean Crossing	Adjusted	
July	139	69	139	69
August	86	41	68*	36*
September	102	50	102	50
October	73	33	73	33
November	95	48	95	48
December	117	74	92*	60*
Six Month Total	612	315	569	296
Year Total	1551	796		

* These two months had five reporting periods instead of four. The adjusted column assumes all months as having four reporting periods.

The total casualties per month listed in the Loss Book by the Liverpool Underwriters are as follows:

Month	500 gross tons & over	Ocean Crossing Vessels (Tabulator)
January	596	114
February	1147	107
March		65
April		65
May	478	81
June	461	49
July	498	69
August	435	41
September	388	50
October	484	33
November	486	48
December	599	74
TOTAL	6046	796

Percentage of the larger casualties which could use a satellite communication service is 13+1%.

On the average there are 17 casualties every day of 500 gross tons or over. There are 4 casualties a day away from the land masses, and of these, 2 are large ocean crossing vessels.

5.4 MONTHLY CONFLUENCE AREA CASUALTIES

Each month the U.S. Coast Guard provides a list of preferred shipping routes, which depend on the weather currents and winds. The routes are chartered for the North Atlantic and the North Pacific on a monthly schedule; the rest of the routes are charted quarterly. These monthly AMVER charts are used for the Confluence Area Casualty Plots.

Each casualty is located by latitude and longitude and plotted on the AMVER charts weekly. At the completion of a month of plotting, areas with a high concentration of casualties are traced and collected. The areas are:

The English Channel (Figure 2)

The General Mediterranean (Figure 3)

The Approaches to the Northeastern United States (Figure 4)

The United States Gulf Coast (Figure 5)

The Coastal Waters of Japan (Figure 6)

5.4.1 The English Channel

The casualties from Ushant Island and Lands End through the channel and up to latitude 56° N in the North Sea are considered as happening in the English Channel.

Month	No. of Casualties	Percentage of the Month's Total
January	35	15
February	15	7
March	25	17
April	16	13
May	16	10
June	8	7
Total	115	Ave. 11+4%

From 7 to 15 percent of the total casualties happen in this area. Many factors contribute to this percentage, including the large volume of traffic, the narrowness of the channel, and hazardous weather conditions.

