# SSC-272

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Executive Director Ship Structure Committee U.S. Coast Guard (G-MI/R) 2100 Second Street, SW Washington, DC 20593-0001

# IN-SERVICE PERFORMANCE OF STUCTURAL DETAILS



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# SHIP STRUCTURE COMMITTEE 1978

#### SHIP STRUCTURE COMMITTEE

AN INTERAGENCY ADVISORY COMMITTEE DEDICATED TO IMPROVING THE STRUCTURE OF SHIPS

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SR-1232

The fabrication of structural design details represents a significant part of a ship's structural cost. These details also represent potential sources of premature failure, fatigue cracking, and, perhaps, spontaneous fracture. Although periodic or pre-repair surveys are made on ships, insufficient information is reported to evaluate the performance of the structural details.

Therefore, the Ship Structure Committee initiated a project to examine 50 ships undergoing repairs or periodic surveys to determine the type and frequency of different structural details and pin-point those areas where problems have occurred.

This report describes the results of that project. An additional 36 ships are now being examined.

W. M. Benkert Rear Admiral, U.S. Coast Guard Chairman, Ship Structure Committee FINAL TECHNICAL REPORT

on

## Project SR-1232

"Structural Details Failure Survey"

## IN-SERVICE PERFORMANCE OF STRUCTURAL DETAILS

by

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NEWPORT NEWS SHIPBUILDING

under

Department of the Navy Naval Sea Systems Command Contract No. N00024-76-C-4362

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> U. S. Coast Guard Headquarters Washington, D.C. 1978

#### ABSTRACT

This report includes the results of a structural detail survey of twelve families of approximately fifty different ships. Seven ship types were surveyed to determine whether or not predicted failures actually occurred.

The families are beam brackets, tripping brackets, non-tight collars, tight collars, gunwale connections, knife edge crossings, miscellaneous cutouts, clearance cuts, deck cutouts, stanchion ends, stiffener ends, and panel stiffeners. Fifty-six groups evolved with a total of 553 observed variations in structural configuration. The data are synthesized by family groups.

During the survey 490,210 details with 3,307 failures were observed. Eighty-two percent of the failures were in the cargo space and were predominately located in structure adjacent to the side shell. The remaining 18% were distributed, 10% forward and 8% aft of the cargo spaces.

Feedback data of this type should be invaluable to design and repair offices. It depicts, with sketches and photographs, the variations of structural configurations and tabulates all of the data collected during the survey. As an aid to engineers and designers, failure causes such as design, fabrication, maintenance and operation are postulated. Systematic performance studies of this type should be conducted in all areas of ship construction.

## CONTENTS

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	<u>ge</u>
INTRODUCTION	1
SHIPS IN THE SURVEY	6
SHIPYARDS VISITED AND CONDITIONS OF SURVEY	7
SHIPBOARD SURVEY ENVIRONMENT	7
DOCUMENTATION 1	1
DETAIL FAMILIES	2
Family Number 1 - Beam Brackets 1   Family Number 2 - Tripping Brackets 2   Family Number 3 - Non-Tight Collars 3   Family Number 4 - Tight Collars 3   Family Number 5 - Gunwale Connections 4   Family Number 6 - Knife Edges 5   Family Number 7 - Miscellaneous Cutouts 5   Family Number 8 - Clearance Cutouts 6   Family Number 9 - Deck Cutouts 7   Family Number 10 - Stanchion Ends 9   Family Number 11 - Stiffener Ends 9   SummARY OF RESULTS 10   CONCLUSIONS AND RECOMMENDATIONS 11	4 1 9 9 6 1 1 4 4 2 2 2 3 .0
REFERENCES	1
ACKNOWLEDGEMENTS	2
APPENDICES	3
Table A-1, Detail Family No. 1 - Beam Bracket	24 10 13 16 19 55 59 83

## LIST OF ILLUSTRATIONS

## FIGURES

<u>Page</u>

1	Detail Classifications	2
2	Failed Cargo Tank Ladder Clips	9
3	Cracks in Landing Platform for Cargo Tank Ladder	10
4	Beam Brackets Details	15
5	Sample Beam Bracket Failure Modes	22
6	Failed Flat Plate Corner Bracket on a Containership	26
7	Failed End Beam Bracket on a Combination Carrier	27
8	Failed Flanged Plate End Bracket on a Tanker	28
9	Tripping Bracket Details	29
10	Sample Tripping Bracket Failures	34
11	Failed Tripping Bracket at a Hatch End on a	
	Containership	36
12	Failed Tripping Brackets Supporting the Bulwark	- 0
	at the Shell on a General Cargo Ship	37
13	Failed Tripping Bracket Supporting a Deck-House	-,
	Bulwark on a Tanker	38
14	Non-Tight Collar Details	40
15	Sample Non-Tight Collar Failures	43
16	Tight Collar Details	44
17	Gunwale Connection Details	47
18	Failed Gunwale Connection on a Miscellaneous Vessel	49
19	Failed Gunwale Connection on a Tanker	50
20	Miscellaneous Cutout Details	52
21	Defect at an Access Opening in a Containership	56
22	Historical Defect at an Access Opening in a	20
	Containership	57
23	Inadequate Drainage on a Bulk Carrier	59
24	Lapped Web Cutouts and Other Structural Details	
	in a Bulk Carrier	60
25	Failed Lightening Hole in a Web Frame of a Bulk Carrier	61
26	Sound Weld Clearances on a Tanker	62
27	Failed Weld Clearance Cut on a Containership	63
28	Sample Miscellaneous Cutout Failures	65
2 <del>9</del>	Clearance Cutouts Details	67
30	Sample Clearance Cut Failures	69
31	Failed Clearance Cut at an Access Opening on a	
	Combination Carrier	70
32	Failure Mode for Group "D" Clearance Cutouts on a	
	Combination Carrier	71
33	Failure Mode for Group "D" Clearance Cutouts on	
	a Tanker	72
34	Repaired Clearance Cut Failure on a Combination	
	Carrier	73
35	Failed Group "E" Clearance Cutouts on a Bulk Carrier	75
36	Unusual Crack at a Group "E" Clearance Cutout on a	
	Bulk Carrier	76
37	Failed Group "E" Clearance Cutout on a Tanker	77

## LIST OF ILLUSTRATIONS (Cont'd)

## FIGURES

•

1.1

38	Deck Cutout Details	78
39	Sample Deck Cutout on a Tanker	80
40	Failed Hatch Corner on a Combination Carrier	81
41	Historical Crack at a Hatch Corner on a Containership	83
42	Stanchion End Details	84
43	Sample Stanchion End Failures	89
44	Failed Stanchion End Bracket Connection on a	
	Combination Carrier	90
45	Distorted Stanchion on a General Cargo Ship	91
46	Stiffener End Details	93
47	Sample Stiffener End Failures	96
48	Failed Stiffener End on a Combination Carrier	98
49	Failed Stiffener End on a Tanker	99
50	Panel Stiffener Details	100
51	Sample Panel Stiffener Failures	104
52	Panel Stiffener Failure on Web Frame of a Tanker	105
53	Buckled Panel Stiffener on a General Cargo Ship	106
54	Reinforced Panel Stiffener on a Containership	107
55	Service Failure Rate	108
56	Detail Variations with Observed Failures	112

## TABLES

l	Summary of Ships Surveyed	6
2	Compartment Accessibility	8
3	Distribution of Detail Configurations	13
4	Summary of Beam Brackets	20
5	Summary of Tripping Brackets	32
6	Summary of Non-Tight Collars	41
7	Distribution of Failed Non-Tight Collars	42
8	Summary of Tight Collars	45
9	Summary of Gunwale Connections	48
10	Summary of Miscellaneous Cutouts	55
11	Summary of Clearance Cutouts	68
12	Summary of Structural Deck Cuts	79
13	Summary of Stanchion Ends	88
14	Summary of Stiffener Edns	95
15	Summary of Panel Stiffeners	102
16	Summary of Data from 50 Ships	109
17	Top Ten Failed Details	111

The SHIP STRUCTURE COMMITTEE is constituted to prosecute a research program to improve the hull structures of ships by an extension of knowledge pertaining to design, materials and methods of fabrication.

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The SHIP STRUCTURE SUBCOMMITTEE acts for the Ship Structure Committee on technical matters by providing technical coordination for the determination of goals and objectives of the program, and by evaluating and interpreting the results in terms of ship structural design, construction and operation.

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--vi--

#### INTRODUCTION

On January 9, 1976, Newport News Shipbuilding received a contract from the Department of the Navy, Naval Sea Systems Command, Code: SEA 0242 to perform the Ship Structure Committee project SR-232. This project, under the advisorship of the National Academy of Sciences, Ship Research Committee, was to conduct a structural detail failure survey of twelve detail families on approximately fifty different ships. The twelve families of details were to be surveyed by an on board visual inspection of several ships of various types, undergoing repairs or periodic surveys, to determine whether or not predicted failures actually occurred.

The goal of the project is to provide design and repair personnel with structural service data and recommendations that can be used to significantly decrease the number of detail failures that occur in ships which operate in an environment that is constantly changing, inconsistent, and often times hostile. Current design and repair practices are based on theory and empirical data that produce satisfactory performance except in relatively isolated cases which have vulnerable areas of instability in localized structural arrangements. Failures that do occur, however, are usually in the plate crack or buckle modes and must be repaired or confined to the local area to prevent a threatened total collapse of the ship structure.

A number of structural details that are common to many ships are examined in the survey in order to evaluate the effectiveness of various existing geometrical configurations that have been used for similar shipboard conditions. Data from sound and failed details are gathered from interviews, repair specifications, and inspections aboard ships which are undergoing repairs or periodic surveys in repair yards or aboard accessible ships at loading and unloading docks. Results from the orderly and systematic study of structural details on ships in service can make a significant contribution to design and repair knowledge that should result in an improvement in design and fabrication practices and increase the number of sound details in present and future ships.

Structural details that have histories of failures in the past were selected on the basis of References 1, 2, and 3, and from preliminary interviews with ship design and repair personnel. After grouping the observed details according to their intended functions, a typical configuration for each of the twelve detail families was selected as a basis for discussing the variations within each family. These typical configurations, as shown in Figure 1, were selected according to their maximum frequency of occurrence on the ships surveyed.

This method of classification provided for inclusion in the survey of other details; ones that did not have known failure histories but were expected to be vulnerable to the magnifying stress patterns imposed on the local structure by the detail geometry, fabrication methods and other environmental factors such as corrosion. Also included were the numerous sound and successful details that have remained strong and functionally effective throughout many years of ship service.

-1-

## DETAIL CLASSIFICATIONS

Type No.	Name	Functional Provision	Typical Configuration
1	Beam Bracket	Increase strength of framing and stiffening members at their supports.	
2	Tripping Brackets	Laterally support framing and stiffening members.	E
3	Non-Tight Collars	Provide a connection from webs of framing and stiffening members to the plating of supports that have cutouts at the members.	

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## FIGURE 1, Detail Classifications (Cont'd)

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Type No.	Name	Functional Provision	Typical Configuration
4	Tight Collar	Same as 3. above except also cover the cutouts to prevent passage of fluid or objects through the cutout.	
5	Gunwale Connection	Join the strength deck stringer plate to the shear strake.	
6	Knife Edge Crossing	No functional provision	

## FIGURE 1, Detail Classifications (Cont'd)

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Type No.	Name	Functional Provision	Typical Configuration
7	Miscellaneou <b>s</b> Cutouts	Provide a wide variety of holes for access, drainage, ease of fabrication, cableways, pipes, stress relief, etc.	
8	Clearance Cutouts	Provide a hole in an intersecting member to allow another member to go through.	
9	Structural Deck Cuts	Allow passage through decks for access, tank cleaning, piping, cables, etc.	

## FIGURE 1, Detail Classifications (Cont'd)

Type No.	Name	Functional Provision	Typical Configuration
10	Stanchion Ends	Transfer loads between stanchions and deck supporting members.	
11	Stiffener Ends	Connect an unbracketed non-continuing stiffener to a supporting member.	
12	Panel Stiffeners	Stiffen plating and webs of girders. These are non- load carrying members.	

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#### SHIPS IN THE SURVEY

Various merchant and naval vessels were surveyed as shown in Table 1. The merchant ships are presented according to their commercial classification and, for national security reasons, the naval ships presented as one class. Included in the table are columns giving the average lengths between perpendiculars, displacements, and ages. These averages vary over ranges of 430 to 770 feet for LBP, 11,000 to 71,000 long tons for displacement, and four to thirty years for age. Of the fifty ships surveyed, forty-two were built or converted in sixteen different domestic shipyards and the remaining eight were built or converted in four different foreign shipyards.

			TABLE 1								
SUMMARY OF SHIPS SURVEYED											
No. of Ships	<u>Classification</u>	Avg. LBP (feet)	Avg. Displmt. (long tons)	Avg. Age (years)	<u>No.</u> USA	<u>Built</u> Foreign					
4	Bulk Carriers	618	46,300	10	1	3					
5	Combination Carriers	782	43,300	8	5	0					
12	Containerships	622	27,500	11	10	2					
. 5	General Cargo	490	18,300	11	3	2					
2	Miscellaneous	505	28,600	10	1	1					
9	Naval			13	9	0					
13	Tanker	630	42,600	19	13	о					
50	AVERAGE/TOTAL	622*	34,980*	13	42	8					

Does not include size of the naval vessels.

#### SHIPYARDS VISITED AND CONDITIONS OF SURVEY

All of the ships, except one miscellaneous vessel at a Gulf Coast loading dock were in repair yards for scheduled maintenance and periodic inspections, overhauls, or for unscheduled emergency repairs. Thirty-three ships were surveyed at Newport News. The remaining seventeen (17) that were surveyed elsewhere included one bulk carrier, one combination carrier, one general cargo ship, one miscellaneous vessel, nine naval vessels, and four tankers.

A complete list of the yards in which the ships were surveyed are: Newport News Shipbuilding, Newport News, Virginia Norfolk Naval Shipyard, Portsmouth, Virginia Norfolk Shipbuilding & Dry Dock Company, Norfolk, Virginia Jacksonville Shipyards, Inc., Jacksonville, Florida Bethlehem Steel Corporation, San Francisco, California Todd Shipyards Corporation, Alameda, California Bethlehem Steel Corporation, Boston, Massachusetts

Personnel involved with commercial, civil, naval and regulatory operations in these yards and those on the surveyed ship were interested in the project and were very helpful and cooperative. Permission was granted by the Port Engineer and usually the ship's Captain for each survey with the understanding that the ship's name would remain anonymous.

#### SHIPBOARD SURVEY ENVIRONMENT

Typically, the ships contained some ballast and sometimes one would have a partial or full cargo load aboard. Inspection of the ship's structure was limited to the accessible details in open compartments as given in Table 2. Tanks that were entered had been checked for gas by a yard chemist and certified safe for man and usually, but not always, safe for welding. In a few cases tanks were bypassed because the ladders were considered unsafe for access. (See Figures 2 and 3) Occasionally, access was gained to a normally closed compartment that had been opened for the repair yard's use or for inspection by the United States Coast Guard and/or the American Bureau of Shipping.

Only the structure that was visibly accessible in the open compartments was surveyed. No attempt was made to remove insulation, chip off the paint, strike loose corroded metal, or alter any item that could cause subsequent repair to the vessel. Inspection of the details was aided by the use of a small hammer and pen knife to determine sound metal. Other testing methods such as dye penetrant, magnetic particles, ultrasonic or x-ray techniques were not used. Under no circumstances was the surveyor to disrupt repair operations or alter

TABLE 2	
COMPARTMENT ACCESSIBILITY	
Compartments	Number Open
Forecastle storerooms	90
Forepeak tanks	30
Chain lockers	40
Forward pump rooms	90
Cargo spaces	46
Inner bottom	1
Fore and aft passageways	100
Miscellaneous deck-houses	30
Public spaces	100
After pump rooms	96
Machinery spaces	98
Fuel oil tanks	2
Potable water tanks	0
Voids	10
Weapons stowage	0
Shaft tunnels	96
Steering gear rooms	80
Main deck-houses	10

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-8-

## FAILED CARGO TANK LADDER CLIPS



The flat bar clips are welded to the underside of the deck and to the ladder frame. A square piece of cardboard has been inserted in the crack in the left-hand clip.

## CRACKS IN LANDING PLATFORM FOR CARGO TANK LADDER





The cracks are encircled by white paint in order to aid location by repair men. The platform was still intact enough to hold the ladder. the existing condition of the ship's structure, to do so was not within the scope of this contract.

Housekeeping on the ships varied from well kept and clean to neglected and unclean. All of the yards required the surveyor to wear a hard hat and safety glasses. Additionally, safety shoes and ear plugs were either required or urged in most of the yards. Other surveyor equipment included coveralls, flashlight, ruler, camera (when permissible) and a notebook of data sheets.

#### DOCUMENTATION

Quantitative data on the twelve details were accumulated throughout the twelve month period of the ship surveys. The data were collected by the systematic use of the following pre-established check-off list which was developed to ensure that the same type of data was recorded for each surveyed detail. Historical facts were also gathered, when available, for use in the final synthesis.

Ship

- . Туре
- . Size (but not name)
- . Age
- . Whether domestic or foreign built
- . Shaft horsepower

Each Configuration

- . Detail family number
- . Geometrical sketch
- . Location on ship
- . Number of details observed
- . Estimated number of details
- . Number of failed details observed
- . Estimated number of failed details
- . Failure mode
- . Corroded condition
- . Weld condition
- . Workmanship
- . Conformity of parts to shape intended

- . Manual or machine preparation
- . Material type
- . Alignment
- . Probable cause of failure

Interviews

- . Present structural problems
- . Historical structural problems
- Suggestions

The estimated quantity of details with a particular configuration was extrapolated from a count within one compartment or area where that particular configuration prevailed within each ship. Estimated failure quantities were calculated as a function of the observed failed details, repairs requested in specifications, and those mentioned in interviews.

In addition to the recorded data, photographic pictures, where allowed by the owner, were taken of sample sound and failed details on diverse types of commercial ships. Pictures were not permitted on any naval ship.

#### DETAIL FAMILIES

As the survey progressed it became apparent that each family had various configurations with unique geometrical features that could significantly affect the stress patterns within and around the details. In order to find failure trends in the various features, the details were grouped within each family according to their similar or related characteristics. Thus, each family is composed of two or more detail groups, containing related configurations, which were designed to perform the same function, but differ from each other in one or more geometric features. This grouping method resulted in the twelve detail families being subdivided, see Table 3, into fifty-six separate groups with a total of 553 distinct configurations. The detail variations are identified by their assigned position in the individual families, i.e., the first number(s) is the family number, the letter is the group number and the last number(s) is the variation number.

Each family is presented according to the above grouping with discussions containing sketches of each observed configuration, a summary of each group survey, and sketches and/or pictures of sample failure cases.

TABLE 3

## DISTRIBUTION OF DETAIL CONFIGURATIONS

Detail Family <u>Number</u>	Detail <u>Family</u>	Number of <u>Groups</u>	Number of Configurations
1	Beam Brackets	14	125
2	Tripping Brackets	3	66
3	Non-tight Collars	3	36
4	Tight Collars	4	32
5	Gunwale Connections	2	20
6	Knife Edges	0	0
7	Miscellaneous Cutouts	8	65
8	Clearance Cutouts	5	35
9	Deck Cutouts	3	23
10	Stanchion Ends	3	79
11	Stiffener Ends	5	32
12	Panel Stiffeners	6	40
12	TOTAL	56	553

#### FAMILY NUMBER 1 - BEAM BRACKETS

Variations in beam bracket configurations are given in Figure 4 and are grouped according to similar characteristics within the continuous, corner, end, and transition functional classification of the bracket. Of the 125 observed variations, forty-four geometrical forms were observed in two or more ship types, and the remaining eighty-one were observed in only one ship type.

Table 4 gives a summary of both the observed and estimated sound and failed bracket details as they existed on the ships. There were no observed failures in the "G" group. Family group "C" appeared more times during the survey and group "J" appeared least. Although group "C" has the highest number of estimated failures, the possibility of failure is only 1.5%. Group "J" has the highest estimated percent failure. All of the group "G" corner brackets were sound although "1-G-5" had a failure history prior to being modified from a curved face plate to the straight one.

The distribution of failures along the ship's length are 10% for the stern aft of the cargo spaces, 75% for the cargo space length, and 15% for the bow area forward of the cargo spaces. Heavy weather, neglect, questionable items, collision, design, and fabrication were the most frequently cited reasons for the failures with heavy weather given as a contributing factor in two-thirds of the failure cases. Twenty percent of the failures were caused by factors which could possibly have been eliminated by the use of a presently congruous design method relative to the stability of unsupported plate edges and stiffness transition factors.

Bracket failures which occurred in the ends of the ship were generally concentrated near the water line where collisions with tugs resulted in dished side shell plating and straited shell frames. Other collisions which caused damage to beam brackets include those of the ship with a pier, possibly another ship or large objects at sea, and grounding. Additional observations about the surveyed beam brackets include:

- . Little or no correlation between failures and lapped brackets.
- Tangency chocks should be at ends of bracket face plate (group "A").
- . Flat plate brackets and plating panels should be carefully sized to suit stability calculations.
- . Brackets near the water line at fore and aft tug stations should be strengthened and have a flange.
- . Brackets which land on the inner bottom in machinery spaces and on decks directly under forecastle deck should have scantlings and/or coating to suit corrosive conditions.
- . Longitudinals should continue through transverse bulkheads rather than through heavy plate brackets (group "B") which tend to create a hard spot with cracks in the bulkhead plating and connecting stiffeners.



#### CONTINUOUS

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FIGURE 4 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)

CORNER

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D.





-16-

FIGURE 4 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)

CORNER (Cont'd)

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G.

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F.

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-18-

FIGURE 4 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)



-19-

TABLE 4

SUMMARY OF BEAM BRACKETS

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Ē			Ц	 								ĩ 						
ESTIMAT.	Number	of	Failures	24	133	743	4	4	35	1	30	49	46	06	24	51	64	1297
	Number	of	Details	12290	10070	48320	8750	4100	2410	12500	2830	260	1550	2360	5320	1470	1350	113580
	%	Sound	Details	9.66	97.4	0.86	6.66	8.66	97.3	100.0	98.3	81.1	95.1	93.6	1.99	94.1	93.2	98.3
OBSERVED		Sound	Details	4928	4073	22133	3917	1857	1022	5040	1366	211	666	992	2449	593	615	49862
	Number	of	Details	4950	4180	22580	3920	1860	1050	5040	1390	260	700	1060	2470	630	660	50750
	<u> </u>	Family	Group	ď	,a	0	קי	Ð		σ	Д				m		Ω	TOTAL

Face plates should not be butt welded in curved corner brackets (group "F").