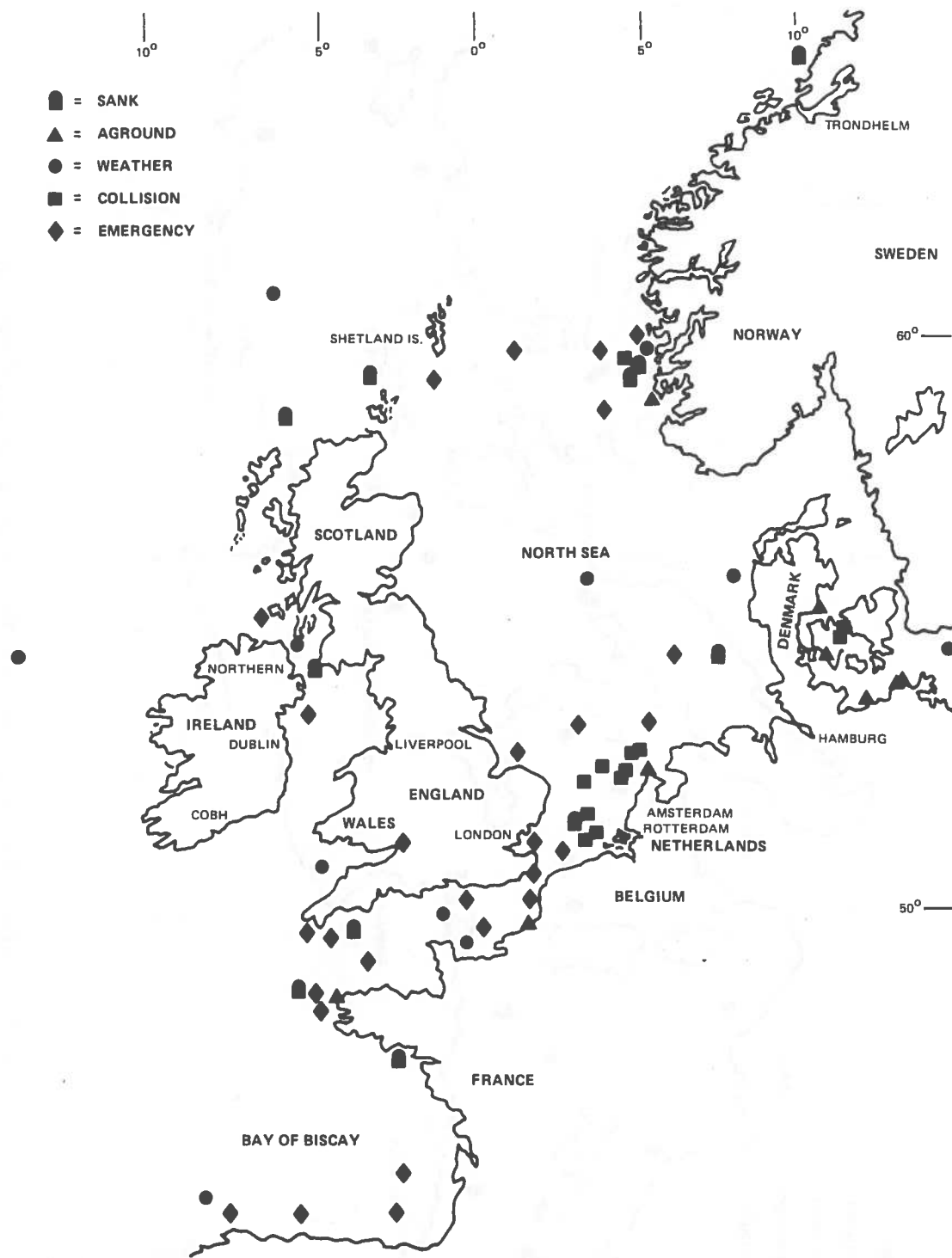


Figure 2. Casualties Reported in the English Channel

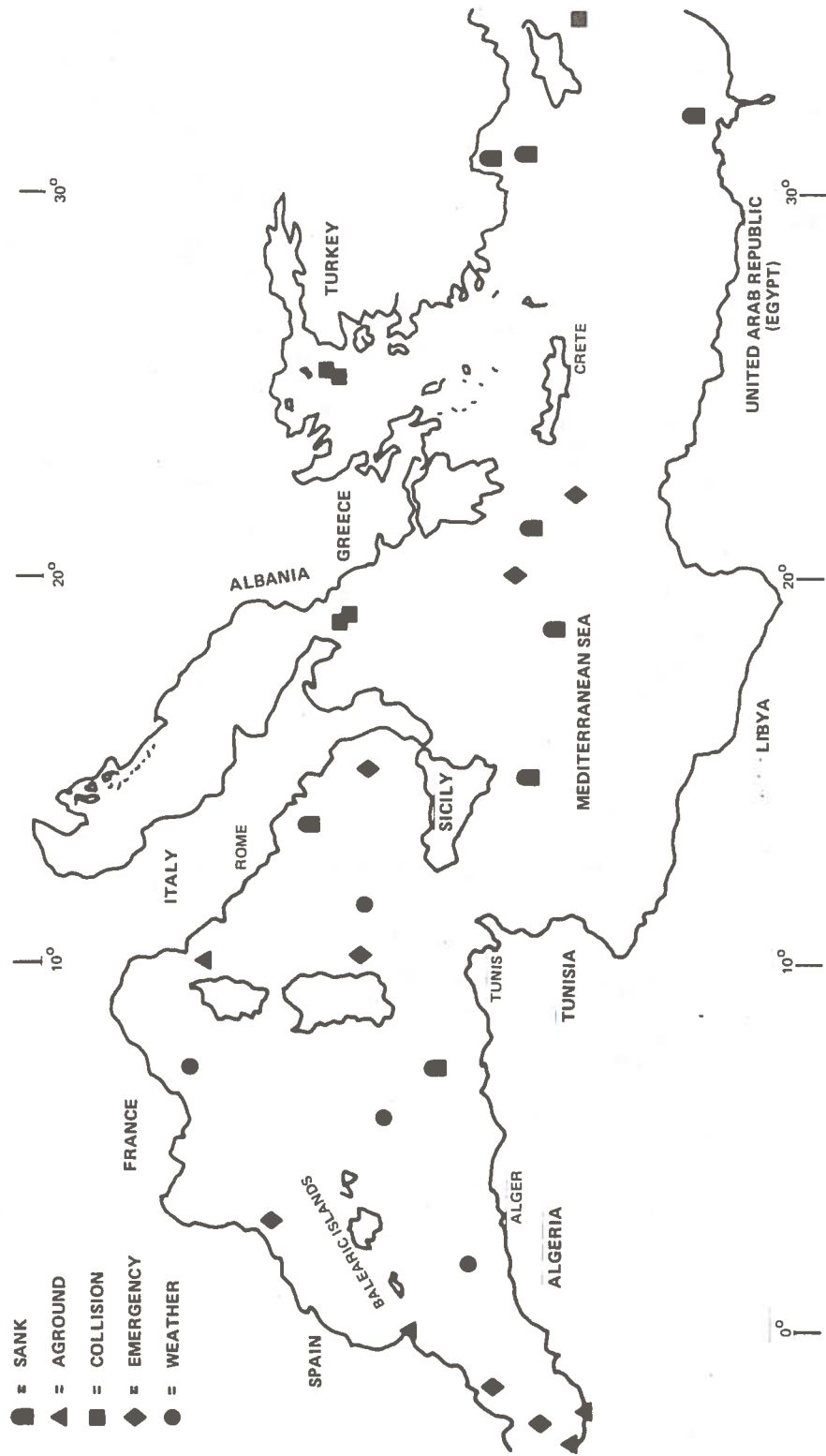


Figure 3. Casualties Reported in the General Mediterranean

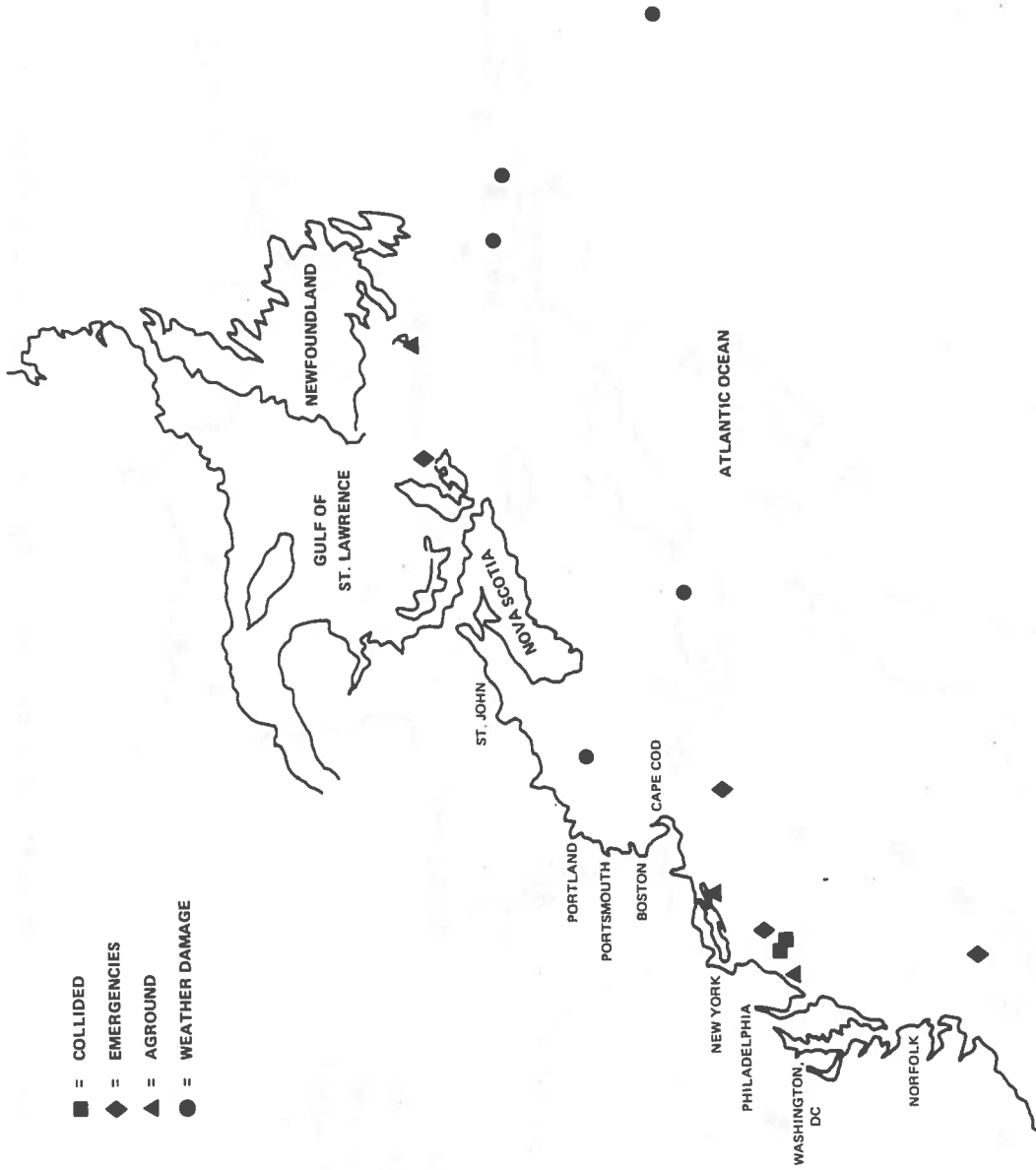


Figure 4. Casualties Reported in the Approaches to the Northeastern United States