Sample failure modes in beam brackets are presented in Figure 5 which shows several conditions as they existed on the ships. Cracks are shown occurring in ends of face plates, welds, abrupt member endings, cutouts and in a relatively soft end of a hatch coaming. Buckles are shown as they existed in deck plating, flat bars reinforced by a bracket, flat plate corner bracket, curved face plate brackets and a straight flanged bracket. Three of the sample details have both cracks and buckles in which one type of failure perpetrated the appearance of the other such as in detail 112 where the failure of the bulb bar added to the bending moment in the flanged plate bracket and released the lateral supportive forces at the bracket top.

Figures 6, 7 and 8 are photographs of failed beam brackets in a containership, combination carrier, and a tanker. Figure 6 shows a flat plate corner bracket that buckled due to low plate critical stability level and an unusually high end moment created during heavy weather. The end bracket in Figure 7 has an abrupt ending which contributed to the appearance of the 13 inch horizontal crack just above the weld to the deck. Shown in Figure 8 is a flanged plate bracket that buckled possibly due to a high dynamic head of water on the forecastle while the ship was being "driven" through heavy seas.

#### FAMILY NUMBER 2 - TRIPPING BRACKETS

Tripping brackets used to prevent lateral instability failures of webs or flanges of longitudinals, beams or girders are placed in three general groups. Group "A" consists of single plate brackets on one side of the web only; group "B" consists of single plate brackets of the same type located on both sides of the web; and group "C" consists of flanged brackets on one side of the web only. There were no observed cases of flanged brackets on both sides of the web. Figure 9 is the three general group arrangement of the sixty-six variations of tripping brackets seen during the survey period and Table 5 is a summary of observed and estimated data.

The highest failure percentage occurred in group "C" where side loadings on the supported girders created high stresses at the connection of the bracket toe to the deck. Resulting cracks occurred immediately above the weld in the heat affected zone.

Heavy weather and design, followed by a significantly lower rate by welding, misuse/abuse, and collisions, are the most frequent reasons cited for the failures. Two or more reasons are frequently given for a particular failure, such as for detail 2-B-8 where design, welding and heavy weather apparently contributed to the occurrence of cracks in the bracket toes. In this case, it was learned from an interview with one of the ship's officers that the ship had recently encountered a severe storm while the hatches were loaded with three tiers of containers. This combined loading condition developed stresses in the hatch and girder brackets that design had failed to back up with stiffening members under the deck and production had fabricated with

#### SAMPLE BEAM BRACKET FAILURE MODES





-22-

FIGURE 5 - SAMPLE BEAM BRACKET FAILURE MODES (Cont'd)



TRANS FRAMING



TRANS FRAMING DET 104 CONTAINERSHIP





CONTAINERSHIP

-23-



-24-



# FIGURE 5 - SAMPLE BEAM BRACKET FAILURE MODES (Cont'd)

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FAILED FLAT PLATE CORNER BRACKET ON A CONTAINERSHIP



The buckled bracket is similar to detail 1-C-1.

### FAILED END BEAM BRACKET ON A COMBINATION CARRIER





This photograph snows the end of a hatch side coaming (detail 1-J-3) on weather deck. The ruler is oriented for and aft and parallels the crack in the heat affected zone of the weld to the deck.

#### FAILED FLANGED PLATE END BRACKET ON A TANKER



The photographer is standing on upper deck and looking up toward forecastle deck. The bracket (similar to detail 1-K-3) is cantilevered in the transverse direction from the chain locker bulkhead and attaches to a deck longitudinal girder on the outboard end. Loading apparently came from on forecastle deck and continued through the deck girder and into the bracket.
TRIPPING BRACKET DETAILS FAMILY NO. 2

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FIGURE 9 - TRIPPING BRACKET DETAILS, Family No. 2 (Cont'd)

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FIGURE 9 - TRIPPING BRACKET DETAILS, Family No. 2 (Cont'd)

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## TABLE 5

## SUMMARY OF TRIPPING BRACKETS

		OBSERVED		ESTIMATED			
FAMILY GROUP	Number of Details	Sound Details	% Sound Details	Number of Details	Number of Failures	% Fail <u>ure</u> s	
А	10240	10179	99,4	22470	72	.3	
В	6920	6865	99,2	15210	68	•4	
с	3480	3282	94.3	<u>7540</u>	218	2,9	
TOTAL	20640	20326	98.5	45220	358	.8	

-32-

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undercut welds at the bracket toe edges. The combined conditions resulted in cracks developing in the heat affected zone.

Conclusions drawn from groups "A" and "B" in Table 5 indicate that tripping brackets are not necessary on both sides of the web. Results for individual details support this conclusion. For instance, detail 2-A-4 has one lateral supporting bracket whereas detail 2-B-1 has identical brackets on each side of the web. Neither detail failed. Failures occurred in both details 2-A-6 and 2-B-12 which are identical except for the chock on the opposite side of the web in detail 2-B-12. This further strengthens the position that tripping brackets are needed on one side only of a girder subject to in-plane loading and can also be designed to be effective in the support of a girder subject to lateral loading.

Twenty percent of the tripping bracket failures were in the buckling mode due to collisions, corrosion, heavy weather, and design in descending order of cited frequency. Most of these failures occurred forward of amidship which suggest that details in the forward end of the ship which are subject to seawater loading should be given special attention.

In several of the interviews ship officers stated that the ships had to slow down in heavy weather; that the actual speed is a matter of judgment with consideration for the safety of the crew, cargo and ship; and that a trade-off occurs between repair items and meeting cargo delivery schedules. Usually the ship was slowed down just enough for safety but not enough to prevent minor structural damage. This damage was most noticeable at the bow on forecastle decks and in structure attached to the forward side shell plating.

Five samples of failed tripping brackets are shown in Figure 10. Shown are one case of a buckled bracket and four cases of cracks at bracket toes. Detail 200 was buckled primarily as a result of severe corrosion of the flat plate bracket which lowered its critical buckling stress level. Detail 201 had a crack that started at the toe of the bracket and extended in one direction through the shell longitudinal's flange and in the other direction into the longitudinal's web and near the shell plating. Cracks at the toes of detail 202, 203, and 204 were in the heat affected zone of the weld and in detail 204 the crack had extended into the flexing bulkhead plating which resulted in a noticeable oil leak between the two compartments.

Figures 11, 12, and 13 are photocopies of failed tripping brackets on a containership, general cargo ship and a tanker. A weld build-up was added at the bracket toe of Figure 11 in an historical attempt to prevent further cracks which later occurred as shown. Figure 12 shows a tripping bracket that received impact blows from presumably rough handling of containers or heavy bulk items. Other structure within the cargo area of the ship had a similar extensive damage appearance. Figure 13 shows a buckled flat plate bracket that supported a deck-house bulwark on a tanker. This apparent impact damage also included a crack at the cutout in the deck-bulwark corner. Failed brackets were also present in the cargo oil tanks but their photographs were not reproducible.

-33-

## SAMPLE TRIPPING BRACKET FAILURES



#### -34-





DET 203 CONTAINERSHIP

-35-

## FAILED TRIPPING BRACKET AT A HATCH END ON A CONTAINERSHIP



This flanged plate tripping bracket supports a transverse hatch coaming on main deck. The picture is of the bracket toe at main deck where layers of welds have been added in an attempt to distribute the load in the deck plate over a larger area. A short crack exists in the bracket immediately above the weld layers.

## FAILED TRIPPING BRACKETS SUPPORTING THE BULWARK AT THE SHELL ON A GENERAL CARGO SHIP



The photograph is on starboard side looking outboard and aft. In addition to the obvious battered coaming and flanges, cracks exist in diverse places in the brackets at the connections.

### FAILED TRIPPING BRACKET SUPPORTING A DECK-HOUSE BULWARK ON A TANKER



The bulwark is on the forward side of a deck-house. The buckle in the bracket is due to an impact load on the bulwark. A crack also exists at the corner weld clearance cutout where the bottom of the bracket connects to the bulwark and to the deck.

In summary, design of tripping brackets on transverse hatch ends should be carefully considered especially on ships where three tiers of containers on the cargo hatches are expected; tripping brackets need not be on both sides of an in-plane loaded web; and landings of tripping brackets should be on relative strong stiffeners or on deck locations directly above backup structure. Ship operators can expect structural failures when the ship is "driven" through stormy seas.

#### FAMILY NUMBER 3 - NON-TIGHT COLLARS

Thirty-six variations of non-tight collars were observed in thirty-four of the fifty ships surveyed with failures occurring in only five ships. The remaining sixteen ships had no non-tight collars. The thirty-six variations were separated into three general groups in Figure 14 based on the method of attachment used to connect it to the through members. Group "A" has one connection to the through members; group "B" has two connections to the through members; and group "C" has three connections to the through members. Results for each group is summarized in Table 6.

A very high percent (99.9%) of the details were sound. The remaining .1% is an estimated thirty-three failures as presented in Table 7 which gives the distribution according to ship types, location within the ships, and reasons for the failure of the details. They were in three different forms as shown in Figure 15 where cracks existed at the intersection of the collar clips and the cutouts in two cases and where distortions were present in the web plating and collar clip in the other case. Detail 300 could reasonably be considered a failure of the web frame plating rather than the collar.

Form 3 in group "B" (detail 3-B-3 in Figure 14) appeared to be a historical repair item since the clips were on bottom transverse web frames at longitudinals where shell framing deflections are expected to be large during heavy weather. This clip method or a modified one can reasonably be expected to alleviate the crack problem around the cutouts. A suggested modification is to add a radius in the clip at the resulting cutout corner nearest the free end side of the stiffener flange.

In summary, the physical integrity of the non-tight collars was very high over the full survey range and a meaningful percentage of the sparse failures could be attributed to adjacent web plating panel buckles. One clip method for alleviating cracks around cutouts appears reasonable.

#### FAMILY NUMBER 4 - TIGHT COLLARS

All observed tight collars were sound. Figure 16 shows the thirty-two configurations in the four family groups as reported in the data of Table 8. Note that group "D" contains slots which accommodate through members and are considered as "tight collars" in this report.

Singular collar forms were assumed to be adapted to the type of vessel service and the construction techniques used in the building

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## TABLE 6

## SUMMARY OF NON-TIGHT COLLARS

	FAMILY GROUP	OBSERVED			ESTIMATED		
		Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failure Details	% Failures
	А	6550	6539	99.8	14770	13	.1
	В	5700	5700	100.0	11850	_	-
	с	4000	3983	99.6	11420	20	.2
	TOTAL	16250	16222	99.8	38040	33	.1

-41-

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## TABLE 7

## DISTRIBUTION OF FAILED NON-TIGHT COLLARS

Number of Failures	Location Along Ship Length	Failure Cause	
10	Aft	Questionable	
4	2 aft, 2 amidship	Fabrication/ workmanship	
10	Aft	Fabrication/ workmanship	
3	Forward	Collision	
6	Forward	Collision	
	Number of Failures 10 4 10 3 6	Number of FailuresLocation Along Ship Length10Aft42 aft, 2 amidship10Aft3Forward6Forward	

-42-

### SAMPLE NON-TIGHT COLLAR FAILURES



TANKER



CONTAINERSHIP

DET 302 BULK CARRIER

TIGHT COLLAR DETAILS FAMILY NO. 4

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-44-

## TABLE 8

## SUMMARY OF TIGHT COLLARS

	OBSERVED			ESTIMATED		
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details
A	7220	7220	100	19740	0	0
В	3770	3770		16620		
с	740	740		2100		
D	6270	6270		17300	▼	V
TOTAL	18000	18000	100	55760	0	0

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yards. Collars such as detail 4-A-11 cover cutouts that have both horizontal and vertical clearances around the through angle. Collars such as detail 4-B-3 enclose cutouts which have only horizontal clearances, and those such as detail 4-D-1 have very little horizontal and vertical clearances. The majority of the collar lugs were lapped onto the plating around the clearance cutouts. Frequent areas of rough welds and weld splatters on transverse bulkhead plating were found around the collars in the merchant ships but did not result in any collar or adjacent structure failures.

In summary, the inspection results show that all the tight collars in the survey were functional and undamaged.

#### FAMILY NUMBER 5 - GUNWALE CONNECTION

Throughout the history of ship design and construction, particular emphasis has been placed on the connection of the side shell to the strength deck in an effort to eliminate the possibility of a crack propogation that could result in such a catastrophic structural failure that the ship would be ultimately lost. This gunwale connection has been accomplished by either riveting or welding and of the twenty gunwale connections observed, twelve were of riveted construction and eight of welded construction. They are shown as two groups in Figure 17 with data summarized in Table 9.

Workmanship in the examined gunwale connections was excellent except in one or two places on a few ships where minor variances would be present in a weld overlap. In one gunwale detail, a liner was in the riveted connection between the shear strake and the deck flat bar as shown in detail 5-A-9 of Figure 17.

Two ships had several local out-of-plane displacements above main deck in the vertically cantilevered portion of the shear strakes on both sides of the ships. Probable causes for the out-of-plane areas are excessive compressive stresses in the gunwale, lateral forces applied by wire ropes, or collisions with horizontal objects at piers. In every occurence, however, plate displacements were inboard. Photographic records of the weakened gunwales include those in Figures 18 and 19.

One interesting aspect about the "B" group is the amount of roundness at the top edge or corner. Excluding detail 5-B-1, the sharpness of the shear strake's top outboard edge ranges from square in detail 5-B-5 and 5-B-8 to a full radius in detail 5-B-7. Detail 5-B-4 had a 5 mm radius as specified on the ships copy of the midship section plan.

Deterioration by corrosion of the gunwale details was evident on the older commercial ships but was not present on the naval vessels. Group "A", the riveted connections, contained corroded areas where the rivets had loosened during service; no rivets were missing. Other weakened effects such as notch cuts, drainage holes or abrasions were not seen in any of the connections.

The inspection results given in Table 9 contain numbers related to the sound and failed details. Totals should be interpreted by





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## TABLE 9

### SUMMARY OF GUNWALE CONNECTIONS

	OBSERVED			ESTIMATED		
F AMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details
A	58	56	96.5	58	2	3.4
В	42	40	95.2	42	2	4.8
TOTAL	100	96	96.0	100	4	4.0

-48-

#### FAILED GUNWALE CONNECTION ON A MISCELLANEOUS VESSEL



Photographer is standing on main deck looking down at the gunwale. These out-of-plane displacements occurred in several places along the length of the gunwale on both sides of the vessel. Cracks were not observed in the detail which is similar to 5-B-8. The upper part of the picture shows part of a rope above the ruler.

# FAILED GUNWALE CONNECTION ON A TANKER



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The inward displacements of one to two inches (as indicated by the folding rule) in the shear strake extension were present at several midship and forward locations on both sides of the ship. The gunwale connection is similar to detail 5-A-7. realization that each ship contains only two gunwale details - one on each side of the ship. Only one failure is given in the table for each failed gunwale although several places along the gunwale length may have been defective. If the percent failure were considered as the failed segment lengths relative to the total length of all the gunwales, the calculated percentage would be too small to reveal the gunwale faults. As presented in the table, the defective bends in the four gunwales become significant.

In summary, two ships had visible bent places along the length of their gunwale connections. These were suspected, but unverified, to be due to exterior abuse rather than to internal stresses from expected ship operations. Workmanship in these details was excellent.

#### FAMILY NUMBER 6 - KNIFE EDGES

Knife edges were not found on any of the fifty ships. This does not eliminate the existence of knife edges since they are almost certain to occur in the design and alterations of complex ship structure. The problem is to locate them on the ship. To detect a definite "knife" requires a study of the detail structural plans used in the construction of the ship and in all subsequent structural modifications. This would be extremely time consuming as well as impossible for a study of this type since the ships do not carry these drawings with them.

It would normally be expected that most cracks due to knife edges show up very early in a ship's life, however, the survey interviews did not totally confirm this. Statements regarding repairs involving knife edges crossings were relevant to vessels not included in the survey. In those vessels most knife edge problems were allegedly at the terminations of platform decks and bulkheads in and around miscellaneous tanks, machinery spaces and deck-houses.

#### FAMILY NUMBER 7 - MISCELLANEOUS CUTOUTS

Functional groups in the miscellaneous cutout family are access openings, air escapes, drain holes, lapped web openings, lightening holes, pipeways, wireways, and weld clearances. Sketches of the miscellaneous details are presented in the eight groups of Figure 20. The family was deliberately limited to these cases in order to omit data on unique one-of-a-kind geometrys.

Each individual detail is placed in only one group according to the detail's major function irregardless of the number of duties it may fulfill on the ship. A few details look alike such as 7-A-1, 7-C-13, and 7-E-1, but the primary function is different from group to group. For instance, detail 7-A-1 has a primary function to provide access and could in some places have a secondary function as a drain hole and air escape. Detail 7-C-13 has a primary function to provide drainage but could also act as an emergency access, a lightening hole, and an air escape. Thus, because the primary function changes, the circular cutout is placed in two or more groups.

-51-







FIGURE 20 - MISCELLANEOUS CUTOUT DETAILS, Family No. 7 (Cont'd)





Table 10 contains the component numerical results. The wireways had the highest percent of sound details, whereas the lapped web openings and the lightening holes had the highest failure percentage. Totals for the entire family show a high percentage of sound details; however, since the family contains numerous details, failures averaged 14-1/2 per ship which is the third most prevalent within the twelve families. This can be seen in the report summary in Table 16, "Summary of Data from Fifty Ships".

The access openings in group "A" had failures in details 7-A-6, 7-A-8, 7-A-9, and 7-A-11. Except for detail 7-A-11, these were mostly cracks in steel and aluminum bulkhead plating at two diagonal corners of each forward doorway inserted in the main deck-house longitudinal enclosure bulkheads immediately above the main deck. Detail 7-A-11 appeared in miscellaneous steel bulkheads where cracks originated at the square corners.

Openings in any beam like structure that develops both shear and bending stresses require additional consideration in both design and fabrication. The longitudinal box girders on a containership are this type of structure. It was evident on the containerships surveyed that weld repairs had been made to prior cracks adjacent to openings in the box girders. A possible damaging crack was also observed in the bulkhead plating at the corner of an access opening in one of the box girders (Figure 21). The crack apparently originated in the weld and propagated a few inches into the adjacent bulkhead plating. Workmanship in and around the detail appeared very good. Corrosion did not appear to be a problem. The crack location and the detail structural setting suggests the presence of both excessive secondary bending stresses combined with primary bending stresses and the presence of a possible weld defect at the start of a new weld layer. These secondary bending stresses are produced by the resulting shear in the beam or girder and are usually cyclic in nature due to varying loading conditions and constantly changing environment. The primary stresses in the structural beam or girder may be acceptably below the fatigue limit even with an opening added, but, the secondary bending stress, when combined with the primary stress, may produce stress levels above the fatigue limit. These unpredicted stress levels reduce the member's fatigue life. Eventually a loading condition, which may have occurred in the past, produces stresses which result in crack development and propagation. In all designs, a prudent arrangement of structural openings should be selected and secondary stress analyses performed. This could eliminate costly repairs that occur following delivery. Figure 22 is a picture of another opening aft of the one in Figure 21. This after opening has a smaller face plate with intermittent weld. A vertical weld repair is visable at the top of the arch.

Air holes were relatively free from defects except on containerships and naval vessels where the failures were due to heavy seas and corrosion in inaccessible or nearly inaccessible locations, respectively. Structure behind wireways and vent trunks was frequently susceptible to corrosion from neglect. One tanker operator suggested minimizing the number of air holes to reduce coating costs.

-54-

## TABLE 10

## SUMMARY OF MISCELLANEOUS CUTOUTS

	OBSERVED			ESTIMATED		
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details
A	3850	3822	99.3	11120	29	•3
В	16810	16782	99.8	42700	40	.1
с	49980	49894	99.8	112130	99	.1
D	2190	2171	99.1	4390	24	.5
E	17510	17351	99.1	44370	221	.5
F	4010	4000	99.8	10420	12	.1
G	9900	9895	99.9	28240	5	•0
H	148620	148309	99.8	536340	364	.1
TOTAL	252870	252224	99.7	789710	794	.1

-55-

DEFECT AT AN ACCESS OPENING IN A CONTAINERSHIP



The access opening similar to detail 7-A-6, is near the forward end of the cargo space and in the longitudinal bulkhead of the box girder. The defect is a four inch crack in the weld of the coaming to the bulkhead plating. This detail has a history of repairs - see text.

-56-

## HISTORICAL DEFECT AT AN ACCESS OPENING IN A CONTAINERSHIP



The access opening is in the same box girder as the opening in Figure 21. Similar to detail 7-A-6, this opening has intermittent welds connecting the face plate to the longitudinal bulkhead of the box girder. The face plate is smaller than the one in Figure 21. The vertical weld centered above the opening repaired a crack that had developed in the bulkhead plating. Drain holes were also susceptible to corrosion in locations of poor access and neglect. Failure causes also include location in high stress regions, jagged edge cuts during construction or on board repairs, heavy sea areas in the bow, and collision. Holes in many ballast tanks, machinery spaces and shaft alleys were inadequate to properly drain water, oil, and mud from horizontal stiffeners as shown in Figure 23. A close examination of the photo in the figure shows a thick layer of mud near a drain hole in a horizontal longitudinal that has a flange extending above the web.

Reasons for failed fabrication laps were not readily apparent. Heavy weather conditions were suggested as a cause for three or four cracks at the openings. Most of the cracks, however, were due to a poor fitting, welding, eccentric forces due to the laps, and other reasons not apparent in the physical and design detail environment. A sample of a sound lap detail is shown in Figure 24 which also shows other miscellaneous cutoutsin this detail family.

Some lightening holes were in buckled web plating subjected to heavy sea loading. Some were in obvious regions of high shear and secondary bending stress. Others were the target area for cracks emanating from cutouts at web bases. Suggestions in the interviews were to eliminate lightening holes except in secondary cases where they are used for drainage and could be used for emergency access and light penetrations. Comments were that they were dangerous in horizontal structure and that metal at the edges are susceptible to rapid corrosion. Figure 25 shows a buckled web containing cracks that intersect a lightening hole. The buckle is not obvious in the picture.

Pipeways had a few failures due to defective welds, notches in irregular cut edges and poor design geometries, and improper locations relative to stress patterns in the structure. Most, but not all, pipeways were in machinery spaces and cargo tanks.

Wireways were free from failures except for five cracks in detail 7-G-3. These cracks were due to secondary bending, welding, and heavy seas. One was amidship on a containership, three were aft on a naval vessel and one was aft on a tanker.

Weld clearances had more failed details than any other group in the family. Configurations 7-H-1, 7-H-5, 7-H-10, 7-H-11, 7-H-3, 7-H-12 and 7-H-7 contained the defects in numerically descending order. More cracks were observed in detail 7-H-1 than all the others combined. Elongated cracks that originated at the cutouts were the only failure modes. Numerous explanations were cited for the cracks and include design workmanship, welding, corrosion, heavy seas and collisions. Except for obvious collisions no one factor predominated as the most influential.

Figures 26 and 27 are pictures of sound and failed weld clearances. The jagged part of the sound weld clearance in Figure 26 was cut by a hand held torch during fabrication of the tanker. The cracks in Figure 27 are through the welds on a containership.