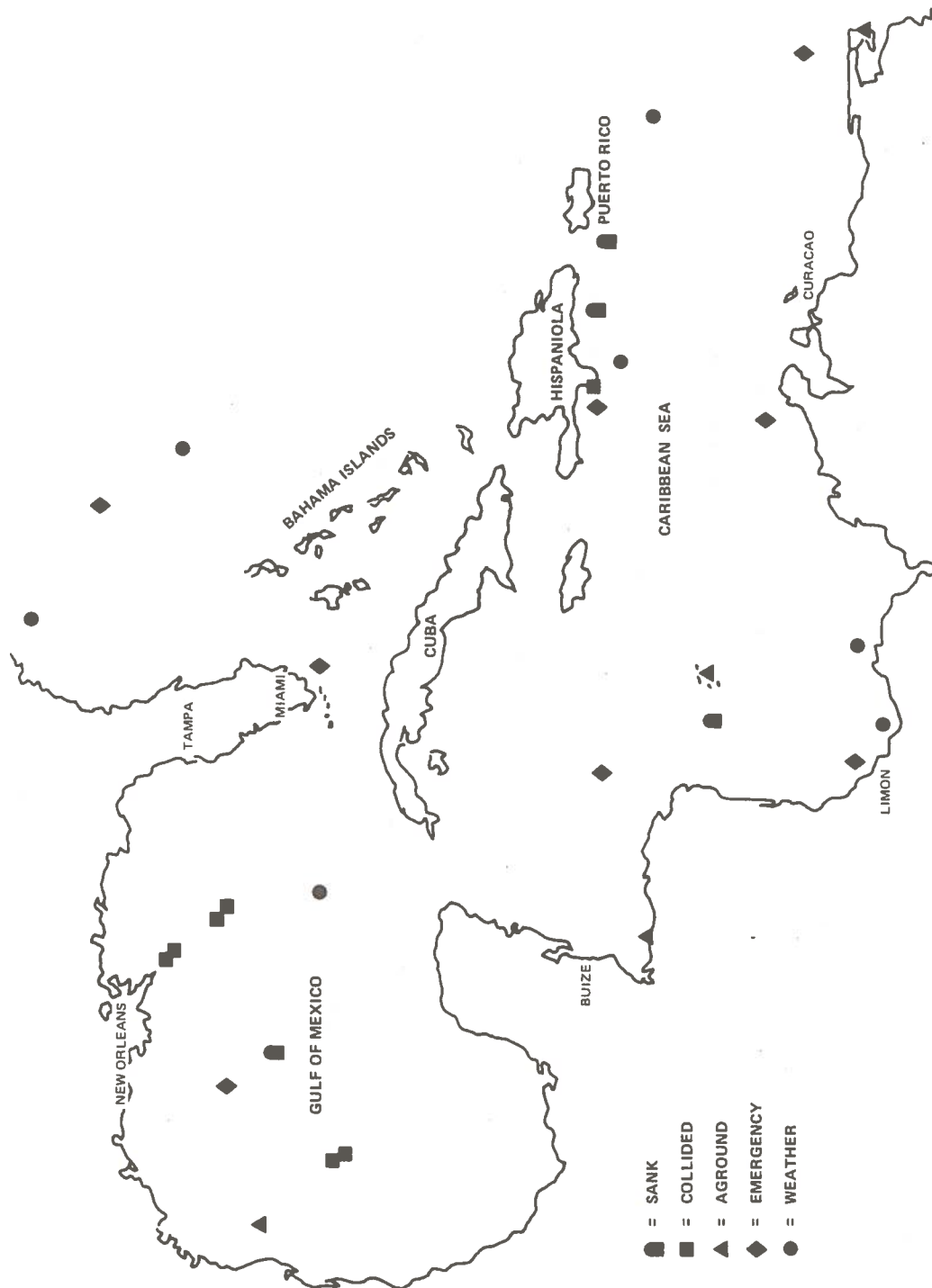


Figure 5. Casualties Reported Along the United States Gulf Coast

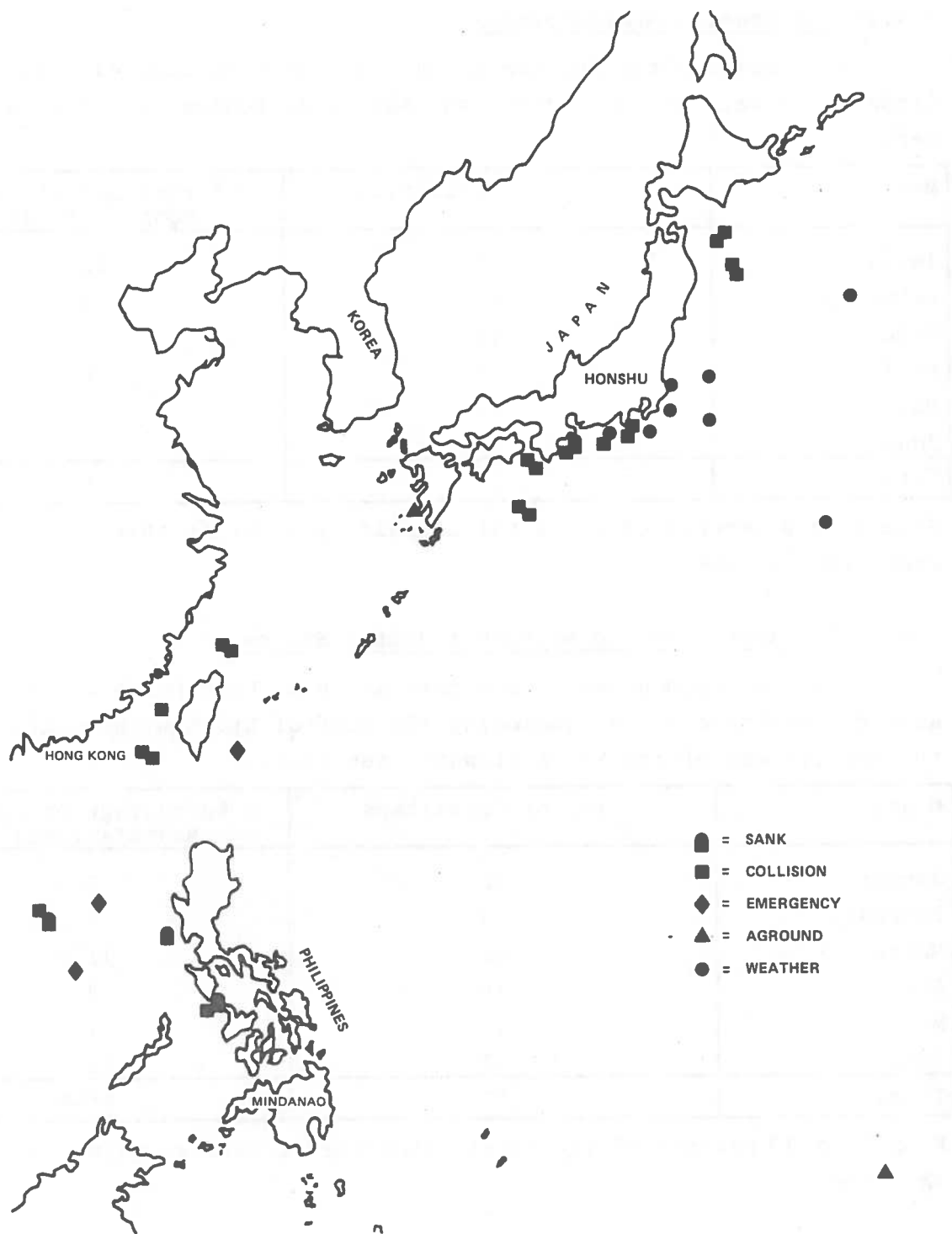


Figure 6. Casualties Reported from the Coastal Waters of Japan

5.4.2 The General Mediterranean

This includes the Mediterranean Sea from Gibraltar east to Lebanon, as well as the Tyrrhenian, Adriatic, Ionian, and Aegean Seas.

Month	No. of Casualties	Percentage of the Month's Total
January	28	12
February	10	5
March	10	6
April	8	6
May	12	7
June	8	7
Total	76	7+2%

From 5 to 9 percent of the total casualties occur in this Mediterranean area.

5.4.3 The Approaches to Northeast United States

This area encompasses the waters north of Cape Hatteras and west of Longitude 50° W, including the Gulf of St. Lawrence and the western end of the North Atlantic sea lanes.

Month	No. of Casualties	Percentage of the Month's Total
January	12	5
February	9	4
March	16	11
April	10	8
May	17	11
June	13	12
Total	77	Ave. 8+5%

From 3 to 13 percent of the total casualties tabulated occur in this area.

5.4.4 The United States Gulf Coast

This general area is west of Longitude 60° W and south of Latitude 30° N. It includes the Cristobal entrance to the Panama Canal, the Gulf of Mexico and the Caribbean Sea.

Month	No. of Casualties	Percentage of the Month's Total
January	26	11
February	10	5
March	9	6
April	10	8
May	7	4
June	10	9
Total	72	7+2%

From 5 to 9 percent of the total casualties tabulated occur in this area.

5.4.5 The Coastal Waters of Japan

This area is north of Latitude 30° N and west of Longitude 150° W and extends to the mainland. This includes the Sea of Japan, the Yellow Sea, the East China Sea and the Sea of Okhotsk.

Month	No. of Casualties	Percentage of the Month's Total
January	20	9
February	9	4
March	24	16
April	21	17
May	8	5
June	13	12
Total	95	Ave. 10+5%

From 5 to 15 percentage of the casualties tabulated occur in this area. The five confluence areas accounted for the following number of casualties:

Month	Number	Percentage of the Total
January	121	55
February	53	27
March	84	39
April	65	53
May	60	39
June	52	51
Total	435	Ave. 47+10%

From 40 to 60 percent of the world casualties happen within these five areas. The remainder of the casualties are distributed throughout the major traffic routes.