## INADEQUATE DRAINAGE ON A BULK CARRIER





PLAN VIEW KEY FOR PHOTO

The layers of mud is on the web of an upturned flanged shell longitudinal in the forepeak tank. The mud coated anode almost obscures the 3" x 6" drainage opening located behind the anode near the shell and in the 16" longitudinal. The mud is caked to within four inches of the drainage hole.

# LAPPED WEB CUTOUTS AND OTHER STRUCTURAL DETAILS IN A BULK CARRIER



This picture is of the upper portion of a web frame supporting the side shell and forecastle deck.

### FAILED LIGHTENING HOLE IN A WEB FRAME OF A BULK CARRIER



In addition to the diagonal crack originating at the top and bottom of the center lightening hole, the panel of plating in the side shell web frame is buckled. The buckle is not CRACK LIGHTENING apparent in the picture. HOLE

WEB (BUCKLED) SHELL KEY TO PHOTO

-61-

## SOUND WELD CLEARANCES ON A TANKER



The photograph shows two weld clearance cuts that were obviously elongated with a hand torch during fabrication to suit the shell seam location. These cuts were in side shell frames between forecastle and upper deck.

## FAILED WELD CLEARANCE CUT ON A CONTAINERSHIP



The crack has been rewelded above the clearance cut at the end of the folding rule. The cut is in a bracketed end of a hatch side coaming on main deck. Sample failures in the miscellaneous cutout family are presented as sketches in Figure 28.

In summary, the family groups contained relatively isolated defects in all the ship types. Some doorways had cracks in the surrounding plating at radiused and collared corners when located in high stressed areas. Air holes were relatively problem free except in inaccessible places. Drain holes were susceptible to several problems; however, more are needed in machinery spaces and ballast tanks. Causes for the few lap failures were questionable. Lightening holes should be eliminated except where useful for safety and economic purposes. Pipeway failures were due mostly to locations and workmanship. Wireways were nearly free from defects. Weld clearance cracks were most prevalent with many reasons cited for their problem.

#### FAMILY NUMBER 8 - CLEARANCE CUTOUTS

Ninety-eight percent of the clearance cutouts shown in Figure 29 were functionally sound. Each cutout detail was placed in one of five groups according to its geometrical shape or attachment to the interrupting structural member. Results from this grouping are summarized in Table 11 and show that groups "B", "C" and "E" have the highest percent of sound details, whereas groups "A" and "D" have the highest percent of failures. Samples of failed detail modes are given in Figure 30.

Group "A" details were generally limited to cutouts in brackets supporting bulwarks with failures occurring as cracks at the welded corners of the cutouts. The reduction in shear area is the apparent cause of these failures.

The failures in the group "B" details included those located too close to other cutouts, corrosion, and weld undercuts. Figure 31 is a photograph showing a cutout located too close to a deck access opening.

Heavy weather and rough fabrication cuts were the probable causes for the cracks developing in the configurations of details 8-C-2, 8-C-3, 8-C-5.

Group "D" experienced the highest number of observed failures. It also included the largest number of observed repairs. Failure cracks were prone to be at the angle heel corner of the cutout and were considered to be primarily due to high notch factors. Figures 32 and 33 are illustrations of the failure mode. Both figures show a short crack that has started at an angle heel. Rewelding the crack does not appear to be the best repair technique as verified by the picture in Figure 34 which is of a clearance cutout in a web frame. The cutout permits passage of a side shell longitudinal. Two almost parallel weld beads originated from a corner of the cutout and reveals a history of cracks. Beads of welds where cracks had possibly occurred were relatively common on a few ships. At times, something extra, such as a pad or a flat bar stiffener similar to the one on the web frame, had been added in an effort to prevent future cracks.

-64-
### SAMPLE MISCELLANEOUS CUTOUT FAILURES



FIGURE 28, Sample Miscellaneous Cutout Failures (Cont'd)







-67-

## TABLE 11

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## SUMMARY OF CLEARANCE CUTOUTS

	OBSERVED				ESTIMATED			
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details		
А	420	384	91.4	700	40	5.7		
В	6220	6190	99.5	14450	37	.3		
с	9040	8965	99.2	36200	97	.3		
D	14080	13487	95.8	47200	792	1.7		
E	18750	18663	99.5	64050	110	.2		
TOTAL	48510	47689	98.3	162600	1076	.7		

-68-

### SAMPLE CLEARANCE CUT FAILURES



-69-

## FAILED CLEARANCE CUT AT AN ACCESS OPENING ON A COMBINATION CARRIER





The view is looking down at the side of an access opening in a platform deck aft but forward of the machinery space. The crack is between the clearance cutout, detail 8-B-2, and the larger access opening.

-70-

### FAILURE MODE FOR GROUP "D" CLEARANCE CUTOUTS ON A COMBINATION CARRIER



The view is of a detail 8-D-6 cutout around a shell longitudinal piercing a transverse web frame. The cracks at these cutouts are invariably in the plating at the through stiffener heel.



-71-

## FAILURE MODE FOR GROUP "D" CLEARANCE CUTOUTS ON A TANKER





The view is of a detail 8-D-6 cutout around a horizontal stiffener piercing a vertical web on the transverse oil tight bulkhead. The expected failure mode is a crack in the plating at the stiffener heel.

# REPAIRED CLEARANCE CUT FAILUREON A COMBINATION CARRIER



Photograph shows rewelded cracks in web of side shell web frame in forward cargo hold - combination carrier, (see key plan below). Item with 45 chalk number is a wooden batten over shell longitudinals.



-73-

Group "E" had the largest percentage of non-failures (99.8%). The remaining small percentage (.2%) of the group that experienced failures were limited to details 8-E-2, 8-E-5, 8-E-6, and 8-E-7 and were found on bulk carriers, combination carriers, containerships, general cargo ships and tankers. Cracks occurred at the cutout corners particularly at the angle heel side as shown in Figure 35. In one unusual case a crack was in between the two corners as depicted in Figure 36. Another photograph of a failed group "E" cutout is in Figure 37.

A suggested improvement in group "E" designs is given in Reference 6, which suggests that a desirable ratio of corner radius to opening width is from one-fourth to one-eighth for minor openings in ship steel structures.

A recent study (Reference 7) of cracks around clearance cutouts indicated that vibration of bottom transverses was one failure cause, in addition to effects from fatigue and stress distribution patterns around the cutouts. Shipboard physical environment and loading patterns are also significant as indicated from the results of this survey.

In summary, each cutout group had failures, however, sound details made up over 98% of the total cutouts. Failures were in the cut plate at the welded corner in those details that had no web connections to the through structural shape. Most failures, however, were in the form of cracks in the web plating at the through angle heel corner. Failures were present in all the ship types.

#### FAMILY NUMBER 9 - DECK CUTOUTS

The twenty-three deck cutouts are shown in three groups in Figure 38. There were only twelve failures in the 6030 observed details. Table 12 is a summary of the collected data.

Groups "A" and "B" are relatively small deck openings that are normally used for access. Group "A" has openings with the surrounding deck plate edges unsupported except by a stiffening member a few inches from the hole. Group "B" has the plate edges supported by a flat bar either centered with, or on one side of, the deck plating. Sample deck cuts and failure modes are shown in the photographs of Figures 39 and 40.

Group "C" configurations are deck cuts at corners of large hatch openings. Existing failures in this group were limited to detail 9-C-2 which has a notch cut in the corner radius to allow the heel of vertical cell guides for containers to be recessed into the corner. This improperly designed corner contained cracks in the strength deck which originated from the indention and had progressed about ten inches as shown in the photograph of Figure 40.

A critical historical failure originated at the radius corner of a forward hatch opening in a containership. A crack appeared in the main deck plating at the forwardmost starboard hatch corner and grew

## FAILED GROUP "E" CLEARANCE CUTOUTS ON A BULK CARRIER



The view is of detail 8-E-2 cutouts in a side shell web frame which allows passage of the through shell longitudinals in the forward deep tank. Cracks that continue from cutout to cutout parallel the paint marks.

### UNUSUAL CRACK AT A GROUP "E" CLEARANCE CUTOUT ON A BULK CARRIER





The fourteen inch crack is in a side shell web at a detail 8-E-2 cutout in the same forward deep tank as in Figure 34. Note the deterioration due to corrosion.

## FAILED GROUP "E" CLEARANCE CUTOUT ON A TANKER



The cutout is in a shell web frame between upper and forecastle decks. Flaked paint indicates the crack in the web plating at the through angle heel.



KEY TO PHOTO



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DECK CUTOUT DETAILS FAMILY NO. 9



-78-

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## TABLE 12

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## SUMMARY OF STRUCTURAL DECK CUTS

			OBSERVED	ESTIMATED			
	FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Fail Deta
	A	2630	2629	100.0	3840	l	
	В	2490	2485	99.8	3900	7	•
i	С	910	904	99.3	1920	6	•
	TOTAL	6030	6018	99.8	9660	14	

-79-



## SAMPLE DECK CUTOUT ON A TANKER



The picture is on the forward end of a main cargo tank access opening in upper deck. This particular tank was relatively free from corrosion but note the renewed bolts holding the clips to the ladder. This opening, similar to detail 9-A-8, has no failure.

-80-



FAILED HATCH CORNER ON A COMBINATION CARRIER

KEY TO PHOTO

This view is looking down at a radius hatch corner similar to detail 9-C-2. A notch has been cut in the deck plating to accommodate the vertical container cell guide. A ten inch crack in the plating originated at the notch. several feet in length to within three feet of the shell. The repair included replacing the hatch corner deck plate with a higher strength material and adding a reinforcing longitudinal girder. Outboard of the new plate the crack was rewelded as shown at the outboard end of the folding ruler in Figure 41. The folding ruler is laying on the new plate in the approximate location where the crack existed between the hatch corner and the rewelded portion of the crack.

In summary, emphasis should be placed on the configuration of all openings in the strength deck. Even with the small number of failures observed, it should be remembered that only one crack propagating in a strength deck can lead to a catastrophe.

#### FAMILY NUMBER 10 - STANCHION ENDS

The seventy-nine observed stanchion ends were placed in three groups; (A) includes the connections at the top of the circular stanchions, (B) includes all of the stanchion bottom connections, and (C) includes all of the connections at the top of "H" stanchions. These groups are shown in Figure 42 with a summary of the numerical results presented in Table 13.

The summary of numerical results show the highest observed failure rate (2.2%) in the group "A" details. In general, cracks developed in or at the connections to the attachment structure, although in a few cases local identations were observed in stanchions near their ends. All of the stanchions were straight and in plane except for one ship where exposed stanchions were distorted from horizontal impact loads.

Defects were observed in details 10-A-1, 10-A-2, 10-A-12, 10-B-9, 10-B-21, 10-B-22, 10-B-24, 10-B-25, 10-C-1, and 10-C-5 inclusive. Connections to the main deck-house on containerships and tankers accounted for most of these details. Detail 10-B-9 is the bracket connection between two container stands and in every case where they were oriented fore and aft on the main deck of a ship, the welded connection between the brackets was cracked.

Sample failure modes, depicted in Figures 43, 44, and 45, show tension failure due to an unusual design combined with a heavy side shell load, and cracks and buckles due to relative motions between main deck-houses and the side shell. Figure 44 contains a photograph of the crack problem noted above for detail 10-B-9. Figure 45 is a distorted stanchion on a general cargo ship.

In summary, the major portion of stanchion end failures occurred in deck-house connections, in container stand brackets, and at the ends of exposed pillars on a cargo ship. The design for the container stand brackets should be modified to delete the notch effect at their intersections. Cracks associated with deck-house stanchion connection should be analyzed in relation to interractive motions between the deck-house and ship.

### HISTORICAL CRACK AT A HATCH CORNER ON A CONTAINERSHIP



This view is on the starboard side of the ship and looking down on the main deck plating outboard of the forward corner of No. 1 main cargo hatch. The folding ruler is on the renewed deck plating and in the approximate location where the crack existed outboard of the hatch corner. Note the rewelded portion of the crack at the outboard end of the ruler.



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STANCHION END DETAILS FAMILY NO. 10



FIGURE 42 - STANCHION END DETAILS, Family No. 10 (Cont'd)

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## TABLE 13

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## SUMMARY OF STANCHION ENDS

		OBSERVED ESTIMATED			ESTIMATED		
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details	
А	2040	1995	97.8	2480	57	2.3	
В	3140	3097	98.6	3970	45	1.1	
С	1090	1080	99.3	<b>1</b> 470	10	• 5	
TOTAL	6270	6172	98.4	7920	112	1.4	

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-88 -

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## SAMPLE STANCHION END FAILURES



## FAILED STANCHION END BRACKET CONNECTION ON A COMBINATION CARRIER





### KEY TO PHOTO

View on weather deck looking outboard at the intersection of two container stand brackets, similar to detail 10-B-9. The crack originated at the vee notch and continued through the weld to the deck plating.

-90-

DISTORTED STANCHION ON A GENERAL CARGO SHIP



The stanchion supports equipment on a miscellaneous deck-house. Distortions in the flanges appear to be due to direct impact loading. Note the crack in the right hand flange near the top of the stanchion.

#### FAMILY NUMBER 11 - STIFFENER ENDS

In general, failures associated with stiffeners occur at the ends in the web of the stiffener or in the attached plate. For the purpose of classification, the stiffener ends included in this family are the ends of load carrying structural angles on tees that are attached to panels of plating. Thirty-three variations were observed and placed in one of the four groups shown in Figure 46. A summary of the numerical data is given in Table 14.

The overall success record of the 30,760 observed stiffener ends was 99.3%, however, the remaining 0.7% consisted of 229 failures with numerous causes which are attributed to shear, combination tension and shear, design, heavy seas, neglect, collisions, and tension in descending order.

The variations depicted in details 11-A-1, 11-A-2, 11-A-3, 11-A-5, 11-A-7, 11-A-9 and 11-B-1 contained over one-half of the total failures in the entire family. All of the seven variations were designed to perform the same function, however, when located on the forecastle enclosure bulkhead adjacent to main deck each variation sustained one or more failures. These details appear to have minor failures when located in other areas of the ship except at cargo, fuel or ballast tanks.

Failure modes at the stiffener ends were cracks in the stiffener web or in the stiffened bulkhead plating adjacent to the stiffener end, except for a few cases where stiffener webs were buckled or twisted. Sample failures shown on the sketches in Figure 47 include sniped stiffener webs on oil tight bulkheads. These sniped web stiffeners shown in detail 1101 were frequently associated with leaks in tank boundary bulkheads when used as the end configurations for stiffeners with relatively long spans. Other examples of cracks at stiffeners ends are depicted in Figures 48 and 49.

Failure distributions were 10% in the stern, 83% in the midship or cargo area and 7% in the bow.

Note the similarity to the distribution of 8%, 82%, and 10%, respectively for the total detail family failures. This is the closest correlation between the total percentages and an individual family.

In summary, several different variations were used for similar structural arrangements among the ships with snipe ended stiffeners frequently associated with cracks in tank boundary bulkheads.

### FAMILY NUMBER 12 - PANEL STIFFENERS

Panel stiffeners include those structural angles, tees, and flat bars welded to large panels of plating for the explicit purpose of preventing local instability of the plate. They are non-direct load carrying members. According to its shape and the function of the structural member it is attached to, each of the forty observed variations has been placed in one of the six groups shown in Figure 50. Numerical data is summarized in Table 15.

-92-



STIFFENER END DETAILS FAMILY NO. 11



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-93-

FIGURE 46 - STIFFENER END DETAILS, Family No. 11 (Cont'd)

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**- 1** 



## TABLE 14

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## SUMMARY OF STIFFENER ENDS

		OBSERVED			ESTIMATED		
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details	
A	22080	21938	99.4	55950	180	.3	
В	3370	3334	98.9	6940	44	.6	
с	610	603	98.8	1230	8	.7	
D	4470	4426	99.0	10330	56	.5	
Е	230	230	100.0	580	-	0	
TOTAL	30760	30531	99.3	75030	288	.4	

-95-

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### FAILED STIFFENER END ON A COMBINATION CARRIER



The view is looking forward with the deck above as forecastle deck. The crack in the horizontal stiffener's web completely detached the stiffener from the longitudinal bulkhead plating. Note that the stiffener's flange is sniped as in detail 11-A-7.

### FAILED STIFFENER END ON A TANKER



Photograph shows a crack in a transverse bulkhead horizontal stiffener web at the connection to a bracket plate on the longitudinal bulkhead - tanker. See key plan below and Figure 47 detail 1100. Crack is encircled with white paint. The stiffener end is similar to detail 11-D-5.



KEY PLAN FOR PHOTO





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FIGURE 50 - PANEL STIFFENER DETAILS, Family No. 12 (Cont'd)



# TABLE 15

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# SUMMARY OF PANEL STIFFENERS

		OBSERVED			ESTIMATED	
FAMILY GROUP	Number of Details	No. of Sound Details	% Sound Details	Number of Details	No. of Failed Details	% Failed Details
A	13100	13015	99.4	32940	93	.3
В	9610	9592	99.8	25110	21	.1
с	15140	15100	99.7	37220	48	.1
D	1370	1270	92.7	3000	125	4.2
E	430	420	97.7	670	12	1.8
F	380	372	97.9	650	9	1.4
TOTAL	40030	39769	99.3	99590	308	.3

-102-

Of the 40,480 details observed in this family there were only 261 (0.6%) failures. Individually, however, group "D" had the most observed failed details (100) and the highest percentage of failures (7.3%). The large number of failures in this group is attributed to collisions or impact from large objects which resulted in loadings not anticipated in the design stage. Unnecessary fabrication notches also contributed to some of the failures. Failure modes associated with panel stiffeners are shown in Figure 51 which includes a crack in the attaching welds, in a stiffener end, and in plating at a stiffener end. Weld cracks in detail 1200 were due to inadequate welding and possibly elongation of the longitudinal corrugated bulkhead while the ship was in a seaway. In detail 1201, the crack resulted from the interaction of the shell longitudinal and panel stiffener at a cutout in the web frame in conjunction with the possible concurrent swashing loads from oil in the tank. Cracks in detail 1202 resulted from lateral distortion of the shell frame during a collision.

The photograph in Figure 52 shows a crack similar to detail 1201 in Figure 51. These cracks occurred on the bottom of cargo tanks as well as at mid depth. Figure 53 shows a buckled flat bar stiffener which has been subject to an unusual and local horizontal load on a miscellaneous bulkhead. Figure 54 contains a photograph of a reinforced panel stiffener on a transverse hatch coamway.

In summary, the most predominate cause of failures in panel stiffeners was collisions which distorted the stiffened plating. Detail 11-C-3 and possibly 11-C-4 through 11-C-9 should be strengthened at the connection to the longitudinal. Notches similar to the one in detail 11-A-8 should be avoided.

#### SUMMARY OF RESULTS

The data in this report were collected in a one year period. Twelve selected details used for structural connections were surveyed on fifty different ships in seven repair yards in the United States. Ships included in the survey were four Bulk Carriers, five Combination Carriers, twelve Containerships, five General Cargo, thirteen Tankers, nine Naval, and two Miscellaneous. The service age of the ships ranged from four to eight years and eleven to thirty years with the largest number of failures appearing in the ships with fourteen years service. The histogram of ship failures versus service age in Figure 55 shows that no conclusive age-failure pattern exists in this group of surveyed ships and indicates that correlation of age to failure is less significant than design, fabrication or maintenance.

The twelve details selected for survey were beam brackets, tripping brackets, non-tight collars, tight collars, gunwale connectior knife edge crossings, miscellaneous cutouts, clearance cuts, stanchion ends, stiffener ends, and panel stiffeners. These twelve details evolved into twelve families which included fifty-six groups of configuration variations. The twelve groups contained 553 distinct detail variations. Table 16 is a summary listing the total number of details and detail failures observed for each family. Additionally, the table includes the estimated total number of details and detail failures that could be anticipated on the fifty ships.

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#### SAMPLE PANEL STIFFENER FAILURES



## PANEL STIFFENER FAILURE ON WEB FRAME OF A TANKER





The photograph shows the connections of a detail 12-C-3 panel stiffener to a shell longitudinal at mid depth of the cargo tank. Encircled by white paint, the crack is in the heat affected zone. Note the stiffener is offset about 1-1/2 inches from alignment with the web of the shell longitudinal.

## BUCKLED PANEL STIFFENER ON A GENERAL CARGO SHIP



The photograph shows the buckled position of a detail 12-C-5 flat bar panel stiffener on a girder web. The 26" x 4" girder was laterally displaced resulting in the buckled panel stiffener.

-106-

## REINFORCED PANEL STIFFENER ON A CONTAINERSHIP



The vertical sniped flat bar panel stiffeners are on a transverse hatch side coaming. Reinforcement of the panel stiffeners to alleviate cracks at the ends was by an addition of a flanged plate which makes the detail into a tripping bracket. Visible in the upper right corner of the picture is a horizontal crack in the hatch cover side immediately below two attached container tie down fittings.

## SERVICE FAILURE RATE



SERVICE AGE

\* Ships of ages 9, 10 and 24 through 29 were not surveyed.

# TABLE 16

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## SUMMARY OF DATA FROM 50 SHIPS

			OBSERVED	·	EST	IMATED	
FAMILY NO.	DETAIL FAMILY NAME	No. Details	No. Failures	% Failures	Total No. Details	Total No. Failures	% Failure:
1	Beam Bracket	50750	888	1.75	113580	1297	1.14
2	Tripping Bracket	20640	314	1.52	45220	358	.79
3	Non-Tight Collar	16250	28	.17	38040	33	.09
4	Tight Collar	18000	0	0	55760	0	0
5	Gunwale Connection	100	4	4.00	100	4	4.00
6	Knife Edges	0	0	_	0	0	-
7	Miscellaneous Cutouts	252870	646	.26	789710	794	.10
8	Clearance Cutouts	48510	821	1.69	162600	1076	.66
9	Deck Cutouts	6030	12	.20	9660	14	.14
10	Stanchion Ends	6270	98	1.56	7920	112	1.41
11	Stiffener Ends	30760	229	.74	75030	288	.39
12	Panel Stiffeners	40030	26 <b>7</b>	.67	99590	308	.31
	TOTALS	490210	3307	.67	1397210	4284	.31

-109-

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A total of 490,210 details were observed during the overall survey period with a total of 3,307 failures. Eighty-two percent of the observed failures were located in the midship portion of the ship, predominately in structure adjacent to the side shell. The remaining 18% observed failures had a distribution of 10% forward of the cargo spaces and 8% aft of the cargo spaces. Table 17 is a listing of the twenty detail variations that had either the most observed failures or highest percentage of failures. They are listed in two columns of ten each in descending order of participation. The detail variations are identified by their assigned position in the individual families, i.e., the first number(s) is the family number, the letter is the group number and the last number(s) is the variation number.

Figure 56 depicts each detail variation, by family, that had an observed failure. Directly below each sketch is the calculated failure percentage. Failure types and locations are indicated by (+) for a buckle and (-) for a crack.