5.5 CASUALTY VS. MONTH

The casualties for the months from January to December 1972 have been separated into five categories. The overdue category was discarded, since in six months there were only five ships overdue. In each of the five categories, the total number of reports for each month are listed in the first column. The percentage of the annual total in each category is listed in the second column. If the number of reports were equally distributed among the months, the second column would then be 8.3% (100% divided by 12 months) for each month. By making a comparison with the tabulated percentages, January had the most casualty reports for the year. The third column is the number of vessels in the category which were listed in Lloyd's Shipping Index (Figure 7). These ships are ocean crossing vessels. The fourth column is the percentage of reports for the month coming from the larger vessels. On the average, 69% of the weather damage reports come from ocean crossing vessels. Fifty-three percent of the emergency reports, 52% of the groundings and 58% of the collisions come from larger vessels. Reports in the sank category are predominately from smaller vessels. On the average, 19% of the reports come from larger vessels.

VESSEL	FLG.	BLT	GROSS	NET	FROM	FOR	LATEST REPORT
Raeburn	Br	57	6274	3625	Itajai May 23	Cardiff	Ar Liverpool July 12
RAFAEL LOTITO	Bz	69	4331	2705	SANTOS JUNE 14	ANTWERP	AR. BREST
							JUNE 27, - IN
							TOW OF TUG
							BALTIC - BEEN
							AGROUND
Rafaela	Li	52	2441	1330	Mombasa July 11	Kismayu	
Raffaele Cafiero	It	62	24434	14596	Taranto July 5	Borry	Pd Gibraltar July 8

Figure 7. Example of Lloyd's Shipping Index

5.5.1 Weather Damage

Ships reporting weather damage are usually ocean going vessels; of the vessels damaged, 69 \pm 20% are large vessels. This category makes up 15% of the reports in this tabulation. As would be expected, the months of December, January, February and March have the highest percentage of the weather damage reports (60%). September was the least active month. The observed values are shown in Table 2.

TABLE 2. WEATHER DAMAGE REPORT CATEGORY

MONTH	NUMBER OF REPORTS	% OF THE YEARS TOTAL WEATHER DAMAGE	NUMBER OF REPORTS FROM OCEAN CROSSING	% OF THE MONTHS REPORTS FROM OCEAN CROSSING
January	39	17	31	79
February	41	18	33	80
March	29	13	21	72
April	24	11	23	95
May	18	8	17	94
June	9	4	8	88
July	14	6	8	57
August	6	3	3	50
September	5	2	1	20
October	6	3	3	50
November	9	4	5	55
December	28	12	24	86
Totals	228	101%	177	69 \pm 20% average

The expected number of reports of weather damage per month is 19 (228 reports for the year divided by the number of months in a year). For vessels of the ocean crossing type there are 15 expected reports of weather damage per month. The observed values show that the reports are not equally distributed by month and that the winter season causes more weather damage reports (60%) than any of the other three. Of the weather damage reports, 69 \pm 20% come from the larger vessels. The \pm 20% is the RMS uncertainty in the percentage or the standard deviation.

5.5.2 Emergencies

This category includes requests for assistance, fire damage, explosions and call for tows. All emergencies happen on moving vessels which are not in harbors, canals or on inland bodies of water. Of the reports from vessels with emergencies, 53+8% are ocean crossing ships and this category accounts for 35% of the reports. January and February account for 25% of the reports while April had 29 reports or 5% of the total. The observed values are shown in Table 3.

TABLE 3. EMERGENCY REPORT CATEGORY

MONTH	NUMBER OF VESSELS	% OF THE YEARS TOTAL EMERGENCIES	NUMBER OF OCEAN CROSSING VESSELS	% OF MONTHS EMERGENCIES
January	67	12	37	55
February	70	13	41	59
March	42	8	21	50
April	29	5	11	38
May	55	10	31	56
June	45	8	25	56
July	38	7	24	63
August	31	6	16	52
September	37	7	17	46
October	39	7	19	49
November	45	8	22	49
December	40	7	25	63
Total	538	98%	289	53 <u>+</u> 8% average

The expected number of emergency reports per month are 45. The expected number of emergency reports from the ocean crossing vessels per month is 24. Emergency reports are not equally distributed throughout the year.

5.5.3 Aground

This category consists of ships that go aground within sight of land (30 nautical-miles) but does not include groundings in harbors, in canals, on lakes or on rivers. In many cases, there would be direct communication with land service, but in this situation all methods of communication, including satellite service, would be used. Of the ships reported as aground, 52+4% were listed as ocean crossing vessels. This category accounted for 15% of the casualty reports for the year. January, February, April, July and September had 10 or 11% of the reports. The reports are equally distributed among the months. The observed values are shown in Table 4.

TABLE 4. AGROUND REPORT CATEGORY

MONTH	NUMBER OF VESSELS	% OF THE YEARS TOTAL AGROUND	NUMBER OF OCEAN CROSSING VESSELS	% OF THE MONTHS AGROUND
January	26	11	13	50
February	22	10	11	50
March	18	8	9	50
April	25	11	13	52
May	21	9	10	48
June	14	6	7	50
July	23	10	12	52
August	21	9	12	57
September	24	11	14	58
October	10	4	6	60
November	14	6	7	50
December	9	4	4	44
Total	227	99	118	52+4% aver.

The expected number of aground reports per month is 19, while expected number from ocean crossing vessels per month is 10. The number of reports are independent of the month. If the reports were evenly distributed, 8.3% would appear in the second column of the above table for each month.

5.5.4 Sank

Ships that sink are usually smaller vessels. Of all the ships sank, 19±12% are listed in Lloyd's. The variability in the percentage indicates the wide spread from 7% to 31% (1 standard deviation) in the data for listed ships. One must be careful to differentiate between ships which were a total loss from those which sank. In January 1972 there were 20 vessels considered by the Liverpool Underwriter's Association as a total loss (500 gross tons and over); of this total, 2 were foundering and abandonments. More ships sank, but they are considered under other categories, such as explosion and fires and weather damage. To determine how a casualty would impact on an emergency communication service through a satellite system, each casualty must be considered in terms of its immediate distress, as contrasted with its ultimate fate. Since by size alone larger vessels are not prone to foundering quickly, excluding situations involving large storms, there are opportunities for the vessel to receive assistance and hence a greater likelihood of appearing in the emergency category. Of the ships in the sank category, 19±12% are ocean going vessels, and this category represents 18% of the total number of reports. The observed values appear in Table 5.

TABLE 5. SANK REPORT CATEGORY

MONTH	NUMBER OF VESSELS	% OF THE YEARS TOTAL SINKINGS	NUMBER OF OCEAN CROSSING VESSELS	% OF THE MONTHS SINKINGS
January	49	17	8	16
February	32	11	2	6
March	29	10	1	3
April	19	7	7	37
May	35	12	6	17
June	15	5	2	13
July	30	11	8	27
August	15	5	3	20
September	14	5	2	14
October	9	3	1	11
November	13	5	3	23
December	24	8	11	46
Totals	284	99	54	19±12% average

The expected number of ships lost per month is 24. The expected number of ocean crossing vessels lost due to sinking per month is 5 vessels. January, February and March accounted for 38% of the sank reports while October accounted for 3%. The reports are not equally distributed among the months.

5.5.5 Collision

In this category 58+13% of the participants are larger ships and are usually in confined waters. This category accounts for 17% of the total number of tabulated casualties. In January there were 140 collisions of ships 500 gross ton and over posted by the Liverpool Underwriter's Association, and 2 were total losses. (See Table 6.)

TABLE 6. COLLISION REPORT CATEGORY

MONTH	NUMBER OF VESSELS	% OF THE YEARS TOTAL COLLISIONS	NUMBER OF OCEAN CROSSING VESSELS	% OF THE MONTHS COLLISIONS
January	39	14	25	64
February	30	11	20	66
March	23	9	13	56
April	26	10	11	42
May	24	9	17	71
June	19	7	7	37
July	34	13	17	50
August	13	5	7	54
September	22	8	16	73
October	9	3	4	44
November	14	5	11	79
December	16	6	10	62
Total	269	100	158	58+13% aver.

The expected number of collisions per month is 22 (total collisions divided by the number of months in a year). The expected number of ocean crossing vessels in a collision per month is 13. If evenly distributed, 8.3% of the collisions would occur

each month; January and February, however, accounted for 25% of the collision reports, which indicates that the reports are not independent of the month.

5.6 CASUALTY VS. WEEK

This casualty vs. week tabulation is collected on a calendar week basis. The data in the weekly tabulation is collected by the week, but the date is the volume date of Lloyd's Weekly Casualty Report. For simulations of emergency procedure, it is necessary to rearrange the Lloyd's data to reflect the date of occurrence rather than the date of the report. From an initial review of the data it appears that there is a cyclic nature to the occurrence of casualties. Tests of significance will have to be made to establish the realism of the cyclic appearance (see Tables 7-8).

5.6.1 Weather Damage Reports

This category can not be tabulated on a weekly basis because of the nature of the weather damage reports. The report lists the voyage, start and destination, and the port where the damage is declared. If the date of the occurrence is given at all, it is usually a range of dates, i.e., June 3-6.

5.6.2 Emergency Reports

There were 305 emergency reports in the first half of the year and 227 emergency reports in the second half. The most reports (21) were received in the weeks ending January 22 and February 5. The least number of reports (2) were received during the week ending November 4. Of the larger vessels there were 167 emergency reports in the first half of the year and 122 in the second half. The largest number of reports (11) were received on January 22, February 5 and 11. During the week of July 29 there was only one report. During the week ending November 4 there were two emergency reports. A preliminary time trend analysis shows a decreasing number of reports as the year progresses.

TABLE 7. OCEAN CROSSING VESSELS REPORTING CASUALTIES (1972)

WEEK ENDING	SANK	COL	EMER	AGR	TOTAL
JAN 1	1	3	9	1	14
JAN 8	0	9	4	3	16
JAN 15	3	6	5	3	17
JAN 22	2	1	11	5	19
JAN 29	0	2	9	2	13
FEB 5	0	3	11	2	16
FEB 12	0	4	11	4	19
FEB 19	0	3	6	1	10
FEB 26	2	4	6	1	13
MAR 4	1	3	8	4	16
MAR 11	0	3	5	3	11
MAR 18	0	3	5	1	9
MAR 25	0	5	7	4	16
APR 1	1	0	3	3	7
APR 8	1	0	3	4	8
APR 15	4	5	3	2	14
APR 22	0	4	2	3	9
APR 29	0	2	4	1	7
MAY 6	1	0	8	1	10
MAY 13	0	7	7	1	15
MAY 20	3	3	7	5	18
MAY 27	2	6	5	2	15
JUNE 3	0	0	4	0	4
JUNE 10	0	1	4	1	6
JUNE 17	1	3	10	3	17
JUNE 24	2	3	7	0	12
JULY 1	0	0	3	4	7
TOTAL	24	83	167	64	338

TABLE 7. OCEAN CROSSING VESSELS REPORTING CASUALTIES (Continued)

WEEK ENDING	SANK	COL	EMER	AGR	TOTAL
JULY 8	3	3	3	1	10
JULY 15	2	8	6	2	18
JULY 22	1	4	6	4	15
JULY 29	1	3	1	3	8
AUG 5	1	2	7	2	12
AUG 12	0	0	3	2	5
AUG 19	0	0	3	3	6
AUG 26	2	4	4	1	11
SEPT 2	0	1	8	4	13
SEPT 9	0	3	4	3	10
SEPT 16	1	6	4	2	13
SEPT 23	1	5	4	6	16
SEPT 30	0	4	3	3	10
OCT 7	1	2	4	2	9
OCT 14	0	2	4	0	6
OCT 21	0	0	6	2	8
OCT 28	0	0	7	2	9
NOV 4	0	2	2	4	8
NOV 11	1	2	5	1	9
NOV 18	2	5	6	1	14
NOV 25	0	2	3	0	5
DEC 2	1	0	6	1	8
DEC 9	2	1	9	1	13
DEC 16	5	6	7	3	21
DEC 23	2	1	3	0	6
DEC 30	1	2	4	0	7
TOTAL	27	68	122	53	270