The appendix of this report includes tabulations of all of the numerical data for each detail variation observed in the survey. These data, in conjunction with photographs and shipboard interviews, were used in the development of the synthesis presented in the report.

#### CONCLUSIONS AND RECOMMENDATIONS

The data presented in this report were collected from on board inspections of fifty ships of various types. Operating service of these ships ranged from four to thirty years. The service performance of the twelve structural detail families was obtained from visual inspections, interviews with ship personnel, and review of repair specifications.

The twelve structural detail families were found to be 99.33% sound. The remaining 0.67%, however, represents 3,307 observed failures (4,280 estimated). This is an average of sixty-six observed failures per ship (eighty-six estimated).

No conclusions are made for any one of the 553 observed detail variations. Since many of the variations occurred only a few times, the survey data was synthesized by family groups and not ship types. Itemized . tabular sheets containing data for each detail variation are included in the appendix to aid the engineer or designer in the selection of detail configurations.

Several of the detail families resulted in damage in the forward shell and forecastle areas of the ship. Damage of this type results from "driving" the ship at high speeds in heavy weather. Interviews with ship personnel indicated that this type of operating condition is necessitated by delivery schedules. With the uncertainty of the slamming loads produced by such conditions, extreme care should be used in the selection and design of all structural connections in the forward areas of the ship.

Fabrication techniques should be used that ensure proper continuity of structural parts and welding so that notches, jagged edges, or under-cut welds will be minimized. Ship owners and operators could

## TABLE 17

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# TOP TEN FAILED DETAILS

	MOST	PREVALENT		Н	IGHEST PERCEN	TAGE
RANK	Details Number	No. of Failures	% Failures	Details Number	No. of Failures	% Failur
1	8-D-6	420	4.8	10-B-9	30	100.0
2	7-H-1	224	.8	12-A-7	10	100.0
3	1-C-1	153	2.3	2-C-13	60	60.0
4	2-C-22	124	20.7	10-B-24	6	60.0
5	8-D-5	124	4.6	9-C-2	6	60.0
6	11-A-1	96	1.7	10-C-5	6	60.0
7	7-E-1	94	•6	1-К-4	16	40.0
8	1-C-2	86	2.2	11-C-6	7	35.0
9	12-D-4	80	20.0	1-J-4	16	32.0
10	8-C-2	72	6.7	2-A-9	15	30.0

.

## DETAIL VARIATIONS WITH OBSERVED FAILURES

FAMILY NUMBER 1 - BEAM BRACKETS



8

8.0%



10

3.5%

11



6

.4%



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FAMILY NUMBER 5 - GUNWALE CONNECTIONS

















5.6%













FAMILY NUMBER 11 - STIFFENER ENDS





.1%







.2%



.5%

-117-





FAMILY NUMBER 12 - PANEL STIFFENERS Α. 10 8 6 7 3 1 .6% 1.1% 100% .2% .7% 4.2%







.4%

1.2%

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.3%







FAMILY NUMBER 12 - PANEL STIFFENERS (Cont'd)







eliminate some structural failures if they maintained protective coatings on structures subject to the corrosive action of the ocean environment.

The design of openings in "girder-like" members should include secondary bending stress analyses in the areas of the openings to ensure proper sizing of shear areas and face plates. The repetitive type cracks observed in these areas during the survey should be reduced with this type of design procedure.

Each of the twelve families included detail variations which showed no signs of failure. These detail variations should provide guidance in the selection of structural detail configurations in future designs and repairs. It was apparent that many of the detail variations were well designed, and probably the preference of individual design offices, while others were the results of an exigent situation.

The importance of the selection, design, fabrication, and maintenance of structural detail connections cannot be overemphasized. References 8 through 16 contain information on data germane to the subject of structural failures and are included as recommended resource material.

Projects of this type are extremely beneficial in providing "feed-back" data to the engineer and designer who develops a design and never receives the performance data that is needed for future design improvements, growth, and increased confidence. Systematic projects of this type should be a continuing effort and conducted on all areas of the ship with the synthesized data made available to design and repair offices.

It became apparent in the course of this project that ship operators exhibited reluctance in permitting access to their ships when "survey" was suggested since the regulatory bodies also conduct "surveys". It is, therefore, recommended that in future studies the word "performance" be substituted for the word "survey".

The summary of data from 50 ships, Table 16, includes estimates of the total number of details on the ships. These estimates were included to give an indication of the accessibility of all the details on ships undergoing normal maintenance and repairs. Many compartments are inaccessible, loaded with cargo, or outfitted such that details cannot be seen. These estimates were not arrived at by formulas. Since the conditions of each ship were different, the estimates are intuitive based on the surveyor's experience and familiarity with the structural design of the various ship types. In many cases, less than 50% of the details were accessible, it is felt that more ships should be surveyed in an effort to develop a sufficient data bank for conducting statistical analyses.

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-121-

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#### APPENDIX

#### Compilation of Performance Data for 553 Observed Structural Detail Variations

This appendix contains a table of failure data arranged by family groups for each of the detail variations observed in the survey. Both observed and estimated results for the various ship types are presented. The "Failure Mode" and "Failure Cause" columns are postulated by the use of appropriate identification numbers listed in "Notes" (C) and (D) at the bottom of each table. A design office or repair facility can use this reference material in selecting the most economical and appropriate configuration for a particular loading condition and structural arrangement.

### TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SI	ΠP	Number of	Number of	Total	Percent	Estimated	·Detail	Failure	Failure	
		Sound	Failed	Number	Failures	Details		Mode	Cause	
SHIP TYPE	1 I I	Details	Details	Details		on Ship	Family		]	
	$\mathbf{l'}$	Observed	Observed	Observed	_	1 -	Number		]	
	Fwd	30		30		50				
Naval	<b>X</b>	140		140	ļ	360	1-A-1			
	Aft	40	l	40		90				
	Fwd	20	<u> </u>	20		40	_	[		E-1
Naval	) X	110	•	110		280	1-A-2			
	Aft	30		30		80				L,
	Fwd	240	f	240		610		f	[	f
Naval	1	1680	Ĩ	1680		4200	1-A-3	1		
	Aft	490		490		1220			1	
	Fwd	120	<u> </u>	120	l	200		<b> </b>	ļ	
Naval	N N	510	ľ	510	ł	1400	1-A-4	i i		
	Aft	200	1	200		400		ł	1	1 11
	E al		<u>                                     </u>							ખ
Miccelleneous	T WG	40		40		100	1.4.5			
PIL SCELLARIEOUS		40		1 70		100	TUND			
	1220			<b></b>		·		h		R. P
Tonkow	rwu H	198	2	200	10	520	1	.	11	♠
Tanvel.		1,0	<u> </u>	200	1.0	520	1-4-2	1 -	[ ++	
	ALL	····	<u> </u>	ļ				<b></b>		
Tenkon	L M L	45	1 15	60	25.0	120	1-4-6	1.	0 12 14	$[\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{\overline{$
Tauret	<u>и</u>		1 1 2	60	25.0	130	I-A U	¦ ⊥ .	8,11,14	
	AIC	FO	<b>}</b>	F				┢		4
	#wa	50		50		110		1		
Naval	N.	270		270		720	1-A-/			
	Art	90	}	90		2/0	<b></b>	<b>}</b>	<u> </u>	ł
	Fwd	40		240		620	1_1_8	1	ţ	
Naval	18	240	ļ	240		030	I-A-0	1		ΙΠ
	[Aft	, /0	1	1 10	1	180		L	1	<u>।</u> भ
	Fwd	20		20		60	1			to the second se
Tanker	)X	56	4	60	6.7	160	1-A-9	1 1	8,13	I NZ
	Aft	30		30		40			l	, μ
[	Fwd		<u> </u>		1			1	1	
General Cargo	١ŭ.						1-A-10	ľ		
] -	Aft	29	1	30	3.3	50		1	13	
<u> </u>	Fwd	30	t	30	1	80	1		1	]
Naval	18	90	1	90	1	230	I 1-A-11		J	
<b></b>	Aft	20		20	l .	40		1	1	(
j	The state		╊───────	+	<u>+</u>	<u> </u>	<del> </del>	<u> </u>	<u> </u>	1
Neurol	L.M.	70	1	70	Į.	160	1-8-1	ł	1	1
INAVAL	1.2			1 ()	1	1 100	1 × <i>µ</i> -1		1	1 Ī
·	AIT	<b></b>	·}	<b></b>	<b> </b>	<b> </b>	┟────	╂	<u>↓</u>	
m .1	LIMG	26	1	30		50	1_B_1	1	13	1
Tanker	1.2	20	1 7	1 30		1		1		<b></b>
	LAIT	ļ	L	L	J		<b>.</b>	<u> </u>	<b></b>	4

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey. (B) The rows labeled aft, \$\$, and fwd refer to locations along the ship length. The

midship symbol row covers the mid-length

throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect

5. Shear

6. Tension

7. Combined Tension and Shear

13. Questionable 14. Heavy Seas

15. Collision

12. Misuse/Abuse

8. Design 9. Fabrication/Workmanship 16. Other - See Notes 10. Welding

-124~

TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SH	ПΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
SHIP TYPE		Sound Details Observed	Failed Details	Number Details	Failures	Details on Ship	Family Number	Mode	Cause	
	Fwd	observed	Observed	Observed				<u> </u>		
Miscellaneous	у Aft	110 50		110 50		300 100	1-B-2	ļ		
Tanker	Fwd M Aft	30		30		50	1-B-2			
Tanker	Fwd M Aft	39 20	1	40 20	2.5	100 30	1-в-3	1	8	
Tanker	Fwd M Aft	266 40	14	280 40	5.0	700 100	1-B-4	1	8	
Tanker	Fwd M Aft	394	6	400	1.5	900	1-B-5	1	8,9,10	
Miscellaneous	Fwd Ø. Aft	160		160		400	1-в-6			
Tanker	Fwd £ Aft	1494 40	6	1500 40	.4	3800 60	1-B-6	1	8,9	<b>f</b>
Bulk Carrier	Fwd X Aft	80		80		200	1-B-7			
Tanker	Fwd M Aft	515	45	560	8.0	1400	1-в-8	1	8	
Tanker	Fwd M Aft	150		150		300	1-B-9			
Tanker	Fwd M Aft	<b>28</b> 8 40	12	300 40	4.0	700 100	1-B-10	1	8	÷
Containership	Fwd M Aft	40		40		100	<b>1-</b> B-11			
Miscellaneous	Fwd M Aft	46	4	50	8.0	100	1-B-11	2	12	<b>↑</b>
Tanker	Fwd M Aft	28	12	40	30.0	70	1-B-11	1	13	
Tanker	Fwd M Aft	58	2	60	3.3	150	1-B-12	1	8	
Bulk Carrier	Fwd ) Aft	49	1	50	2.0	100	1-B-13	1	14	
Tanker	Fwd M Aft	40		40		100	1-B-13			
Combination Carrier	Fwd M Aft	600 2999 150	1	600 3000 150	•0	1300 5900 300	1-C-1	1	15	
Containership	Fwd M Aft	100 550 110	150	100 700 110	21.4	200 1350 230	1-C-1	2	12,14	1

DETAIL FAMILY: BEAM BRACKETS

Surf PTYFE         Sound Observed         Failed Observed         Details Observed         Details Observed <thdetails Observed</thdetails 	LOCATION ON SH	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
SHIP TYPE         Indext and the probability of the proba		. 1	Sound	Failed	Number	Failures	Details	Family	Note	Cause
I         Observed         O	SHIP TYPE	]↓	Details	Details	Details		on Ship	Numban	1.000	Cause
Frid         140         140         320         320         120 </td <td></td> <td>1</td> <td>Observed</td> <td>Observed</td> <td>Observed</td> <td></td> <td></td> <td>Number</td> <td></td> <td>1</td>		1	Observed	Observed	Observed			Number		1
ceneral Cargo $M$ 1010       230       2240       1-C-1       640       1-C-1         Tanker $M$ 198       2       200       1.0       460       2       14         Tanker $M$ 400       1000       1-C-1       2       14         Containership $M$ 2590       10       2600       2.4       1000       1-C-2       1       10         Containership $M$ 2590       10       2600       2.4       1000       1-C-2       2       14,11         Tanker $M$ 114       6       120       5.0       270       1-C-2       2       14,11         Tanker $M$ 20       20       200       400       1-C-3       2       14         Tanker $M$ 260       260       400       1-C-3       2       14         Containership $M$ 260       260       400       1-C-3       2       14         Containership $M$ 70       150       1-C-4       2       14       1-C-3       2       14         Containership $M$ 450       100		Fwd	140		140	f · · · · · - ·	320		f	F
Art         230         230         640         2           Tanker         I         198         2         200         1.0         460         1-C-1           Tanker         I         400         400         1000         1-C-1         2         14           Containership         I         2590         10         2600         .4         5350         1-C-2         1         10           Containership         I         542         58         600         9.7         1250         2         14,11         10           Tanker         I         Art         60         60         130         -         2         14,11           Tanker         I         6         120         5.0         270         1-C-2         1         14,11         1	General Cargo	۲Ŭ,	1010		1010		2240	1-C-1		
Find         198         2         200         1.0         460         2         14           Aft         400         1000         1-C-1         1 <td>-</td> <td>Aft</td> <td>230</td> <td></td> <td>230</td> <td>1</td> <td>640</td> <td></td> <td></td> <td></td>	-	Aft	230		230	1	640			
Tanker       H       400       400       100       1-C-1       1         Find       400       400       1000       1-C-1       1		Fwd	198	1	200		460	}	1 2	14
Art         400         1000 $1-C-1$ Containership $\tilde{M}$ 488         12         500         2.4         1000         2         11,12           Containership $\tilde{M}$ 2590         10         2600         .4         5350         1-C-2         1         10           Art         542         58         600         9.7         1250         2         14,11           Tanker $\tilde{M}$ 60         60         100         1-C-2         1         14           Tanker $\tilde{M}$ 20         20         440         1-C-3         2         14           Tanker $\tilde{M}$ 260         260         400         1-C-3         2         14           Containership $\tilde{M}$ 48         2         50         4.0         100         1-C-3         2         14           Containership $\tilde{M}$ 485         130         1000         1-C-4         2         14         1-C-3         2         14         14         14         14         120         1250         1-C-4         2         14         14         14         14	Tanker	Ϋ́.	-			1		1	1 -	
Nd         488         12         500         2.4         1000         1-C-2         1         11,12           Containership $\mathbb{K}$ 2590         10         2600         .4         5350         1-C-2         1         10           Art         542         58         600         9.7         1250         2         14,11           Tanker $\mathbb{H}$ 60         60         130         1-C-2         2         14           Tanker $\mathbb{H}$ 20         20         440         1-C-3         2         14           Combination $\mathbb{W}$ 20         20         440         1-C-3         2         14           Containership $\mathbb{H}$ 48         2         50         4.0         100         1-C-4         2         14           Containership $\mathbb{W}$ 48         2         50         1000         1-C-4         2         14           Containership $\mathbb{W}$ 450         130         200         1-C-4         2         14           General Cargo $\mathbb{W}$ 90         200         1-C-4         2         14 <t< td=""><td>10000101</td><td>Aft</td><td>400</td><td></td><td>400</td><td>1</td><td>1000</td><td>1-C-1</td><td></td><td></td></t<>	10000101	Aft	400		400	1	1000	1-C-1		
Containership       R       2590       10       2600       .4       5350       1-C-2       1       11/1         Art       542       58       600       9.7       1250       2       14,11         Tanker       H       60       60       9.7       1250       2       14,11         Tanker       H       60       60       9.7       1250       1-C-2       1       14,11         Tanker       H       60       60       130       1-C-2       14       14         Tanker       H       60       60       130       1-C-2       14 </td <td></td> <td>1</td> <td>488</td> <td>t 12</td> <td>500</td> <td>1-<u>2</u></td> <td>1000</td> <td>f</td> <td>+</td> <td>11 15</td>		1	488	t 12	500	1- <u>2</u>	1000	f	+	11 15
Art       542       58       600       9.7       1250       12       14,11         Tanker       H       Art       60       60       130       1-C-2       2       14,11         Tanker       H       60       60       130       1-C-2       2       14         Combination       R       200       20       40       1-C-3       2       14         Combination       R       200       20       40       1-C-3       2       14         Combination       R       200       200       40       1-C-3       2       14         Containership       H       48       2       50       1000       1-C-4       2       14         Containership       H       450       450       1000       1-C-4       2       14         General Cargo       H       90       90       200       1-C-4       2       14         Tanker       H       450       130       1200       1-C-4       2       14         General Cargo       H       90       90       200       1-C-6       1       15         Tanker       H       1       100 <td>Conteinershin</td> <td>'n</td> <td>2590</td> <td>1 10</td> <td>2600</td> <td>4</td> <td>5350</td> <td>1-c-2</td> <td>1 5</td> <td>10</td>	Conteinershin	'n	2590	1 10	2600	4	5350	1-c-2	1 5	10
Art         -972         50         600         5.7         120         2         147,11           Tanker $H$ 6         120         5.0         270         1-C-2         14           Combination $H$ 20         20         40         1-C-2         14           Combination $H$ 260         260         400         1-C-3         2         14           Containership $H$ 48         2         50         4.0         100         1-C-3         2         14           Containership $H$ 48         2         50         4.0         100         1-C-4         100         1-C-4         100         1-C-4         100         1-C-4         100         1-C-4         100         1.0	concarner surp	A for	542	50	600	07	1250		5	10 11
Tanker $\vec{\mu}$		Dua l			120	5.7	12.30		+	14,11
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Deniron	rwa K	114	ļ	120	1 2.0	270	1	2	14
Art         Boo         Boo         Art         Boo         Boo <td>Tanver</td> <td><u>м</u> 444</td> <td>60</td> <td>l</td> <td>60</td> <td></td> <td>120</td> <td>1-0-2</td> <td>1</td> <td></td>	Tanver	<u>м</u> 444	60	l	60		120	1-0-2	1	
Combination Carrier $1 \\ Aft$ $260$ 30 $40050$ $1-C-3$ Containership $MAft       48 2 50 4.0 100 1-C-3 2 14         Containership       MAft       Aft 30 70 150 1-C-3 2 14         Containership       MAft       450 450 1000 1-C-4 2 14         Containership       MAft       450 450 1000 1-C-4 2 14         General Cargo       MAft       90 90 200 1-C-4 2 14         Tanker       MAft       240 200 200 1-C-5 2 14         Containership       MAft       200 200 1-C-6 2 14         Containership       MAft       200 200 500 1-C-6 2 14         Containership       MAft       200 200 200 1-C-6 1 155         Tanker       MAft       100$		N. 6				{	130			
Combination $\chi$ 260       260       400       1-C-3         Carrier       Aft       30       50       1-C-3       2       14         Containership $\chi$ 450       440       100       1-C-3       2       14         Containership $\chi$ 450       450       450       1000       1-C-4       2       14         Containership $\chi$ 450       450       130       250       1-C-4       2       14         Containership $\chi$ 450       450       130       250       1-C-4       2       14         General Cargo $\chi$ 90       90       200       1-C-4       2       14         Tanker $\chi$ 108       2       110       1.8       300       1-C-5       14         Containership $\chi$ 16       4       120       3.3       300       1-C-6       2       14         Containership $\chi$ 16       4       120       3.3       300       1-C-6       1       15         Tanker $\chi$ 1       60       1.7       150       1       1-C-7 <td>• • • • • • • • • •</td> <td>1.Ma</td> <td>20</td> <td></td> <td>20</td> <td></td> <td>40</td> <td>1 0 2</td> <td>1</td> <td></td>	• • • • • • • • • •	1.Ma	20		20		40	1 0 2	1	
Carrier       Att       30       30       30       30       30       100       100       1         Fwd       48       2       50       4.0       100       1-C-3       14         Art       130       130       150       1-C-3       14         Containership $H$ 450       1000       1-C-4       14         Art       130       130       250       1-C-4       14         General Cargo $H$ 108       2       110       1.8       300       1-C-4         Fwd       108       2       110       1.8       300       1-C-5       14         Tanker $H$ 108       2       110       1.8       300       1-C-5         Fwd       108       2       110       1.8       300       1-C-5       14         Containership $H$ 100       1-C-6       1       15         Tanker $H$ 100       100       250       1-C-6       1         Tanker $H$ 100       100       250       1-C-6       1       15         Tanker $H$ 100       10	Compination	LX.	260	ł	260	1	400	1-0-3		
Containership	Carrier	AIU		<u> </u>	30		30			1
Containership $M$ $Art$ $1-C-3$ $1-C-3$ Containership $M$ $450$ $450$ $1000$ $1-C-4$ Containership $M$ $450$ $130$ $250$ $1-C-4$ General Cargo $M$ $90$ $90$ $200$ $1-C-4$ Tanker $M$ $108$ $2$ $110$ $1.8$ $300$ $2$ $14$ Tanker $M$ $108$ $2$ $110$ $1.8$ $300$ $1-C-5$ $2$ $14$ Containership $M$ $16$ $4$ $120$ $3.3$ $300$ $1-C-6$ $2$ $14$ Containership $M$ $416$ $4200$ $600$ $1-C-6$ $2$ $14$ Containership $M$ $80$ $80$ $200$ $1-C-6$ $1$ $15$ Taker $M$ $100$ $250$ $1-C-6$ $1$ $15$ Taker $M$ $497$ $3$ $500$ $6$ $1000$ $1-C-7$ $14$ $140$ $100$	Anntada na abin	rwa M	48	2	50	4.0	100	1	2	14
Art       70       70       150       1-C-4         Containership	containership	X	ł					1-0-3		
Containership $\frac{1}{M}$ $\frac{1}{40}$ $\frac{1}{40}$ $\frac{1}{100}$ $1-C-4$ Art       130       130       250 $1-C-4$ $\frac{1}{200}$ $\frac{1}{200}$ General Cargo $\frac{1}{M}$ 90       90       200 $1-C-4$ $\frac{1}{200}$ <	·	AIU		ļ		<u> </u>			4	i
Containership $             \mathbb{R}         $ 450       1000       1-C-4         Aft       130       250       1-C-4       1-C-4         General Cargo $             \mathbb{N}         $ 90       90       200       1-C-4         Aft       90       90       200       1-C-4       1-C-4         Tanker $             \mathbb{N}         $ 108       2       110       1.8       300       1-C-5         Tanker $             \mathbb{N}         $ Aft       240       600       1-C-6       2       14         Containership $             \mathbb{N}         $ 116       4       120       3.3       300       1-C-6       2       14         Containership $             \mathbb{N}         $ 100       200       500       1-C-6       2       14         Miscellaneous $             \mathbb{N}         $ 100       100       250       1-C-7       1       15         Miscellaneous $             \mathbb{N}         $ 497       3       500       .6       1000       1-C-8       2       14         General Cargo $             \mathbb{N}         $ 400       100       2000       1-C-8	· · · · ·	F.M.	10				150	1		
Art       130       250       200         Fwd       90       90       200 $1-C-4$ Aft       90       90       200 $1-C-4$ Tanker       H       108       2       110       1.8       300 $1-C-5$ Tanker       H       240       600 $1-C-5$ 2       14         Containership       H       200       3.3       300 $1-C-6$ 2       14         Containership       H       200       200       500       1 $1-C-6$ 2       14         Tanker       H       200       200       500       1 $1-C-6$ 2       14         Containership       H       200       200       500       1 $1-C-6$ 1       15         Tanker       H       100       100       250       1 $1-C-7$ 1       15         Tanker       H       40       100       200 $1-C-7$ 1       15         Miscellaneous       H       400       400       100       1 $1-C-8$ 2       14         General Cargo       H	Containership	<u>.</u>	450		450	ļ	1000	1-C-4		
General Cargo $\vec{W}$ $90$ $90$ $200$ $1-C-4$ $1-C-5$ $1-C-5$ $1-C-5$ $1-C-5$ $1-C-5$ $1-C-6$ $1-C-7$ $1-C-6$ $1-C-7$		Ait	130		130	<u> </u>	250		Į	<u>·</u>
General Cargo R Art 90       90       200 $1-C-4$ 1         Tanker       H Art 240       200 $1-C-5$ 14         Tanker       H Art 240       200 $1-C-5$ 14         Containership       H Art 200       200 $1-C-5$ 14         Containership       H Art 200       200 $500$ $1-C-6$ 2       14         Tanker       H Art 200       200 $500$ $1-C-6$ 2       14         Tanker       H Art 100       100 $250$ $1-C-6$ 1       15         Tanker       H Art 100       100       250 $1-C-6$ 1       15         Miscellaneous       H H 4100       40       100 $1-C-7$ 14       14         Containership       H H 4100       4100       900       2000 $1-C-8$ 2       14         General Cargo       H Art 30       30       230       13.0       500 $1-C-8$ 2       12,14         Bulk Carrier       H       140       140       300       50 $1-C-9$ 12,14		Fwd	90	{	90		200	1		
Aft       90       90       200       200       1         Tanker $M$ 108       2       110       1.8       300       1-C-5       2       14         Aft       240       600       1-C-5       2       14         Containership $M$ 200       3.3       300       1-C-6       2       14         Containership $M$ 200       200       500       1-C-6       2       14         Tanker $M$ 200       200       500       1-C-6       2       14         Tanker $M$ 100       100       250       1-C-6       1       15         Tanker $M$ 100       100       250       1-C-7       1       15         Tanker $M$ 100       100       200       1-C-7       1       15         Miscellaneous $M$ 100       40       100       1-C-8       2       14         Ontainership $M$ 4100       4100       900       1-C-8       2       14         General Cargo $M$ 200       30       230       13.0       500	General Cargo	18				l		1-C-4	1	
Fwd       108       2       110       1.8       300       2       14         Tanker       M       Aft       240       600       1-C-5       1         Containership       M       Aft       200       3.3       300       1-C-6       2       14         Containership       M       Aft       200       200       500       1-C-6       2       14         Tanker       M       Aft       200       200       500       1-C-6       1       15         Tanker       M       Aft       100       100       250       1-C-6       1       15         Miscellaneous       M       B0       80       80       200       1-C-7       1       15         Containership       M       4100       400       100       1-C-7       2       14         General Cargo       M       4100       4100       900       2000       1-C-8       2       14         Bulk Carrier       M       200       30       230       13.0       500       1-C-8       2       12.14         Bulk Carrier       M       140       140       300       100       300		Art	90		90	<u> </u>	200			
Tanker $\Pi$ 240       240 $1-C-5$ 1         Art       240       3.3       300       1-C-5       2       14         Containership $\Pi$ $\Pi$ $120$ $3.3$ $300$ $1-C-6$ $2$ $14$ Containership $\Pi$ $Art$ $200$ $500$ $1-C-6$ $2$ $14$ Tanker $\Pi$ $Art$ $200$ $100$ $250$ $1-C-6$ $1$ $15$ Tanker $\Pi$ $Aft$ $100$ $100$ $250$ $1-C-6$ $1$ $15$ Mi scellaneous $\Pi$ $Aft$ $40$ $40$ $100$ $1-C-7$ $1$ $1$ Containership $\Pi$ $4100$ $4100$ $4100$ $900$ $2000$ $1-C-8$ $2$ $14$ General Cargo $H$ $200$ $30$ $230$ $13.0$ $500$ $1-C-8$ $2$ $12,14$ Bulk Carrier $\Pi$ $140$ $140$ $300$ $1-C-9$ $2$ $15$ $2$ $15$ $2$		Fwd	108	2	110	j 1.8	300		2	14
Aft       240       240       600       1         Fwd       116       4       120       3.3       300       1-C-6       2       14         Containership $M$ 200       200       500       1-C-6       2       14         Aft       200       200       500       1-C-6       1       15       1       15         Tanker $M$ 100       100       250       1-C-6       1       15         Miscellaneous $M$ 100       100       200       1-C-7       1       15         Miscellaneous $M$ 40       40       100       100       200       1-C-7       14         General Cargo $M$ 400       400       100       1-C-8       2       14         General Cargo $M$ 200       30       230       13.0       500       1-C-8       2       12.14         Bulk Carrier $M$ 140       300       30       50       1-C-9       2       15	Tanker	D (				1		1-C->5		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	-	Art	240		240	]	600			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Fwd	116	4	120	3.3	300		2	14
Aft         200         500         1           Fwd         59         1         60         1.7         150         1         15           Tanker         H         1         100         100         250         1-C-6         1         15           Miscellaneous         Fwd         80         80         200         1-C-7         1         15           Miscellaneous         Fwd         497         3         500         .6         1000         2         14           Containership         H         4100         4100         900         2000         1-C-8         2         14           General Cargo         H         200         30         230         13.0         500         1-C-8         2         12,14           Bulk Carrier         H         140         140         300         1-C-9         2         15	Containership	IХ.						1-C-6		
Fwd       59       1       60       1.7       150       1       1       15         Tanker       H       100       100       250       1       160       1.7       150       1       15         Miscellaneous       Fwd       80       80       200       1       1-C-6       1       15         Miscellaneous       Fwd       80       80       200       1       1-C-7       1       15         Containership       Fwd       497       3       500       .6       1000       1-C-7       2       14         General Cargo       H       4100       900       900       2000       1-C-8       2       12       14         Bulk Carrier       H       140       30       30       50       1-C-9       2       15		Aft	200		200	]	500		1	_
Tanker $H$ 100       100       250 $1-C-6$ Miscellaneous       Fwd       80       80       200 $1-C-7$ $1-C-7$ Miscellaneous $H$ 40       40       100 $1-C-7$ $1-C-7$ Containership       Fwd       497       3       500       .6       1000 $2$ 14         Containership $H$ 4100       900       2000 $1-C-8$ 2       14         General Cargo $H$ 200       30       230       13.0       500 $1-C-8$ 2       12,14         Bulk Carrier $H$ 140       140       300 $50$ $1-C-9$ 2       15		Fwd	59		60	1.7	150		1	15
Aft       100       250         Miscellaneous $\vec{\mu}$ 80       80       200       1-C-7       1-C-7         Miscellaneous $\vec{\mu}$ 40       40       100       1-C-7       100       1-C-7         Containership $\vec{\mu}$ 4100       400       100       1-C-7       14         Containership $\vec{\mu}$ 4100       900       2000       1-C-8       2       14         General Cargo $\vec{\mu}$ 200       30       230       13.0       500       1-C-8       2       12,14         Bulk Carrier $\vec{\mu}$ 140       300       50       1-C-9       15	Tanker	ЦЙ.		]		1		1-C-6		
Fwd Miscellaneous       Fwd Miscellaneous       80 Miscellaneous       80 Miscellaneous       80 Miscellaneous       200 1-C-7       1-C-7       1-C-7         Containership       Fwd Miscellaneous       40       100       1-C-7       2       14         Containership       Fwd Miscellaneous       4100 Aft       900       -6       1000 9000       1-C-8       2       14         General Cargo       Fwd Aft       200       30       230       13.0       500       1-C-8       2       12,14         Bulk Carrier       Miscellane       30       30       50       1-C-9       15		Aft	100	1	100	l	250	l	1	
Miscellaneous		Fwd	80		80	[	200			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Miscellaneous	j 🕅		1	1	ł	1	1-C-7	1	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Ψt	40	1	40		100			
Containership		Fwd	497	3	500	6	1000	÷	2	14
Aft         900         900         2000 $1-C-0$ Fwd         900         2000         1-C-0         12,14           General Cargo $M$ 200         30         230         13.0         500 $1-C-8$ 2         12,14           Fwd         30         30         50 $1-C-9$ 2         12,14           Bulk Carrier $M$ 140         300         50 $1-C-9$ 2         15	<b>Container</b> ship	ซี	4100		4100	••	1000	1_0 0		<u> </u>
General Cargo       Fwd       200       30       230       13.0       500       1-C-8       2       12,14         General Cargo $M$ 200       30       230       13.0       500       1-C-8       2       12,14         Aft       Fwd       30       30       50       1-C-9       2       12,14         Bulk Carrier $M$ 140       300       1-C-9       2       15	· · · · · · · · · · · · · · · · · · ·	Aft	900		4100	1	2000	1-0-0	1	
General Cargo $M_{ATL}$ 2003023013.05001-C-8212,14ATL Fwd303050501-C-9212,14Bulk Carrier $M_{ATL}$ 1401403001-C-9215		Fwd			<u> </u>	<u>                                      </u>			1	
Aft     200     30     230     13.0     300 $1-C-8$ 2     12,14       Fwd     30     30     50     1-C-9     140     140     300     1-C-9       Bulk Carrier $M$ 140     140     300     1-C-9     2     15	General Cargo	[ซีไ	200	20	220	1 1 2 0	500	1 0 0		12 14
Fwd         30         30         50           Bulk Carrier         M         140         140         300         1-C-9           Aft         38         2         40         5.0         50         2         15		AT	200	30	230	1 13.0	500	T-C-8	1 -	12,14
Bulk Carrier $140$ $140$ $300$ $1-C-9$ Aft         38         2         40         5.0         50         2         15		Fwd	30	1	30	1	50		1	r
laft 38 2 40 5.0 50 2 15	Bulk Carrier	U.	140	1	140		300	1-C-9		
		Aft	38	2	40	5.0	50	_	2	15