TABLE 8. TOTAL NUMBER OF REPORTED CASUALTIES (1972)

WEEK ENDING	SANK	COL	EMER	AGR	TOTAL
JAN 1	9	8	13	3	33
JAN 8	4	11	7	3	25
JAN 15	11	7	10	5	33
JAN 22	9	3	21	10	43
JAN 29	6	4	14	7	31
FEB 5	3	4	21	4	32
FEB 12	3	8	20	6	37
FEB 19	8	6	9	3	26
FEB 26	6	6	11	2	25
MAR 4	10	4	11	6	31
MAR 11	5	3	14	6	28
MAR 18	7	8	8	3	26
MAR 25	10	10	10	8	38
APR 1	8	0	7	5	20
APR 8	4	1	7	8	20
APR 15	10	9	10	4	33
APR 22	1	11	4	5	21
APR 29	1	4	12	3	20
MAY 6	7	0	15	5	27
MAY 13	10	12	9	3	34
MAY 20	10	3	13	10	36
MAY 27	8	7	8	3	26
JUNE 3	3	0	9	1	13
JUNE 10	2	2	7	3	14
JUNE 17	3	8	17	5	33
JUNE 24	5	6	12	1	24
JULY 1	1	3	6	5	15
TOTAL	164	148	305	127	744

TABLE 8. TOTAL NUMBER OF REPORTED CASUALTIES (Continued)

WEEK ENDING	SANK	COL	EMER	AGR	TOTAL
JULY 8	6	5	7	3	21
JULY 15	9	12	13	6	40
JULY 22	6	11	6	5	28
JULY 29	6	4	3	5	18
AUG 5	4	3	10	3	20
AUG 12	3	1	4	4	12
AUG 19	2	1	7	5	15
AUG 26	4	6	9	3	22
SEPT 2	3	2	12	7	24
SEPT 9	1	5	8	7	21
SEPT 16	5	6	6	5	22
SEPT 23	4	7	9	10	30
SEPT 30	3	4	10	3	20
OCT 7	2	2	8	3	13
OCT 14	3	6	8	2	19
OCT 21	2	0	12	3	17
OCT 28	1	1	14	2	18
NOV 4	3	3	2	5	13
NOV 11	1	2	12	4	19
NOV 18	5	6	10	2	23
NOV 25	2	2	8	1	13
DEC 2	6	4	12	2	24
DEC 9	3	2	12	3	20
DEC 16	10	7	14	4	35
DEC 23	5	2	6	1	14
DEC 30	2	2	6	1	10
TOTAL	101	106	227	99	533

5.6.3 Aground Reports

There were 127 aground reports during the first half of 1972, and 99 aground reports during the second half. The most reports (10) were received during the weeks ending January 22, May 20 and September 23. The least number of reports (1) were received during the weeks ending June 3, June 24, November 25 and the last two weeks of the year. Of the ocean crossing vessel category, there were 6 reports of vessels aground received during the week ending September 23. There were six periods with no reports of ocean crossing vessels aground.

5.6.4 Sank Reports

For this category a time trend analysis was completed. The reports were divided into the first and second half of the year. In the first half of the year 164 reports of vessels lost were received. During the second half of the year 101 were received. During the week ending January 11 there were 11 reports of vessels lost. There were 6 periods with 10 reports and 3 periods with 9 reports. These periods were spread throughout the year. During 6 periods there were single reports of vessels lost and 6 periods where there were 2 reports; these were also spread throughout the year. The time trend analysis showed that there was a decreasing trend in the number of reports as the year progressed. At the first of the year the trend was in excess of 7 reports per week, decreasing to 5 reports at the half-way point. This decreasing trend continued in the second half of the year and ended with 3 reports per week period. This trend reflects itself in all the tabulations and can be partially explained by natural causes, such as weather. This decreasing trend, however, should not be used to predict the number of reports in the following year, since the trend is a function of unpredictable natural effects. For the purpose of designing an experiment to assess the effect of reports of vessels lost on channel capacity and other parameters, this decreasing time trend has to be a factor. For ocean crossing vessel category there were 5 reports during the week ending December 5, and 24 periods with no reports. The larger vessels

are not likely to founder as the smaller vessels, and hence the fewer reports.

5.6.5 Collision Reports

During the first half of 1972 there were 148 collision reports. During the second half there were 106 reports. There were 12 reports received from collisions during the period ending May 13 and July 15. There were four periods of a week with no collision reports. In the ocean crossing vessel category there were 83 collision reports in the first half of the year and 68 reports in the second half. During the period ending January 8, there were 9 collisions. There were ten periods with no reports.

5.6.6 Composite Reports

There is a decreasing time trend for the composite reports as the year progresses. The trend starts with 34 reports per week period and decreases to 22 reports at mid-year. The trend continues in the second half. During the first half of the year, there were 744 reports of casualties; in the second half, there were 533 reports. During the week ending January 22, there were 43 reports; in the week ending December 30, there were 10 reports.

In the ocean crossing category, there were 338 reports during the first half of the year and 270 reports during the second half. For the period ending January 22 and February 12, there were 19 reports from the larger vessels. The least number of reports per week period (4) were received during the week ending June 3.

5.7 CASUALTY VS. DAY

If casualties happened randomly during the week one would expect 14% of any accident category to occur on any one of the seven days. To simulate an emergency situation and evaluate the emergency communication link through a satellite a realistic estimate of the occurrence of casualties as a function of the day of the week must be used. The yearly tabulation shows that some days of the week have significantly less accidents observed than expected.

5.7.1 Weather Damage Reports

There is no daily tabulation on weather damage due to the nature of reporting this casualty: a vessel declares weather damage for the voyage when it arrives in port. In the report these is no means of extracting the daily data.

5.7.2 Emergency Reports

Casualties of this category happen less frequently on Sundays than on Mondays or Thursdays. The expected number of emergencies on any given day is the total number of emergencies divided by the number of day of the week. There were 532 emergencies; therefore one would expect 76 emergencies per day. The observed data is as follows:

Day of the Week	Total Number of Vessel Reporting Emergencies	Ocean Crossing Vessel Reporting Emergencies
Sunday	46	27
Monday	87	56
Tuesday	80	42
Wednesday	83	44
Thursday	87	44
Friday	83	45
Saturday	<u>66</u>	<u>31</u>
Total	532*	289*

Expected emergencies = 76 per day. For ocean crossing vessels the expected number of emergencies per day is 41.

*The total number of emergencies for the year was 538. Six of the emergencies did not identify the day of the week when the emergency occurred.

note: Throughout the data collection manipulation to develop the material in the "Casualty Tabulation" a goal was maintained that "all numbers would be within 5% of the reported values." In most cases it was much less than this value.

To determine the significance of the hypothesis that the expected value of the number of casualties per day is the total number divided by the number of days of the week a Chi-Square test was made. For this test a 5% level of significance was chosen.

This means 5 times out of 100 experiments would be incorrect in assuming that casualties are not uniformly distributed among the days of the week. In both cases, the total number of ships and the ocean crossing vessels, the hypotheses was rejected. Therefore, in designing experiments to evaluate the communication requirements, the difference in the number of emergencies for each day of the week must be examined.

5.7.3 Aground Report

In this category 226 vessels went aground. If the occurrence is randomly distributed throughout the days of the week, one would expect each day of the week to have 32 ships aground. The observed values are:

Day of the Week	Total Number of Vessels Reported Aground	Ocean Crossing Vessels Aground
Sunday	21	9
Monday	33	13
Tuesday	46	22
Wednesday	26	17
Thursday	38	23
Friday	42	23
Saturday	20	10
Total	226*	117*

$$E = \frac{226}{7} = 32 \text{ Ships Aground Day}$$

$$E_{oc} = \frac{117}{7} = 17 \text{ Ships Aground Day}$$

*Note: The yearly totals are 227 and 118, respectively. One vessel of the ocean crossing type did not indicate which day of the week it went aground.

Saturday and Sunday have the least number of reported groundings for both the total number of vessels and the larger ocean crossing vessels.

The test of significance, when applied to these numbers, demonstrated that the groundings are not uniformly distributed per day of the week.

5.7.4 Sank Reports

Of the 265 total vessels lost, 32 were on a Sunday and 48 on a Tuesday. The expected number of vessel lost per day would be 38; the expected number of ocean crossing vessels lost per day would be 7. The observed values are:

Day of the Week	Total Number of Vessels Sank on this day	Ocean Crossing Vessels Sank
Sunday	32	8
Monday	36	9
Tuesday	48	6
Wednesday	45	5
Thursday	32	8
Friday	37	8
Saturday	35	7
Total	265*	51*

*Note: Of the 284 vessels lost in 1972, only 265 were identified by day of the week. There were 54 vessels lost of the ocean crossing category, and 3 reports did not indicate the date of the loss.

$$\text{Expected value, } E = 38 \frac{\text{vessels}}{\text{day}}, E_{oc} = \frac{51}{7} = 7 \frac{\text{vessels}}{\text{day}}$$

The test of significance when applied to the observed numbers of ships sunk and the expected number indicate that the number of ocean crossing vessels lost on any day is independent of the day. For the total number of vessels lost, the assumption that the number of vessels lost is uniformly spread throughout the week is also true.

5.7.5 Collisions Reports

In this category 254 vessels reported the day of the collision, while 15 did not. Sunday and Saturday has fewer collisions, 26 and 23, respectively, while Monday, Wednesday and Friday had 45, 45 and 44. If the collisions were randomly spread throughout the week, the expected value for each day would be 36 collisions. The observed values are:

Day of the Week	Total Number Vessels In Collisions	Ocean Crossing Vessels in Collision
Sunday	26	18
Monday	45	29
Tuesday	43	21
Wednesday	45	24
Thursday	28	18
Friday	44	30
Saturday	23	11
Total	254*	151*

*Note: The yearly totals are 269 and 158, respectively. The reports for 15 vessels did not indicate the date of the collisions.

The test of significance when applied to the above data demonstrates that the collisions are not uniformly distributed among days of the week. Experiments that evaluate a communication service via a satellite must therefore be designed to reflect the effect of the day of the week.

5.7.6 Composite Reports

This category is the accumulated casualties for the entire year (excluding those reported as weather damaged). From a statistical point of view Saturday and Sunday have fewer casualties reported than any other day of the Week. Tuesday had the most reports. The observed values are:

Day of the Week	Total Number of Vessels in an Accident on this Day	Ocean Crossing Vessels
Sunday	125	62
Monday	201	107
Tuesday	217	91
Wednesday	199	90
Thursday	185	93
Friday	206	106
Saturday	144	59
Total	1277*	608*

Expected value $E = \frac{1277}{7} = 181$ casualties
day

$E_{oc} = \frac{608}{7} = 87$ Ocean crossing casualties
day

*To these totals 1277 and 608 one adds the weather damage reports, 228 and 177, and gets for totals 1505 and 785, which compares with the yearly totals of 1546 and 796.

For this category, it appears that the casualty reports for Sunday will be 42% less than the number on Tuesday. The test of significance applied to these numbers demonstrates that the casualty reports are not evenly distributed throughout the week. As the observed data shows, the weekends, Saturday and Sunday, are less busy than Tuesday and Friday. This occurrence will be incorporated in the design of experiments for a communication satellite service.