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, ↓, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

- 5. Shear
- 6. Tension 7. Combined Tension

and Shear

- 11. Neglect 12. Misuse/Abuse
  - 13. Questionable 14. Heavy Seas
- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes
- 10. Welding

DETAIL FAMILY: ' BEAM BRACKETS

LOCATION ON S	9 TH	Number of	Number of	Total	Domest	1 Patinata 3		T=	
SHIP TYPE	זו	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Detail Family Number	Mode	Failure Cause
General Cargo	Fwd M Aft	20 100 40		20 100 40		. 40 280 80	1-C-9		
Tanker	Fwd M Aft	50		50		100	1-C-9		
General Cargo	Fwd M Aft	39	1	40	2.5	100	1-C-10	2	9,14
Containership	Fwd Ø Aft	236	4	240	1.7	500	1-C-11	2	8
Bulk Carrier	Fwd M Aft	_45		45		100	1-C-12		
Tanker	Fwd M Aft	45		45		100	1-C-12		
Containership	Fwd M Aft	30		30		50	1-C-13		_
Containership	Fwd X Aft	20 158 _20	2	20 160 20	1.2	30 360 30	1-C-14	2	9,14
Containership	Fwd Aft	136 100	14	150 100	9.3	300 200	1-C-15	2	11,14
Containership	Fwd JU Aft	96 190	4	100 190	4.0	200 400	1-C-16	2	15
Bulk Carrier	Fwd U Aft	100 300		100 300		200 600	1-C-17		
Containership	Fwd Ju Aft	85 340 90	5	90 340 90	5.6	200 700 200	1-C-17	2	15
Tanker	Fwd M Aft	9	1	10	10.0	20	1-C-17	2	14,8
Containership	Fwd J Aft	50 300 90		50 300 90		100 700 200	1-C-18		· · · ·
Naval	Fwd Ø Aft	20 100 20		20 100 20		40 280 80	1-C-19		
Combination Carrier	Fwd Q Aft	120		120		200	1-C~20		
Combination Carrier	Fwd M Aft	50 170		50 170		100 300	1-C-21		
Containership	Fwd M Aft	76 400	4 120	80 520	5.0 23.1	200 1300	1-C-22	2 2	14 (11,12, 14,15)
General Cargo	Fwd Ju Aft	60		<b>6</b> 0		100	1- <b>C-</b> 23		
	<u></u>								

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DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SI	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause
SHIP TYPE		Details	Details	Details	1	on Ship	Number		6
····		Observed	Observed	Observed					
	Fwd	}	]						
l'anker	<u>A</u>								
	AIL		<u> </u>	120	7.5	300	1-C-24	2	
Dulle Constant	rwu W	140	1	140		300	1 5 1	1	
Buik Carrier		190	í .	/90	ł	1600	T-D-T	1	}
	JIA T	180		180		400			
· • -	1 Wd	40		40		100			
General Cargo	8	310	}	310	ļ	700	1-0-1	}	j
	Aft	90		90		200			
	Fwd	20	1	20		40			
Miscellaneous	1.0	60	1	60		120	1-D-1		1
<u> </u>	Aft	30		30	[	40			
1	Fwd	50		50		100			
Bulk Carrier	ן אַן	1000		1000		2200	1-D-2	1	1
	Aft	50	<u> </u>	50		100			
	Fwd								
Miscellaneous	X	300		300		800	1-D-2		
•	Aft	80		80		200			
	Fwd	20		20		40		í i	
Miscellaneous	ซี	120		120		280	1-D-3		
	Aft	30		30		200		1	
	Fwd	<u>_</u>			h				
General Cargo	N I	70		70		150	1-D-4		
	1 44	20		20		50	TPI		
	Fwd	30	<u> </u>	30		50		}	}
Bulk Carrier	7	•••					1-D-5		
	Aft						1 2 0		
	Fwd							1	
General Cargo	8	38	2	40	5.0	100	1-D-6	2	9
ocheron ombe	1 +++		-				тро	_	-
<u> </u>	Fwd	40		40		100		<b> -</b>	
Miscellaneous	[ ซู ไ	280		280		700	1-D-7	1	
	Aft	80		80		200			
<i></i>	Fvd								
Bulk Carrier	[ א]						1_0_9		
	Aft	49	1	50	2.0	100	T-D+9	[ 1 ]	10
	<b>F</b> 74				<b>`</b>		·····		
Combination	T WU					· · ·			
Compiliation	X.	60		60		100	1-E-1	(	
Jaf 1 1 21		<u> </u>		- 46		<del>1</del> 00-1			
Containanabin	r wa	40		70			1 77 9		
concarnersnip	A AL				]		1-E-1	[ ]	
	ALU								
	rwa I	20		20		50		} 1	
ranker	붮			20			1-E-1	ł I	
	Art	30		30		50			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 50 ship survey.
- (B) The rows labeled aft, **b**, and fwd refer to locations along the ship length. The
- midship symbol row covers the mid-length
- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for
- failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
  - 5. Shear
  - 6. Tension
  - 7. Combined Tension
  - and Shear
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 8. Design 9. Fabrication/Workmanship 16. Other See Note
- 10. Welding

• TABLE A-1

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON S	ПΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ך
SHIP TYPE	]↓	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
Bulk Carrier	Fwd U Aft	10 60 30		10 60 30		30 120 50	1-E-2			
Combination Carrier	Fwd Q Aft	60		60		100	1-E-2			-
Containership	Fwd M Aft	20		20		20	1-E-2			-
Tanker	Fwd M Aft	30 40		30 40	-	70 90	1-E-2			╞
General Cargo	Fwd M Aft	20		20		50	1-E-3			
Tanker	Fwd M Aft	20 50		20 50		40 80	1-E-3			
General Cargo	Fwd Ø Aft	90 700 130		90 700 130		200 1600 300	1-E-4			
Combination Carrier	Fwd X Aft	50		50		100	1-E-5			
Miscellaneous	Fwd M Aft	20 80		20 80		50 200	1-E-5			]
Tanker	Fwd M Aft	20 80		20		50 200	1-E-5			1
Bulk Carrier	Fwd X Aft	20		20		20	1-E-6			
Tanker	Fwd M Aft	9	1	10	10.0	10	1-E-6	1	11	1
Tanker	Fwd M Aft	40 30		40 30.		100 100	1-E-7			]
Containership	Fwd M Aft	98	2	100	2.0	220	1-E-8	1,2	5,9	1
Bulk Carrier	Fwd M Aft	20		20		50	1-F-1			1
Containership	Fwd Ø Aft	10 200 31	9	10 200 40	22.5	30 410 60	1-F-1	2	13	
Tanker	Fwd M Aft	442	8	450	1.8	1160	1-F-1	1	10	
Tanker	Fwd M Aft	175	5	180	2.8	400	1-F-2	1	9,10	1
Tanker	Fwd M Aft	30		30		50	1-F-3			1
		,	•	•	•	·····		+	<b></b>	4

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SI	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	}
[	ł	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	[
SHIP TYPE	٦L	Details	Details	Details	Į	on Ship	Number			
r	I	Observed	Observed	Observed	]	]		]		J
/	Fwd	47	3	50	6.0	100		1	14	
Bulk Carrier	17		-	1		1 - 1	1-F-4	ļ		
	Aft			[		ł	·			μ
	Fwd	20		20		50		<u> </u>		<b>i</b> ` <b>∔</b> :
Miscellaneous	ជ	20				L	1-F-4	ł		
	Aft							ł		
<u> </u>	Fwd	47	3	50	6.0	100		1 1	14	
Tanker	ਿੱਖ	- /	-				1-F-5	_		
	Aft			1						
<u> </u>	Fwd	480	<u>}</u>	480		1230		1		
Neval	H	3400	1	3400	1	8430	1-6-1	1		1 17
	AF+	960		960	ł	2410				I H
		10	<b> </b>	1 10	{			f	<b> </b>	. m
Norm 1	[ <u>"</u> "	E0	1	50		140	1-C-2	1		
TIG AST	1	20	ŧ.	30	ł	40	1-0-4	1	1	
	AIC		· · · ·					<u> </u>	4	Ч
L	FMG	30		30	1	50	1 0 2			
. Tanker	2				1		T-G-2	]		
	Art				· · · · · · · · · · · · · · · · · · ·					
	Fwd									
General Cargo	0	20		20		1 50	1 - C - 4		]	
	Aft		-				101	L		μ.
	Fwd			1	1					<b>I</b> ●
Naval	IX I			1	1	ļ	1 - c - 4			
	Aft	40	ļ	40	}	100	1-0-4		[ ]	
	Fwd	20	]	20		30		1		
Combination	l 🛛 🗌			ł			1-G-5	1		
Carrier	Aft			1						l la la
	Fwd	84	6	90	6.7	200		1	14	
General Cargo	U U	130	-	130		300	1-H-1	1		Ē.
	Art	100						1	í	
· · · · · · · · · · · · · · · · · · ·	<b>F</b> wa			<u> </u>	· · · · · · · · · · · · · · · · · · ·	h		<u> </u>	<b> </b>	
Compinetion	1	E0.		50		100	1-н-2	1	<b>I</b>	
Comprise		50	ł	50				1	1 1	
Carrier				20		30		<b>{</b>	<b></b>	
	rwa	20	ļ	20		140	1_H_3	1		
Combination	1 X	80		30		40	T-U-2	1		
Carrier	AIT	20		20				+		
	Fwd	29	1	30	3.3	50	1-H-4	<b>∠</b>	14	
Containership	N N					1		1		1
	Aft			ļ					<b> </b>	
	Fwd			4	ŀ	ł.		1		La
Bulk Carrier	X		ţ				1_H_5	1		
	Aft	90	[	90		200		<u> </u>	ł	
	Fwd				]	1	2	1	1	
Tanker	)ĭ			_			1_1_6			
1	Aft	30		30	1	50	1 1-1-0	E		t

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

- (B) The rows labeled aft, [a] , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect

  - 5. Shear 6. Tension
  - 7. Combined Tension and Shear
- 13. Questionable 14. Heavy Seas
- 15. Collision

12. Misuse/Abuse

÷.,

- 8. Design
- 9. Fabrication/Workmanship 16. Other See Notes
- 10. Welding
- -130-

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SH	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	]
SHIP TYPE	]	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
Bulk Carrier	Fwd M Aft	193 236	74	200 240	3.5 1.7	400 500	1-H-7	1 2	14 12	T.
Bulk Carrier	Fwd M Aft	85 100 40	5	90 100 40	5,5	200 200 100	1-H-8	1	14	
Tanker	Fwd M Aft	30 40		30 _40		60 90	1-н-9			म्ना
General Cargo	Fwd M Aft	29	1	30	3.3	50	1-н-10	1	в	-7
Combination Carrier	Fwd ) Aft_	20		20 20		20 30	1-H-11			
fanker	Fwd M Aft	20 20		20 20		30 40	1-н-11			
Containership	Fwd M Aft	36	4	40	10.0	40	1-J-1	1	8,14	
Naval	Fwd M Aft	8	2	10	20.0	10	1-J-1	2	13	
Combination Carrier	Fwd JU Aft	16	4	20	20.0	20	1-J-2	1	8	
Combination Carrier	Fwd Q Aft	22	8	30	26.7	30	1-J-3	1	8,11	
Bulk Carrier	Fwd J Aft	18	12	30	40.0	30	1-J-4	1	8,14	
Containership	Fwd U Aft	16	4	20	20.0	20	1-J-4	1	8,10	
Containership	Fwd M Aft	35	15	50	30.0	50	1-J-5	1	8	
Bulk Carrier	Fwd U Aft	40		40		40	1-J-6			
Containership	Fwd M Aft	20		20	]	20	1-J-6	<u> </u>		
Containership	rwa M Aft	90		90	 	200	1-K-1	 	ļ	
Containership	rwa N Aft	88	2	90	2.2	200	1-к-2	2	8	
Tanker	FWd M Aft	8	2	10	20.0	10	1-K-3	1	14	
Tanker	fwd M Aft	24	16	40	40.0	70	1-K-4	1	11,13	

-131-

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SI	ΠΡ	Number of Sound	Number of Failed	Total Number	Percent Failures	Estimated Details	Detail Family	Failure Mode	Failure Cause	
SHIP TYPE		Details Observed	Details Observed	Details Cbserved		on Ship	Number			
Containership	Fwd M Aft	168	2	170	1.2	350	1-K-5	1	13	4
Fanker	Fwd M Aft	87	3	90	3,3	200	1-K-6	2	11	5
Containership	Fwd M Aft	9	1	10	10.0	20	1-к-7	1	10	₹ <del>,</del>
General Cargo	Fwd M Aft	112 80	8	120 80	6.7	300 200	1-K-8	1	14	п
Tanker	Fwd M Aft	82	8	90	8.9	200	1-L-1	2	14,15	r interest
Containemphin	Fwd	279	41	320	12.8	800		1,3	7,14,1	
	Aft	266	4	270	1.5	600	1-1-2	2	8,13	
General Cargo	Fwd M Aft	56	4	60	6.7	100	1-L-2	1	7	<b></b> 1
VE scallaneous	Fwd M	33	7	40	17.5	60	1-1-2	2	15	
MI SCELLENEOUS	Aft	20		20		40	т <b>п</b> с			<b></b> - <b>4</b>
Tanker	Fwd M Aft	50		50		110	1-L-3			$ $ $\overline{V}$
Bulk Carrier	Fwd X Aft	46	4	50	8.0	100	1-L-4	1	13	
Containership	Fwd M Aft	50		50		100	1-L-5			[b
Containership	Fwd M Aft	30		30		50	1-L-6			
Containership	Fwd J Aft	80		80		200	1-L-7			
Containership	Fwd M Aft	260 200 320		260 200 320		600 600 800	1-M-1			
Containership	Fwd M Aft	90 120		90 120		150 250	1-M-2	1		

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- in the 50 ship survey.
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- midship symbol row covers the mid-length

- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
- 5. Shear 6. Tension
  - 7. Combined Tension
  - o. Design 9. Fabrication/Workmanship 16. Other See Notes 10. Welding

12. Misuse/Abuse

13. Questionable

14. Heavy Seas

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SP	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
General Cargo	Fwd M Aft	60		60		100	1-M-2			] [
Tanker	Fwd M Aft	39	1	40	2.5	50	1-M-2	1	11	
Combination Carrier	Fwd Q Aft	200		200		300	1-M-3			] [
General Cargo	Fwd M Aft	10		10		10	1-M-4			] [
Tanker	Fwd Ø Aft	30		30		50	1-M-4			<u> </u>
General Cargo	Fwd Ø Aft	50 110		50 110		100 200	1-M-5			
Containership	Fwd M Aft	224 109	16 1	240 110	6.7 0.9	600 200	1-M-6	2 1	14 7	
General Cargo	Fwd •)) Aft	220		220		500	1-M-7			
Tanker	Fwd M Aft	90 160_		90 160		200 300	1-M-7			
Combination Carrier	Fwd Ø Aft	148	2	150	1.3	300	1-M-8	2	13	
Tanker	Fwd X Aft	9	1	10	10.0	10	1-M-8	1	11 -	] 
Bulk Carrier	Fwd U Aft	15	15	30	50.0	40	1-N-1	1	8	
Combination Carrier	Fwd Q Aft	90		90		300	1-N-1			]
Containership	Fwd M Aft	30		30		50	1-N-2			
Naval	Fwd X Aft	10 30 10		10 30 10		10 90 20	1-N-3			L
Naval	Fwd U Aft	20 180 30		20 180 30		50 380 100	1-N-4			
Bulk Carrier	Fwd X Aft	109	21 '	130	16.2	300	1-N-5	3,4	15	
Naval	Fwd Aft	50		50		100	1-N-6			
Naval	Fwd Q Aft	19	1	20	5.0	30	1-N-7	2	8,12	

DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ר
SHIP TYPE	וור	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
Bulk Carrier	Fwd M Aft	40		40		60	1-P-1	<u> </u>		
Miscellaneous	Fwd Ø Aft	10		10		20	1-P-1			
Tanker	Fwd M Aft	181	39	220	17.7	450	1-P-1	1	6,8,14	
Combination Carrier	Fwd M Aft	310		310		600	1-P-2			
Mi <b>scella</b> neous	Fwd M Aft	50		50		150	1-P-3			ſ
Bulk Carrier	Fwd ) Aft	24	6	30	20.0	70	1-P-4	3	15	0

### TABLE A-2

DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
SHIP TYPE	ן,	Sound Details	Failed Details	Number Details	Failures	Details on Ship	Family Number	Mode	Cause	
Naval	Fwd M Aft	10 20 20	UDServed .	10 20 20		20 50 30	2-A-1		<u> </u>	]
Containership	Fwd M Aft	20 110 40		20 110 40		30 200 70	2-A-2			
General Cargo	Fwd M Aft	10 100 40		10 100 40		30 210 60	2 <b>-</b> A-2			
Tanker	Fwd M Aft	20 160 30		20 160. 30		20 500 40	2-A-2			
General Cargo	Fwd M Aft	8	2	10	20.0	10	2-A-3	1	8,12	₽₽

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 50 ship survey.
- (B) The rows labeled aft, ∅, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks
- and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:
  - 5. Shear
  - 6. Tension
- 7. Combined Tension
  - and Shear
  - 8. Design
- 11. Neglect
  - 12. Misuse/Abuse
  - 13. Questionable 14. Heavy Seas

  - 15. Collision
- 9. Fabrication/Workmanship 16. Other See Notes 10. Welding

8-3

~134-

DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP		Number of	Number of	Total	Fercent	Estimated	Dine 1	170411000	[m- 4 ]	<b>,</b>
	_1	Sound	Failed	Number	Failures	Deteils	Detail	raiture	Failure	j
SHIP TYPE	14	Details	Details	Details		on Shin	Family	Node	Cause	ļ
	1.	Observed	Observed	Observed	ļ		Number	4		
	Fwd	20		20	f	40	f			
Combination	X I	310	[	310		580	2-A-4			
Carrier	Aft	100		100		180				
	Fwd			· · · · · · · · · · · · · · · · · · ·			<u>+</u>	+		<u> </u>
Containership	ותן	30		30		50	2-4-4			. ▲
	Aft		ł	1				[ .		
	Fwd		T		····		·}		· · · · · · · · ·	
Tanker	X	30		30		40	2-4-4	1		
	Aft		ł	ľ		_				
	Fwd			<u> </u>	h	·····	<u> </u>	<u>}</u>		
Tanker	1 X	145	5	150	3.3	250	2-A-5	1	8	
**	Aft									
	Fwd	40	i	40		80	f	<u> </u>	· ·	- <u></u>
Bulk Carrier	l X I	885	5	890 1790 2-A-6 2	890 1790 2-4-6 2	890 1790 2-A-	2-A-6 2	14		
	Aft	70	-	70		140			74	
	Fwd	50		50		100	1.0 1 6			
Combination	ועו					100	2-A-6	1		
Carrier	Aft							[		<b>T</b>
	Fwd	110	1	110		230		1		
Tanker	M I	632	8	640	1.2	1610	2-4-6	2	11	
	Aft	140	-	140		360		-		
	Fwd						<u> </u>			
Tanker	1 11 1	80		80		200	2-4-7			
	Aft						/			کے جمع ا
· · · · · · · · · · · · · · · · · · ·	Fwd	40		40		80	{-·			
Containership	1 y	230		230		600	2-4-8			
-	Aft	50		50		120				·
	Fwd	· · · · ·	· · · · · · · · · · · · · · · · · · ·				<u>}</u>			*
Bulk Carrier	l v	35	15	50	30.0	70	2-4-9	2	15	
	Aft							-		
· · · · · · · · · · · · · · · · · · ·	Fwd	10		10		20	<u> </u>			
Containership	τ	200		200	i	400	2-4-10			
-	Art	40		40		80				- <u></u>
	Twa	10		10			╂	<u> </u>		<b>A</b>
Tanker	X I	260	10	270	37	590	2-A-10	1.	<b>C</b> 10	
	Aft	200	10	270	5./	380			6,10	
	Fwa	20		20		30	<u> </u>	1		-
Containership	¥	100	,	100		210	2-A-11			<u> </u>
-	Aft	40		40		60		1 1		- <u></u>
	Fwat	40		40		<u> </u>		<u> </u>		
Containership	ا ۲	370		370	1	750	2-A-12	1		1
-2	Aft	80		80		160		[ ]		- <u></u>
	Fwat	0.8		60		100	\	<u>t                                    </u>		
Naval	18	160		160		440	2-A-13	1 1		T
	Aft	70		70		160		1		
	Fwal	20		20		200	····	<u>├</u>		
Tanker	[8]	20		20		200	2-A-14	. I		
	Aft	20		20		200	}	j		
	500					- /0	ł	┟───┤		
Tanker	["Wul	20		20		30	2-A-15			Π
s and the t	AFt	30		20		70				<u></u>
	Dec a l						<u> </u>	<u>∤ · ·</u> }		
Combinetion	"Wa	30		30		50	2-A-16			
Compinetion	1 X 1							j i		<u></u>
ourrer.	լու է							L		

-135-

DETAIL FAMILY:

TRIPPING BRACKETS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
		Sound 🌯	Failed	Number	Failures	Details	Family	Mode	Cause	1
SHIP TYPE		Details	Details	Details		on Ship	Number			
	'	Observed	Observed	Observed	Į	-			<b>í</b>	
	Fwd		[		1			1		
Bulk Carrier	โซ่ไ	140	Į	140		300	2 4 17			
	Aft.	1.0		1 <b>1</b> 1			2-A-17			
	Fud			{- <i></i>	<u> </u>			<u>  · · · </u>		
Combination	m	110		110	]	200	0 1 17			1 🕈
Combination	X	110	ſ	110	ł	200	Z-A-1/			
Carrier	A1 C					·		ļ		
	iwa.		-		1	1		1		
General Cargo	14	_	1			Į .	2 4 17			
	Aft	20	ļ	20	l	( 50	2-A-1/	ł		
	Fwd	40	1	40	1	100		1		
Tanker	i ŭ l	80		80	1	200	2-A-17	•		
	Aft				1					
	<b>D</b> U2		<b> </b>	<del>{</del>	ŧ			+	• · · · · · · · · · · · · · · · · · · ·	
	rwu	40	]	40		100	2_1_18	1	1	i r
Combination	L.X.	40	1	40		100	2-A-10			
Carrier	Ait		ļ		<b> </b>			<u> </u>	l	
	Fwd	110		110	1	300	0 . 10	1		
Tanker	ותן	1200		1200		3000	2-A-19			
	Aft	40		40		100				
	Fwd	9	1	10	10.0	10		2	15	
Tanker	۲X		_				2-A-20			E   \ _
1	Aft									
	Eved.	=======	- <u> </u>	60	<del>{</del>	100	2 4 21	2	15	1
	- WU	90	4	00	1	100	2-A-21	-		\ r
Combination	<u>, X</u>		i		i					Į <u>▲</u> ▲
Carrier	Art			<u> </u>	1			4	÷	1
}	I wa	80		80	1	100	2 4 22			
Containership	🎗	150		150		350	Z-A-22			
	Aft	40		40		90		<b>_</b>		Į
	Fwd	10		10		20				•
General Cargo	lŭ∣	40		40		60	2-A-22			
-	Aft	20	Į	20	L	20_	l	l		
	Fwd	40		40	1 -	90			1	
Tanker	۲X –	-		ł	[		2-A-22			
	Aft	60		60		110	}	1	l	
<u> </u>	Fwd				1	1	1		1	1 -
Jantainanchin	1	30		30	1	60	2	1		h-2
Concarnership	1.4	20		20	1	20	Z-A-23			
L	<u> </u>	20	·	2 <u>0</u>	·	+	<u>{</u>			1 🔶
	Fwa		1	1	1		2-4-23	1		
Miscellaneous	[ <u>R</u> ]	20	1	20		20			1	h
	Aft						<b></b>		<u></u>	4
· · · · · · · · · · · · · · · · ·	Fwd	140		140		300	1	] 1	13	
Containership	۱Ø.	584	6	590	1.0	1200	2-A-24	11	15	
· ·	Aft	190	1	1 190	1	400	1	1	13	1
<u>├</u> ─	Trwn	30	1	30	1	80	1	1	1	1 🔶
Tenker	18	1 50	1	1	1	1	2-A-24	1	1	
	Art.	20		30	1	50				<b>├</b> ───┙
1	1	1 30	1	1 20	1		1	1		

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

- (B) The rows labeled aft, **b**, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

- 5. Shear 6. Tension

- 7. Combined Tension and Shear
- 11. Neglect 12. Misuse/Abuse 13. Questionable
- 14. Heavy Seas
- 15. Collision
- 8. Design
- 9. Fabrication/Workmanship 16. Other See Notes 10. Welding
TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON S	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
	-	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	1
SHIP TYPE	14	Details	Details	Details		on Ship	Number		l l	Į
ļ		Observed	Observed	Observed					1	ł
Mankan	IFW0	10		10		20	0 1 05		1	1_
Tanker	12		ſ		1		2-A-25		i.	
<u> </u>	The c	50		50		80				
Concernal Concern	1 Wa			10		20	3 4 36			
General Cargo	1 ×	180		180		340	Z-A-20			
	AIT	30		30		40				}d
Toplean	1 Wa									
Tanker	μ λ++	200			2.5		2-A-26	l _		
}	AL C	106	4	110	3.6	200		1	6,10	ļ
Nevel	T T	10		10		10	<b>0</b> 4 07			
Havar		30		30		50	Z-A-27			
	Fyd.	20		20	<u> </u>	40			ļ	
Canker	1	49		50	20	100	2 4 27	<u>,</u>	1 12	
•	Aft		-	. 50	2.0	100	2-R-21	-	13	
	Fwd	10		10					<u> </u>	
General Cargo	<b>T</b>	70		20		150	2-4-28		ľ	
5*	Aft	20		20		20	2 11-40		l I	
}	Fwd	110		110					<b> </b>	ł
Naval	ש	640		640		1600	2-4-29			
	Aft	240		240		620			[ ]	
	Fwd	10		10					} <sup>!</sup>	<u> </u>
Bulk Carrier	[ซ]	40		40		20	0 7 1			
	Aft	10	1	10		20	2-B-1		]	
	Fwd	30		30		50		·	┫━╍───	
Combination	N I	420		420		860	2-B-1			F T
Carrier	Aft	30		30		90	2.01		1	<u></u>
	Fwd	20	· · · · · · · · · · · · · · · · · · ·	20		50		·· ·····	{	
Tanker	X	600		600		1490	2-B-2		[	/∳∖
	Aft	40	_	40		60			1 1	يك أنسكر
	Fwd	10		10		20			<u>}</u> {	•
Bulk Carrier	N I	260		260		540	2-B-3			
	Aft			30		40			<b>I</b> 1	┠╾┯╼┛
	Fwd	40		40		80	0 7 0		1	
Combination	<u>  R</u>	476	4	480	•8	900	2-B-3	2	13,14	
Carrier	Art	70		70		120			]	
	Fwd	20		20		60	0			<b>A</b>
ranker	L M	433	17	450	3.8	1100	2-B-3	2	11,15	
	AIU	40		40		110 }			1 1	
Containemehin	rwa W	20		20		40	2_0_/			
concarner ship	<u>у</u> .	200	ĺ	200		420	2-6-4			
		50		50		80		L .	[]	
Misselleneous	rwa H	10		10		10	2-B-4			
	AT+	10		70	ł	180	~ <i>.</i> , ,		1 1	T
····	FL C	- 10		<u> </u>		10			(	
Tanker	r Wu	20		20	1	50				
	Aft	30		30	I	E 0	2-B-4		{ }	
<u>├───</u>	Fwd									
Naval	1 2	310		210		100	2		e 1	I ∕ <b>T</b> ∖
	Aft	140	,	150	-	200	∠-a->	2		
	Fyrd					28U		4	<u> </u>	t de la companya de l
Naval	ซไ	120		120	l	400	2-8-6			
	Aft			+20	[		2-0-0			1613
	Fud			ł					I	£
Containership	ิชี ไ	ا مە	ł	<u>4</u> 0	í	100	2-B-7			
<b>-</b> F	Aft		ļ			100	~~ ′			
· · · · · · · · · · · · · · · · · · ·	<u>-</u>								L	<u> </u>

TRIPPING BRACKETS DETAIL FAMILY:

LOCATION ON SH		Number of	Number of	Iotal	Percent	Estimatei	Detail	Failure	Failure	1
	ī	Sound	Failed	Number	Failures	Details	Family	Moje	Cause	1
SHIP TYPE	11	Details	Details	Details	1	on Ship	Number		]	1
	T	Observed	Observed	Observed	]					}
	Fwd	30		30		60				1 7
ombination	σ	100	ļ	100		180	2-в-8			
larrier	Aft	90		90		160		1		1 2 2
	Tree A				}					14
H	THU I	20		20	1	20		1		
viscerraneous	X	20		20		20	2-B-8	1		
	AIU								· · · · · · · · · · · · · · · · · · ·	4
	Fwd	20		20	}	50				Ιr
Combination	<u>  R</u>	390		390		750	2-B-9			
arrier	Aft	110 _		110		200		L		1 -
	Fwd	20		20		50				
Combination	ן ען	180	1	180		350	2-B-10	1		<b>j</b> {)
Carrier	Aft	60	ł	60		100		1		🗲
	Fwd	40	1	40		120		†		1
Noval	۲T	220		230	1	600	2 - B - 10			7
	X	230	1	200	1	100				<u> </u>
	AL C	30	· · · - · ·	$\frac{1}{10}$	<b> </b>	<u>-</u> 70		l	<u> </u>	! _
_	Ir∭q∣	10			1	20				F I
fanker	μ	170		170		350	2-8-11			
	Aft	20	1	20		30			l	[ ===
	Fwd		1	1	1					· 、
Bulk Carrier	ا X	30		30		60	2-B-12	1	1	
	Aft	30		30	1	40			1	
	Fwd	10	†	10	·····	20		1	1	1.
Naval	۲ ۲	30		30		50	2 - B - 12			l '
	Sft	20		20		30				
	1									1
Maalaas	12.	621	20	850	34	2150	2 - B - 12	1	8.13	
Tanker	12			50		80		-	·· ·	<b> -</b>
			<b>↓</b>		<b></b>		<u> </u>	<b></b>	ļ	{ _
	IFWd			50		110	2 1 1 2		1	`
Fanker	D.	50		50		110	2-0-13			
	Aft							l	L	! —
	Fwd		1					ļ	1	,
Containership	١¤	20		20		50	2-B-14		1	
	Aft		1	ł	Į	1	_	1		! —
	Fwd	99	1 1	100	1.0	270	i — — — — — — — — — — — — — — — — — — —	1	15	].
Tanker	Ι N	20	1 -	20		60	2-B-15	1		/
	AT+	40		40	1	50		1		_
	1			1	<u> </u>	60		<u>t</u>	······	1
	l'wa		ł	140	ł	370	2-B-16	1		<b>г</b>
laval	1.2	140	1	140	1	370		1	1	∣₫
	Aft	50		<u>1 50</u>	L	120		<u></u>	<u> </u>	4
	Fwd	t	[					1		1 1
Containership	١X -	1	1		]	l	2-B-17	1		
-	Aft	10	1	10		10	t	Ł	1	」 一
	Fwd		1	1	1	I		1	1	1
Containership	ŭ	48	2	50	4.0	100	2-B-18	1	8,14	
<b>-</b>	Aft	ł	1				<i>.</i> .	1		I
	1-24 6	i		1	L	1	1	1	I	1

NOTES:

(A) The above continued table gives infor-

mation related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, M , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

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  - 5. Shear 6. Tension

and Shear

- 7. Combined Tension
- 11. Neglect 12. Misuse/Abuse 13. Questionable

  - 14. Heavy Seas
- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes 10. Welding
- -138-

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SH	пр	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
	ī	Sound	Failed	Number	Failures	Details	Family	Node	Cause
SHIP TYPE	111	Details	Details	Details	}	on Ship	Number		
	11	Observed	Observed	Observed		_		1	
}	Fwd	10		10		10	i	1	
Containership	🕅	99	1	100	1.7	220	2-B-19	11	13
	Aft	20	1	20	Į	20			
<u> </u>	Fwd			t		1	<u> </u>		1
Tanker	Ι M	360		360		900	2-C-1		
1000000	Art								1 1
	1.1.2		<u>↓</u>	•••••••	<u>}</u>	<del>†</del>	<u></u> }····	<b>}-</b>	
The value are	L MO	30	10	40	25.0	50	2 - C - 2	1	8
Tanker	1.8		10	1				-	
	AIT			<u> </u>		<u> </u>	<b>[</b>	ļ.,	<b></b>
	r.Ma					1	2_0_3		
Containership	N.	20		20		50	2-0-5	1	
	Aft							ļ	
1	Fwd					1	1 2 2 1		
Combination	N I	69	1	70	1.4	100	2-6-4	1	14
Carrier	Aft	L	<u> </u>	<u>i</u>	<u> </u>	1			
[	Fwd			1	1	1		1	
Containership	I)≬-	39	1	40	2.5	60	2-C-4	1	14
1	Aft	l		l .	1	1	Į	l	[
	Fwd		1	T			1		1
Containership	١ <u>م</u>	158	2	160	1.2	200	2-C-5	1	14
	Aft	_	1.	1		1	1	1	
	Fwd	<u> </u>	1	1	1	1	† ··· - · -	1	1
Containership	ซ	106	14	120	11.7	250	2-C-6	1	8,10
[	Aft	1						_	
}	Trwa	<u> </u>	1	<u> </u>	1	<u> </u>	<b>↓</b>	+	
Tenker	I K	1 18	2	20	1	20	2-0-6	2	12
	Aft	_ <b>^</b> 0	1 -	1 -0	ľ			_	
<b>├</b>	Fwd		f	+			<u> </u>		
Bulk Carrier	l m	250	1 10	260	30	340	2-0-7	1	7 8 10
burk Carrier	A F+	2.50	10	200	1 3.5	1 340	2-0-7	- <b>-</b>	1,0,10
<u> </u>	5.4		<u> </u>	<b></b>	<u> </u>		<u> </u>	<u> </u>	
Containamahin	rwu m	216	24	240	1 10 0	200	2_6_7	1 .	14
concamersnip	× 1	210	24	240	1 10.0	1 300	2-0-7	-	14
·	ITUA			<u> </u>	<del> </del>	····	<u> </u>	<b></b>	·
	I'wu	200	60	260	23.1	300	2-C-8	1	8.10.14
containership	LX.	200		200			1	-	
<b> </b>	122-2	·	·	<b>\</b>	·	}	·	<b>\</b>	- <b>}</b>
Dulls Generation	L Mg	40	1	1 10	1	50	1.2 0 0	1	
pulk carrier	[쓰	40		40	1	50	2-0-9	1	1
F	AIT	<u> </u>	<del> </del>	<u> </u>	<b>/</b>	·	<u> </u>	<u> </u>	
L	h.Mq	l	ł		ł		2 0 10	1	
Buik Carrier	17	60	ł	60		<sup>60</sup>	1 2-0-10		
L	Aft		<u> </u>	·	<b>_</b>	<u> </u> _	<b>.</b>	4	-
L	Fwd		I		1	1			1
General Cargo	μ¤ –	210	1	210	1	300	1 2-C-II		1
·	Aft		ļ	<u> </u>	<u> </u>	L	<b> </b>	<b></b>	
	Fwd			1	25.5	00		•	14
Containership	Į₿.	ļ 15	5	20	25.0	20	2-C-12	1 1	14
	Aft			<u> </u>	l	L	1	1	<u> </u>
	Fwd		1	1		1		_	
General Cargo	١X -	40	60	100	60.0	100	2-C-13	1	12
	Aft		<u> </u>		<u> </u>	l	1		
[	Fwd		1	1		1		1	1
General Cargo	١X	61	9	70	12.9	80	2-C-14	1	11
-	Aft				l	20			
	Fwd	10	1	10	1	10		1	1
Naval	۱Ø	30		30	1	70	2-C-15	1	ł
	Aft	1 10	1	1 10	1	20	ł	1	1
Law and the second second second	<u>* * *</u>	<u> </u>	· · · · · · · · · · · · · · · · · · ·	<u> </u>		<u> </u>			

DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP TYPE	SHIP 	Number of Sound Details Observed	Number of Failed Details Observed	Total Number Details Observed	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure Cause	
Naval	Fwd M Aft	160 800 310		160 800 310		470 2720 960	2-C-16			<u>1</u> [
Naval	Fwd M Aft	10 10 10		10 10 10		10 20 10	2-C-17			₽
Naval	Fwd Aft	10 20 10		10 20 10		10 30 10	2-C-18			

## TABLE A-3

DETAIL FAMILY: NON-TIGHT COLLARS

TOCATTON ON S	TTP ]	Number of	Number of	Total	Percent	Fetimated	Denesia	Failure	Failure	1
	1	Sound	Failed	humber	Feilures	Deteile	Detail	Vode	Causa	
SHIP TYPE	n L I	Details	Details	Details	1 41141 63	on Shin	ramily	Joue	Cause	
		Observed	Observed	Observed		on tanp	. Mumer.			
	Fwd	130	[	130		250		1		
Combination	1 X	1200	l	1200		2750	3-A-1			
Carrier	Aft	180	1	180		400				5
	Fwd	50		50		80				
Bulk Carrier	) X	260	ļ	260		600	3 <b>-</b> A-2			
	Aft	70	I	70		120				
_	Fwd	10		10		30				
Containership	ן אַן	100		100		200	3-A-2			
	Aft	50		50		100		(		
	Fwd	20		20		40		1		
Tanker	Ω	90		90		<b>2</b> 50	3-A-2			
	Aft	4 <u>0</u>		40		60				
	Fwd			_						
Containership	n i	_					2-1-3			
	Aft	30	i	30		50	J-A-J			1
	Fwd	25	5	30	16.7	40		2	15	
Tanker	¤	110		110		260	3-A-3			
	Aft									
	Fwd	20		20		50				
Containership	ן א	200		200		400	3-A-4	1		
· · · · · · · · · · · · · · · · · · ·	Aft	<u>5</u> 0		50		80				
	Fwd	90		90		180		1		
Containership	₽	470		470		950	3-A-5			
	Aft	120		120		260				9

NOTES:

- (A) The above continued table gives information related to individual detail designs
- in the 50 ship survey.
- (B) The rows labeled aft, § , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for
- failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:
  - 5. Shear 6. Tension

  - 7. Combined Tension and Shear
- 11. Neglect 12. Misuse/Abuse 13. Questionable 14. Heavy Seas
- 8. Design 8. Design 9. Fabrication/Workmanship 16. Other - See Notes
- 10. Welding

TABLE A-3 DETAIL FAMILY: NON-TIGHT COLLARS

LOCATION ON SH	ПΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	
SHIP TYPE	]	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
Bulk Carrier	Fwd M	10		10		30	3-A-6			ন
Containership	Fwd Fwd	10 10 110 30		10 10 110 30		30 200 50	3-A-6			
Containership	Fwd M Aft	30 200 50		30 200 50		60 400 100	3-A-7			
Tanker	Fwd M Aft	40		40		50	3-A-8			F
Bulk Carrier	Fwa X Aft	60	[	60		100	3-A-9			D
Containership	Fwd M Aft	40		40.		120	3-A-10			Ţ
General Cargo	Fwd M Aft	10 10		10 10		10 20	3-A-11			Ţ
Naval	Ewd Q Aft	160 1200 320		160 1200 320		430 3200 870	3-A-11			
Tanker	Fwd M Aft	10		10 30		20 40	3-A-11			
Containership	Fwd M Aft	40 200 50		40 200 50		90 400 100	3-A-12			Ð
Naval	Fwd M Aft	20 100 40		20 100 40		50 250 100	3-A-12			<b>1</b>
Naval	Fwd Aft	20 100 40		20 100 40		50 250 100	3-A-13			Ţ
Containership	Fwd M Aft	70		70		150	3-A-14			e
General Cargo	Fwd M Aft	58	2	60	3.3	100	3-A-15	1	9	T
Containership	Fwd M Aft	30		30		30	3-A-16			ਹ
Containership	Fwd M Aft	58	2	60	3.3	100	3-A-17	1	9	T
General Cargo	Fwd M Aft	68	2	.70	2.9	100	3-A-17	1	9	
Bulk Carrier	Fwd N Aft	90 1200 300		90 1200 300		200 2300 500	3-B-1			] ច
Combination Carrier	Fwd X Aft	140 1200 380		140 1200 380		300 2100 600	3-в-1			

DETAIL FAMILY: NON-TIGHT COLLARS

LOCATION ON S	HIP 7	Number of Sound Details	Number of Failed Details	Total Number Details	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure Cause	
	<u> </u>	Observed	Observed	Observed						ļ
General Cargo	Fwd M Aft	40		40		50	3-B-2			T
Tanker	Fwd M Aft	110		110		200	3-B-3			L
Tanker	Fwd M Aft	20 40		20 40		40 60	3-B-4			J
Tanker	Fwd M Aft	160 1200 400		160 1200 400		470 3100 1030	3-в-5			E
Bulk Carrier	Fwd M Aft	30 260 90		30 260 90		70 550 180	3-B-6			lt
Containership	Fwd M Aft	40		40		100	3-B-7			T
Tanker	Fwd M Aft	80		80		200	3-C-1			
Combination Carrier	Fwd M Aft	110		110		200	3-C-2			T
Bulk Carrier	Fwd M Aft	180 990 302	8	180 990 310	2.6	400 3000 950	3-C-3	1	13	<b>G</b>
Miscellaneous	Fwd M Aft	20 20		20 20		60 40	3-c-4			57
Naval	Fwd M Aft	80 300		80 300		200 800	3-C-5			Ш
Naval	Fwd J Aft	160 700 320		160 700 320		500 2500 1000	3-C-6			T
Containership	Fwd M Aft	50		50		100	3-C-7			I
Naval	Fwd M Aft	30 150 60		30 150 60		70 400 130	3-C-8			ाः
Naval	Fwd M Aft	20 70 20		20 70 20		40 120 60	3-C-9			ग्र

NOTES:

- (A) The above continued table gives information related to individual detail designs
- in the 50 ship survey.
- (B) The rows labeled aft, M, and fwd refer to locations along the ship length. The
- midship symbol row covers the mid-length
- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for
- failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
  - 12. Misuse/Abuse
  - 5. Shear 6. Tension
  - 7. Combined Tension and Shear
- 13. Questionable 14. Heavy Seas
  - 15. Collision

5.4

- 8. Design 9. Fabrication/Workmanship 16. Other - See Notes
- 10. Welding

TABLE A-3 DETAIL FAMILY: NON-TIGHT COLLARS

LOCATION ON SI SHIP TYPE	Ω₽ ]↓	Number of Sound Details Observed	Number of Failed · Details Observed	Total Number Details Observed	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure Cause	
General Cargo	Fwd M Aft	56	4	60	6.7	100	3-C-10	1	9	ਧੁ
Containership	Fwd M Aft	18	2	20	10.0	50	3-C-11	1	9	Ţ
Miscellaneous	Fwd M Aft	57 140 50	3	60 140 50	5.0	80 300 120	3-C-12	2	15	Ţ

TABLE A-4 DETAIL FAMILY: TIGHT COLLARS

LOCATION ON SH	ПР I	Number of	Number of	Total .	Percent	Estimated	Detail	Failure	Failure	}
		Sound .	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	11	Details	Details	Details		on Ship	Number	1	1	1
	יו	Observed	Observed	Observed	J	}		]		ļ
	Ēwd	30	í	30		60				
Bulk Carrier	7	280		280		600	4-4-1			Lì
	Aft	90	ł	90		140	4-A-1			<u> </u>
	Fwd	210		210		400				•
Combination	v I	1100	i i	1100		2900	4-A-1			
Carrier	Aft	290	1	290		700				
	Fwd	30		30		70				- <del></del>
Combination	σ	220		220		600	4-A-2			
Carrier	Aft	70	1	70		130	•	ļ		
	Fwd	40		40		100				]
Combination	ש	300	1	300		900	4-A-3	Į		
Carrier	Aft	. 90	}	90		200		1		
	Fwd	80	}	80		200	1			1 11 11
Tenker	ให้		1				4-A-4			
Tainer	Aft		}	1			]			
	Fwd	10	1	10		30				TT
Containership	ซี					1	4-A-5			
Contraction on P	Aft	120		120		200		J		J
	Fwd	20		20	1	50				
Tanker	X	200		200		800	4-A-5			
	Aft	50		50		80			l	
	Fwd	60		60		130		1		·
Bulk Carrier	U	350		350		720	4-A-6			
<b>Г</b> <sup></sup>	Aft	90	1	90	ļ	190		1		
·	Fwd	50	1	50		140			T	
Combination	D .	210	1	210		540	4-A-0	1		
Carrier	Aft	120	1	120		320				
	Fwd	20		20		50		- F	1	
Containership	۱X –		1	1			4-A-6	1	1	
	Aft	80	·	80		150				
	Fwd	20	T · · · -	20		50			1	
General Cargo	Щ.	120		120	ł	250	4-A-6		1	
	Aft	50	<u> </u>	50	<u> </u>	100	L	<b>_</b>	<b>↓</b>	4
	Fwd	40	1	40	1	100	1.1.1		1	
Miscellaneous	١X.	180		180	1	700	4-A-6		1	
	Aft	80		80	L	200	1	_L	I	ן ד

DETAIL FAMILY: TIGHT COLLARS

LOCATION ON S	ΗТЬ	Number of	Mumber of	Total	Percent	Estimated	Dia 12	Failure	Failuro	ר
	_	Sound	Failed	Number	Failures	Details	Detail	linde	Cause	1
SHIP TYPE	]↓_	Details	Details	Details		on Ship	Family	1 MODE	cause	
	<u> </u>	Observed	Observed	Observed			Number	ł		Į
	Fwd	90		90	<u> </u>	250		╀────	[ <u></u>	4
Tanker	ЦЙ.		ŀ				4-4-6			1 <del></del>
	Aft	100	ļ	100	ļ	280	4 A 0			
	Fwd							{ <u> </u>		-
Bulk Carrier	L XE I	100	l ·	100		200	4-4-7	ļ I		!
L	Aft		ł				4-4-7			L/
	Fwd							<u> </u>		
Containership	X	90		90		200	4-4-7	f i		•
L	Aft						- <u>n</u> -7			
	Fwd	40		40		130				
Combination	िल्ला	210		210	[	840	4-4-8			<u> </u>
Carrier	Aft	60		60		250			1	Lj
	Fwa									-
Combination	ועו	130		130	]	300	4-4-0			<b>⊢</b>
Carrier	Aft					200	ч-лу			
	Fwd	30		30						
General Cargo	🖬			50		100	4-A-9		1	
	Aft		ļ							
	Fwd	30		30						
Tanker	M I			50		50	4-A-10			TTT
l	Aft				1				1	
1	Fwa	90								
Containership	i 🛛 🛛	680		690		240				<u>11-11</u>
	Aft	170		170		1860	4-A-11			الطا
	Fwd	30								
General Cargo	D X I	220		220		1030	1			ਸ਼ਾਸ਼
	Aft	80		80	1	200	4-A-12		1	<u>  + -  </u>
	Fwd	30		30	•					
Containership	ועו	180		180	1	470	4-4-13	1	1	11-11
	Aft	60	4	60		150		1	ł	
	Fwd	20		20						20
Tanker	X		1	20		50	/ A 12	ļ	[	
	Aft	30	1	30		70	4-A-13		<u> </u>	
	Fwd	20								
Tanker	M I			20		50	4 4 14			रेत स
	Aft	30		30		100	4-A-14			
	Fwd	10		- 10					·	
Combination	μ		4	10		20				T** <b>T *</b> *
Carrier	Aft	40	[	40		120	4-0-1		1	للبل
	Fwd									
Containership	M I				1	1			ļ	Ĩ
-	Aft	20		20		50	4-B-1			]
	Fwd	20	ł	- 20						
Containership	ЯÌ	120		12ŏ	1	420	/			
	Aft	10	1	10		20	4-D-2	I	1	ريسي
				,				1		

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, § , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

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  - 5. Shear 6. Tension

  - 7. Combined Tension
  - and Shear 8. Design
- 14. Heavy Seas

12. Misuse/Abuse

13. Questionable

11. Neglect

- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes 10. Welding
- -144-

DETAIL FAMILY: TIGHT COLLARS

OCATTON ON SH	TPT	Number of	Number of	Total	Percent	Estimatei	Detail	Failure	Failure	
	īł	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
HIP TYPE	↓↓	Details	Details	Details	ļ	on Ship	Number			
	' I	Observed	Observed	Observed					L	
	Fwd	50		50		170			1	17 170
ontainership	DØ	200		200		660	4-B-3	1		L L I
	Aft	80		80		240		<u> </u>		
	Fwd	300		300		1050		1	1	•
ໂດນຫລີ	ĥ	1200		1200		7000	4-B-3	1	1	
	Aft	600		600	1	2100				
	2.4		f	20	f	60		f	11	
	rwu			1 100		320	4-B-4			X   H =
aval	X	100	1	100	1	120	- 5 -			
	Aft.				<b> </b>			<u> </u>	<u> </u>	
	rwd	60		60	1	200	1 10 5	1		775
vaval	X	300		300		1400	4⊸b−⊃	•		للا ا
	Aft	100	[	100	l	400			<u> </u>	Į.
	Fwd		1	1				1	1	
Noval	8	30	[	30	l.	100	4-B-6			1 315
1 La 7 Ch.L.	AT+		1	1	1	1		1	_ <b>_</b>	
<u> </u>	1	· · · · · · · · · · · · · · · · · · ·	+·	60	+	200		1		1
	rwa.	60		00		1400	4-B-7	1	1	। सार
Naval	1.8	300		300		1 1400		1		
	Aft	1.00	<u></u>	<u>  100</u>	<b>.</b>	400	<b>↓</b>	+		1
	Fwd		T							। तात
Naval	M I	1		1	1		4-B-8	1	1	I W
	Aft	20		20		100				
	Twd	10	1	10		40	1	T		1
Concerni Corgo	L H	10		40		400	4 - C - 1	1	1	1 [38]
General Cargo	1 ×	40	1	1 30	1	60				
	AIU	311	-{	+	-{		{		1	1
	IFWa	1 100	1	1 100		500	4 - C - 2			
Containership	1.8	1 100		1 100		500				
	Aft		4			200				-
	Fwd	120	1	120	ł	200	4-C-3			सर
Containership	Į₽.	}						1		1 U
	Aft	1	<u> </u>							4
	Fwd			1						
Tanker	۱ŭ						4.0-4			1 111
	Aft	40	1	40		50	4-0-4			
	Fwd	1		1			1			1
Tonker	Γ̈́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́́				1	1		-		
Tanver	1 44	40	1	40		50	4-C-5			
	10.0	1	- <b> </b>	+		1	<del>†</del>		· •	1 .
	Irwa	1 10	1	1 70	1	600	4-0-6	1	1	1 1 1
Bulk Carrier	18	300	ļ	300	1	600		1	1	ال
	Aft	50	<u> </u>	50		140	Į		+	┥ ╰────
	Fwd	<b>1 5</b> 0	1	50		120	4	1	1	I
Tanker	۱)X	1000	1	1000	1	2300	4-0-1	1		
	Aft	180	<u> </u>	180	<u> </u>	280	J			1 .
	Fwd			1		1		1	1	
Miscellaneous	10	200	1	200	ł	500	4-D-2		1	
	Aft	1	1	1	ļ	ļ			_1_	
	Furt	20	1	20	1	80	1		- <u> </u> -	1 .'
Penkor	ן <u>"א</u> "	2000		1 2000	1	8500	4-D-2	1	1	1 🕈
TOUNCI	12	2300	1	1 240	1	620	1	1		J
	AIT.	240	d	1 240	- <b>{</b>	1	<u> </u>	- <del> </del>	+	4
L	Fwd		1			1	1		1	
Containership	12	500	1	500	1	2000	4-0-3	1		
	Aft	1		1			I	1		
	Fwd			1						·
Tanker	١X.	1100	1	1100		2700	4-D-4			
	Aft	80	}	80		200	1	[		1 -

-145-

		Maril and Add	Numbers of	Totol	Domoont	Estimated	Datail	Failure	Failure	1
LOCATION ON SH	<sup>ш</sup>	Number OI	Number OI	Number	Failuree	Deteils	Family	Node	Cause	
	11	Deteile	Deteile	Details	19170162	on Ship	Number			
SALP TIPE	*	Observed	Observed	Observed		on onep	Number			
	Fwd	00801704	00001100							Ъ
Containership	ซี	4		4		4	5-A-1	[		
00mourner emer	Aft	-		_		-				
	Fwd									
General Cargo	ស	2		2		2	5-A-1			<b>_</b>
	Aft									
	Fwd									
Tanker	X	10	ł ·	10	1	10	5-A-1			<b>I</b>
	Aft		1	ļ	L					
	Fwd									╏╫
Containership	Ø	2	1	2		2	5-A-2	1		₁₽₽₽
1 -	Aft		}	]	L			1		
	Fwd				}		<b>F A D</b>			1 1
Containership	M	2		2		2	5-A-3	1		. <del>***</del> ++
	Aft			<u> </u>	<u> </u>					
	Fwd									
Containership	N I	2	ł	2	1	2	5-A-4	1		ttuine .
	Aft		í	{						
	Fwd				[			1		
Naval	) X	4	ļ	] 4	]	4	5-A-5	1		₩
	Aft			1	J	ſ		L	ļ	
	Fwd			1			6.6	1	1	
General Cargo	}-)≬	2	1	2		] 2	J-A-0	}		#1
	Aft			l	<u> </u>	ļ		<u> </u>	{	
	Fwd				1		<b>5 4</b> 7	1		▏╨ ╫ <u>╞</u> ╼═╛
Bulk Carrier	夏	2	{	2	{	2	<b>)</b> -A-/	1		I 17
	Aft		L	<u> </u>	l	<u></u>		<u> </u>	<u> </u>	ł "
<b></b>	Fwd		1		ļ		1 5 4.7			
Combination	N N	4		4	í	4		1	1	<b>-</b>
Carrier	Aft		1	<u></u>	<b></b>		•		<u> </u>	{ }
	Fwd		Ţ	1	)	1	5 . 7	1		
General Cargo	۱X.	2	1	2	4	2	J-A-7	ſ		┟╾╌╾┤
	Aft		<u> </u>	<b></b>	<b></b>	\	<u> </u>	<b></b>	<b>∤</b> -	4 1
	Fwd		ł		Į		5 4.7	}	1	
discellaneous	) Ø	2	1	2	1	2	) -A-/	1		
	Aft		<b></b>	<b></b>	<u> </u>		<b>}</b>	<u>+</u>	-{ <b>−</b>	4
	Fwd	[		1	1				1 1 2 1 5	
Tanker	۱¤	6	2	8	25.0	8	<u>)-A-</u> /	1 4	12,12	<b>├</b> 4
1	Aft	L	<b> </b>	<u> </u>	<u> </u>	<b>_</b>	<u> </u>	+	<b>\</b>	ነ ቤ
	Fwd	_	1		1	1 2	5-1-9	1	1	↓ ₩
Bulk Carrier	风	2		4	1	4	J-A-0		4	#
1	Aft	}	· · · · · · · · · · · · · · · · · · ·		4	<b></b>	<u></u>		÷	1 16

DETAIL FAMILY: GUNWALE CONNECTIONS

## NOTES:

- (A) The above continued table gives information related to individual detail designs
- in the 50 ship survey.
- (B) The rows labeled aft, k, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks
- and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

  - 5. Shear 6. Tension

  - 7. Combined Tension and Shear

  - 8. Design

  - 10. Welding
  - -146-

- 14. Heavy Seas 15. Collision
- 9. Fabrication/Workmanship 16. Other See Notes

11. Neglect 12. Misuse/Abuse 13. Questionable

DETAIL FAMILY: GUNWALE CONNECTIONS

LOCATION ON S	HÌP	Number of	Number of	Iotal	Percent	Estimated	Detail	Failure	Failure	ר
	- 1	Sound	Failed	Number	Failures	Details	Family	Node	Cause	1
SHIP TYPE		Details	Details	Details		on Ship	Number			
	<u> </u>	Observed_	<u>Observed</u>	Observed	]	. ~				
	Fwd	-	i i							1
Compination	1.2	2	1	2	ł	2	5-A-9	1	ł	
Carrier	AIT								[	
	FWd	<b></b>	1			_			[	1
ranker		2		2		2	5-A-9		i	┠╼══┥
	Aft	·			[			I		
	Fwd	_	1							
General Cargo	H	2		2		2	5-A-10		1	╡╫ <sup>══╤</sup>
L	Art				( I	(		ł	[	( 4)
1	Fwd									1 -
Naval	<u>A</u>	2		2		2	5-A-11	ł		1 #
	Aft	-				Į		ļ		¶=====
	Fwd					[				
Naval	Į R.	2		2		2	5-A-12	1		
L	Aft					1	]	<b>j</b>	ļ	#
[	Fwd			· · · · · · · · · · · · · · · · · · ·						1 1 1
Bulk Carrier	X	2		2		2	5-B-1		1	
	Aft								f	
	i vd						· · · · · · · · · · · · · · · · · · ·			
Combination	X	4		4		4	5-B-1			· · · · · · · · · · · · · · · · · · ·
Carrier	Aft									
	rwd									1
Tanker	X I	4		4		4	5-B-1			
1	Aft						-			
	Fwd									
Naval	¥	4		4		4	5-B-2			
	Aft									l Ll
	Fvd									
General Cargo	ĺŭ	2		2		2	5-B-3			( )
-	Aft	_				-				łU
	Fwd									
Containership	D X	2		2		2	5-B-4			
_	Art									
	Fwd									
Naval	6	2		2	· /	2	5-B-4			
	Aft	-								
·	Fwd									_
Containership	<b>V</b>	4	·	4		4	5-B-5			
-	Aft					ł				
	Fwd									<b>▲</b>
Tanker	M	2		2		2	5-B-5			
	Aft	ĺ	[		ĺ	{				
	Fwd								····	n
Containership	Τ	2	1	2		2	5-B-6			
-	Aft									
<b></b>	Fud									<b>▲</b> 1
Naval	Ϋ́	2	i	2		2	5-B-6			I T
	Aft	- 1	1		ł					
	Fw7	<u>.</u> f	f		f					n
Containership	Π	2		2		2	5~B-7			
oonoarnet surb	A Ft	-	ł	-	1	-	1			
		ł				<del> </del>				-
	"wu	~		2	ł	2	5-B-8			n
puis carrier	X I	-	1	-	1	-				
	1 V 1		<b>f</b>						·	L U
0	rwa			4		4	5-B-8			
containersnip	쓰				1	-				<u>├───</u> ┛
·	HL L									•

-147-

DETAIL FAMILY: GUNWALE CONNECTIONS

2.3

LOCATION ON SI	ΠP	Number of Sound	Number of Failed	Total Number	Fercent Failures	Estimated Details	Detail Family	Failure Mode	Failure Cause	
SHIP TYPE	]	Details Observed	Details Observed	Details Observed		on Ship	Number			
Mi scellaneous	Fwd Jú Aft	0	2	2	100.0	2	5-B-8	2	12,15	
Tanker	Fwd M Aft	2		2		2	5-B-8			

## TABLE A-6

DETAIL FAMILY: KNIFE EDGES

	the l	Th-hom of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
OCATION ON SH	1P	Number of	Number of	Number	Failures	Details	Family	Mode	Cause
		Detaile	raiseu Dotoile	Details	14114 00	on Ship	Number	ļ	
SHIP TYPE	¥	Details	Obcomrod	Observed		с			
	12.1	Observed	Observed	JUSELVEG				1	
	rwa								
Bulk Carrier	<u>, X</u>								
	Aft	<del></del>	ļ				<u></u>		
	Fwd								
Combination	Щ		Į.					1	
Carrier	Aft				DOT COO	STRES		┼────	
	Fwd			KNIFE I	DGE CRO	101100	6		
Containership	ן אן					IDVEV	, U		
	Aft		OB	SERVED J	N THE S	URVEI		╡	<u> </u>
	Fwd		l		1				
General Cargo	) X							1	1
	Aft				<b></b>			÷	<u> </u>
	Fwd			Į					]
Miscellaneous	M A			!					]
	Aft				· · · · · ·	<u> </u>		<u>+</u>	<u> </u>
	Fwd		1			1			
Naval	) X				1	ł	1	1	1
	Aft			· · · · · · · · · · · · · · · · · · ·			l		<b> </b>
	Fwa			]			1	ł	1
Tanker	Ľ۲.	1	1		1			1	ł
	Aft				<u> </u>	L	<b>!</b>	_ <b>_</b>	↓
			+		+	+	t	· † • • •	t
TOTALS		0	0	0	0	<u> </u>	<u> </u>	1 0	<u> </u>

NOTES:

- (A) The above continued table gives information related to individual detail designs
- in the 50 ship survey.
- (B) The rows labeled aft, **(b)**, and fwd refer to locations along the ship length. The
- midship symbol row covers the mid-length
- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect 12. Misuse/Abuse

13. Questionable

14. Heavy Seas

- 5. Shear
- 6. Tension
- 7. Combined Tension

- o. Design 9. Fabrication/Workmanship 16. Other See Notes 10. Welding

-148-

LOCATION ON SH	TP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	¥	Details Observed	Details Observed	Details Observed		on Ship	Number			
	Fwd	10		10		.50			11	
Bulk Carrier	N ≜+t	80		80		300	7-A-1	i.		-
	Fwd	50		50		190	,	-{	<u>†</u> [	
Containership	Ŋ.	60		60		200	7-A-1			
	Aft	20		20		60				
	Fwd	10				120	7-4-1	1		
lanker	<u>þ</u>	40		10		40	· · · ·	1	1	
	Fud	30		30		100	· · · · ·		<u>╁╶╼</u> ╶──┤	
Javal	ัชิ	90		90		300	7-A-2			-
	Aft	60	ļ	60		200				
	Fwd	20		20		50	7 4 7	}		
Bulk Carrier	X	120	1	120		450	/-A-3			
	Aft		ļ	30		100			╋ <del>┙┈╺╸</del> ┨	
Containarchin	rwa M	90 450		450		1600	7-A-3			4
outerner.surb	н Aft	90		90		300			]	
	Fwd	60		60		200		1	+	
Naval	X	450		450		1500	7-A-3	]		—
	Aft	100		100		500		<u>_</u>		
	Fwd	10		10		40	7-4-3			
Fanker	μ 	120	1	120		500	/- <u>n</u> -J		1	
	ALC	20	ł	20	<u></u>	50	·		+{	
ombination	τwu Π	70	ł	70		180	7-A-4			
Carrier	Aft	30		30		70			]]	
	Fwd	10		10		20	7 . /			- 4
Containership	Ø	30	ţ	30		90	/-A-4			
	Ait	10				40		<u>↓</u>	<u> </u>	
Dulle Connien	τwa Γ	10		10		10	7-A-5			
BULK GALFIEL	Aft	10	ł	10		10				
	Fwd	10		10	· · · · ·	30			1	-
Containership	Я		1		ł		7-A-5			
	Aft	10	L	10	<u> </u>	40		1	4	
	Fwd	10	}				7-A-5	1		l
Na <b>va</b> l	N 1 4 4 4				1	10		1		
	Fwd	10	+	10	<u> </u>	20		+	<u> </u>	l
Bulk Carrier	<u>ש</u>	10	Į	10		Ĩõ	7-A-6			
	Aft	10		10	I	20	l			1
	Fwd	40	1	40	{	60	7_1_6			Ì
Containership	ĮЯ.	68	2	70	2.9	140	/ -A=0	1	7,14	L
	Aft	40	<u> </u>	40	<b> </b>	60	<b> </b>			
Torker	FMG M	10		10	1	20	7-A-6			1
ISTIVEL.	Aft	20		20		30	ļ	1		
	Fwd	10	<b> </b>	1 10	<u> </u>	1 10				1
Bulk Carrier	Í X		1	-			/-A-/			L
	Aft	10		10	<u> </u>	10	<b> </b>			ł
	Fwd	20		20		30	7-A-7		1	ł
Containership	12	20	l	30		40			4	
	AIU	1 30	i	1 20	ł	<u></u>	L			4

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

-149--

LOCATION ON SE	ШΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	!
	<u>,   '</u>	Sound Detedle	Failed	Number	Failures	Details	Family	Node	Cause	I
SHIP TIPE	1	Observed	Observed	Details		on Snip	Number			1
	Fwa	30	Oberved	30	ł	50		{		{
Bulk Carrier	5	10		10		20	7-A-8	1		1
	Aft	30		30		50		1		
	Fud	20		20		30				
Combination	τ	20		20		40	7-4-8	1		
Carrier	Aft.	30		30		60	/ 11 0	1		—— <b>T</b>
0411101	Fwd	20		20		40		<del>[</del>		
Containershin	ิ ซี 🦷	64	6	70	86	160	7-4-8	1	7.14	
oonourner enry	Aft	40	Ŭ	40	0.0	70	/- <b>A</b> -0	- 1	.,	
	Fwd	10	·····	10		20	-			
General Cargo	โซ๊	10				10	7_1_9			
Contract Val 80	AT+	20		20		50	/-A-0			
	Fwd	10		10				├		
Miscellaneous	[ซ]	10		10		20	7.4.9	1		
	Aft	20		20		30	/-A-0			<del> </del>
	Fud	30		30		110				
No vo 7	<b>' ਸ</b>	175	5	100	20	630	7_4_8		14 16	
	$A_{f+}$	1/5	د ا	100	4.0	100	7-A-0		14,10	
	Furd			30		100	· · · · - · · · ·			
Tankar	Ϋ́	150		150		200	7 4 9	ł !		
IGUINEI	λ. <del>Γ.+</del>	100		100		220	/-A-0			
· · · · · ·	Eud.	<u> </u>				220		ł		
Ceneral Cargo	гwч	22	•	40	20.0	40		,	7 0 14	- E
Generar Cargo		32	8	40	20.0	40	/-A-9	- <b>-</b>	/,0,14	
	AIL	10		10		10	<u> </u>			
a	ιwα	10		10		20				ſ
Containership	<u>, X</u>						7-A-10			
	Ait	10		10		20				_ <u>_</u>
	Fwd	20		20		30				
Tanker	<u>A</u>						7-A-10			
	Aft	20		20		30				
	Fwd		-						]	5
Combination	R	30		30		40	7-A-11		ļ	
Carrier	Aft				ł				1	<u>ا</u> سة
	Fwd									
Naval	X I	6	4	10	40.0	10	7-A-11	1	7.8	1
	Aft							· ·		
	Fwd	17	3	20	15.0	20	7 4 11	1	7,8,9	
Tanker	ŭ					• • •	/-A-11	_		
	Aft					I			ſ	
	Fwd	10		10		20				_
Combination	v	60	1	60		110	7_4_12			ſ
Carrier	Aft	30	ļ	30		50	/		Í	
	Fwd	30		30		50				_
Containership	ជ	70		70		180	7_4_10		l	1
· · · · · · · · · · · · · · · · · · ·	Aft	50 1		50		20	/-A-12		ĺ	
		<u> </u>				70 1				

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, ¥, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

- 5. Shear
- 6. Tension

and Shear

- 7. Combined Tension
- 12. Misuse/Abuse 13. Questionable
- 14. Heavy Seas
- 15. Collision

11. Neglect

8. Design 9. Fabrication/Workmanship 16. Other - See Notes

10. Welding

LOCATION ON ST	IIP ]	Number of	Number of	Total	Percent	Estimated	Datail	Tailure	Failure
	_	Sound	Failed	Number	Failures	Deteile	Decali	1 Sode	Cauca
SHIP TYPE	าไไ	Details	Detaile	Deteile	raiidies	on Shin	ranity	l'ione	Cause
	۲.	Observed	Observed	Observed		on antp	Number	·	
}	Fwd		]					t	f (
Naval	ושו	10		10		10	7 4 10		
ſ	Aft	10		10		10	/-A-12	1	
}	1.1.1		<u> </u>	<u>├──-<u></u>†<u></u><u></u>∽</u>		10			
We min me	T WG	10		10		10			
Tanker	<u> </u>						7-A-12		
	AIT	<u> </u>		10	1	10		1	
	Fwd	50		50		100			-
Containership	1 10	92	8	100	8.0	700	7-B-1	1 1	9.14
-	Aft	100		100		200			
	Fwd	40		40		100		<u> </u>	·
Ceneral Cargo	1 1	300		100		700	7 0 1		. 1
Concret Cargo	1.2	100		100		700	/-D-1		1 1
	AIT A		ł			200		ł	<u> </u>
L.	rwa	30	i	30		100		1	i i
Tanker	ן מן	600		600		2900	7-B-1	1	l
	Aft	120	I	120		400		1	
· · · · ·	rwd	70		70		200		1	
Bulk Carrier	1 1 1	700		700		3500	7_B_?	1	J [
	A ft	200		200		500	/-0-2	1	}
	12.0			200				<u> </u>	
	t wa	100		100		200	_• _	1	
Combination	<u>. X.</u>	900		900		1500	7-B-2	1	[ ]
Carrier	Aft	200		200		300		1	
_	Fwd	150		150		300		1	
Containership	V I	1000		1000		3300 l	7_8_2		
-	Aft	300		300		600	7-0-2		
	Fwd	60		60		100	·····	<u> </u>	
Conerel Cerco	1 <del>-</del> - 1	200		200		1000			
General Cargo		200		200		1000	7-B-2		
	AIT	100		100		200			
	Fwd	70		70		100		1 1	
Naval	ואו	1200	20	1220	1.6	2700	/-B-2	1,2	11,16
	Aft	80		80		200		1	l í
	Fwd	70		70		100			
Tanker	ที่	500		500		800	7-B-2		
	Δ÷+	500		500		100	1-0-7	!	
	D	20						ł	<b>├</b> ────┤
	r wa	30		30		100			
Bulk Carrier	N 1	400		400		1700	/-B-3		1 1
	Aft	150		150		200		1	
	Fwd	40		40		100			
<b>Containers</b> hip	Ι X Ι	80		80 I		300 l	7-B-3	[	
	Aft	70		20		100			
	Fwd	120	··	120			·····	/	
Manallanacura	"n"	120		1200		200	7 7 7		
na scellaneous	X	1300		1300	1	4400	1-8-3	ł I	F
	AIT	300		300		400		[	
'	Fwd	120		120		200			
Naval	X I	600		600		1400	7-B-3		
	Aft	220		220		400	·		l l
	Fwd	80		- 20		300			
Tanker	1	5400		5400	1	10000	2 17 2		1
1.000201	100	5400		3400		T0000	C-0-1		Ĥ
	ALL C	400		400		600			
	rwa				1	. 1			1 1
Containership	<u>8</u>	300		300		400	7-B-4		1
	Aft								

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

~151~

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON S	ΗIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	1
SHIP TYPE	11	Details	Details	Details		on Ship	Numban			1
	<u> '</u>	Observed	Observed	Observed	ł		Humber		[	ł
	Fwd	40		40		200		1		1
Bulk Carrier	D D	100		100		600	7-C-1			
	Aft	70	}	70		200				Į
	Fwd	80		80		200		+		1
Combination	ס	60	<b>i</b> .	60		600	7-C-1	1		<b>↓</b>
Carrier	Aft	90		90		200	, 01		·	<b></b>
	Fwa	90		90		200				{
Containership	17	680	20	700	20	2000	7 - c - 1	1	14	1
i i i i i i i i i i i i i i i i i i i	A for	110	20		2.9	2900	/-0-1	1	14	╞╌┈╼┥
<u>}</u>	1	70				100				
Cananal Canao	1 2 1	400		400		100	7			
Constant Cargo	المما	700	16	400		2700	/-C-1		•	
}	AIU		10	90	1/.8				9	
M cool long and	1 2 2	00		60		100	7 0 1			
Mascellaneous	님겠니	80		80		400	/-0-1			
}	AIT	60		60		100				
	1 Mai	80		80		100				
Naval	0	200		200	1	300	7-C-1			
	Aft	<u>60</u>		60		100				
l .	Fwd	90		90 -		200		1		
Tanker	ומן	2586	14	2600	.5	4500	7-C-1	1	8	
]	Aft	200		200		400				
	Fwd	20		20		60				
Containership	¤	100		100		480	7-C-2			$\square$
-	Aft	20		20		60		1 1		
				20		-60		╋╾╌╍╌╸┤		
Miscellaneous	ที่ไ	20		20		00	7-0-2			T
and bock date out		20		20		40	7-0-2	1 1		
••••••		20		20		40		<u></u>		
	r wa	210		210		600	7 7 2			
Combination	121	900		900		7400	7-6-3			
Carrier	AIT			180		600				
	₽₩d	70		70		150				▲
Containership	<u>  X  </u>	490	10	500	2.0	1750	7-C-3	1	11	
	Ait	68	2	70	2.9	150		1	11	
	Fwd									
General Cargo	0					· 1	701			
	Aft	80		80		150	7-0-3			
	Fwd	90		90		200				
Tanker	¤	1600		1600	1	2600	7-C-3			
	Aft	90		90		200				
	Fwd							1		
Containership	ø	199	1	200	.5	300	7-0-4	1	11.14	0
-	Aft		-				, , , ,	1 - 1	,	l i
· ··· · · · · · · · · · · · · · · · ·	Fwd	200		200-	÷}	400		<u>+</u>		
Naval	Ø	2000		2000		4800	7-0-4			Ī
	AFt	400		400	ļ	-000	/-0-4			
L	<u></u>					000		I		

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, § , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

11. Neglect

12. Misuse/Abuse

13. Questionable 14. Heavy Seas

5. Shear

- 6. Tension
- 7. Combined Tension
- and Shear

- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes
- 10. Welding

LOCATION ON SH	ΠР	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	
SHIP TYPE		Sound Details	Failed Details	Number Details	Failures	Details on Ship	Family Number	Mode	Cause	
		Observed	Cbserved	Observed	· · · · · · · · · · · ·	<u> </u>				
Containership	Fwd M Aft	150		150		200	7-C-5			þ
General Cargo	Fwd Ø 4ft	40 20		40 20		50 20	7-C-6			_م
Combination Carrier	Fwd Q Aft	70 110 60		70 110 60		200 400 200	7-C-7	•		_
Miscellaneous	Fwd M	20 50	<u> </u>	20 50		50 100	7-C <del>-</del> 7			<b></b>
Containership	Fwd I	30		30		50	7-C <b>-</b> 8			4
General Cargo	Aft Fwd W	<u>150</u> 20		<u>150</u> 20		<u>200</u> 40	7-C-8			<b>†</b>
	Aft	20		20 .		60				
Bulk Carrier	Fwd X Aft	70 3000 120		70 3000 120		300 9000 700	7-C-9			0
Containership	Fwd M Aft	80		80		100	7-C-9			<b>1</b>
Naval	Fwd U Aft	96 1491 196	4 9 4	100 1500 200	4.0 .7 2.0	300 2100 600	7-C-9	1 1 1	11 11 15	
Tanker	Fwd M Aft	400 16000 1000		400 16000 1000		1000 27800 2000	7-C-9			<u> </u>
Containership	Fwd J Aft	.8	2	10	20.0	10	7 <b>-</b> C-10	1	8,9	đ
Combination Carrier	Fwd M Aft	10		10		10	7-C-11			-
Containership	Fwd M Aft	20		20		20	7-C-11			
General Cargo	Fwd M Aft	10		10		10	7-C <del>-</del> 11			
Combination Carrier	Fwd ) Aft	8	2	10	20.0	10	7-C-12	1	8	
Containership	Fwd M Aft	70		70		100	7-C-13			ф
Naval	Fwd M Aft	800 2000 1100		800 2000 1100		1200 8000 2300	7-C-13			
Naval	Fwd M Aft	40 30		40 30		200 200	7 <b>-</b> C-14			€

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

-153-

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SI	ΗIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	]
	1	Sound	Failed	Number	Failures	Details	Family	Lode	Cause	
SHIP TYPE	וגר	Details	Details	Details	ł	on Ship	Number			
	<b>'</b>	Observed	Observed	Observed					1 · · · ·	ł
	Fwd							1		1
Bulk Carrier	) X	:				1				I h
·	Aft	40	1	40		60	7-C-15	]		
	Fwd	_								
Combination	ו או					1				↑
Carrier	Aft	60		60		80	7-C-15	[		
	Fwd	20		20		40				· ·
Containership	N I						7-C-15	í		
	Aft	180		180		300		]		
	Fwd	10		10		20	7 0 15			
General Cargo	X						/-0-15	1		
	Aft	40		40		80	_	!		
	Fwd	10		10		20	7 0 15			
Miscellaneous	N N	30		30		50	/-C <del>-</del> 15	9		
	Aft	20		20		50				
	Fwd	10		10		50		[		
Naval	X	20		20		80	7-C-15			
	Aft	10		10		50				
	Fwd	300		300 -		1020				
Tanker	۲Ŭ	8000		8000		14000	7-C-15			
	Aft	800		800		2000				
	Fwd	40		40		50		1		•
Containership	y	300		300		350	7-C-16	1		
_	Aft	80		80		100				
	Fwd			<u> </u>			"	1	}	
Containership	۲T	300		300		400	7-C-17	1		
-	Aft	80		80		100			1	
	Fwd		<u></u>		·····			<u>↓</u>	<u> </u>	
Naval	Ϋ́	70	1	70	1	100	7-C-17	1		♠
	Aft	70		,,,,		100			1 1	
	Fwd							1		
Naval	ซ	78	2	80	2.5	100	7-C-18	1	10	Ь
	Aft		-					1 -		
	Fwd							<u></u>		
Netzell	17	60		60		80	7-C-19			
	AF+	10		10	ł	20		1	1	6-
	Fud	20		20		40			<u> </u>	
Containership	1 ซี ไ	20 59	1	<b>6</b> 0	1 7	300	7-D-1	1	1 14	- T
	Aft	50		50	±• '	60		1 -	l	
· · · · · · · · · · · · · · · · · · ·	Find	10		1-10-				ļ		15
Tanker	ן אין	110	2	120	1 7	240	7_D_1	1	1 1 1	
	Aft	40	-	40		60	, , ,			<b>⊢_</b> ∔
	Ewd 1							<u> </u>		
Bulk Carrier	[ \ \	20		20	ľ	200	7-D-2	1		ਿ ਜਾਜੇ
		104		120		200	1 1 2		0 10 13	╽╶╁╽┊╺
	<u> </u>	104	- 70 I	120	13.3	1 100 1		LT	y,10,13	

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, [m] , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section.

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- 5. Shear 6. Tension
- 7. Combined Tension and Shear
- 13. Questionable 14. Heavy Seas

11. Neglect

12. Misuse/Abuse

- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes 10. Welding

TABLE A-7

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SI	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
	1	Sound	Failed	Number	Failures	Details	Family	Mode ·	Cause	
SHIP TYPE	ן גו	Details	Details	Details		on Ship	Number		1	
	'	Observed	Observed	Observed		-				
	Fwd	40		40		100	7 5 3			
Containership	<u>p</u>			6		100	/-D-3	1		{[ †
	JAIT	60	ļ	60		100			ļ	1
	r wa	10		10		20	7-D-4			l m
Buik carrier	$A \neq +$	20	}	20		50	, , , ,	1		1 40
	5.4	10		10		- 20		<b>.</b>		
Containershin	г wu	20		20		170	7-D-4			
concarner ship	∆ ft	30	1	30		170				
	Tva	50		50		180				
General Cargo	ซ	50				100	7-D-4			
·	Aft	80		80		200				
	Fwd	40	• · ···-	40		100		1		1 📫
Tanker	X	1200	}	1200		2000	7-D-5			A
	Aft	80	<b>j</b> .	80	J	160		]		मिन
	Fwd	50		50		140		1		]
Bulk Carrier	N I	200	1	200		700	7-E-1	l		- <del>- •</del>
· .	Aft	180		180		340		<u></u>		1 T
	Fwd	40		40	_	100				
Combination	X	1200	4	1200		2000	7-E-1	1		
Carrier	Aft	120		120		200	<u> ·= .</u>	<u> </u>		
	Fwd	80		80		200	1	1.		
Containership	<u> </u>	396	4	400	1.0	1600	/-E-1	1	7,14	
	AIT		[	300		500		<b>.</b>		1
L	Fwd	70	1 ·	70		200	7 1 1			
Miscellaneous	1.2	200		200		1000	/-E-1			
<u>├</u>		1/0				2000	<u> </u>			
Norma 7	"#"	5000		5000		16000	7 6-1			
havar	, <del>Д</del>	1200		1200		4000	/-E-I	<b>I</b> 1		
	RUA	140		140		000				
Tenker	Ĩ	5410	90	5500	1.6	11000	7-E-1	1	8.16	
	Aft	700		700		1200			,	
	Fwd	20		20		40		<u>}</u>		Ì 🔶
Bulk Carrier	l m l	40		40		120	7-E-2			1 -{}}
	Aft	40		40		60				
	Fwd	20		20		40				
Combination	X	435	65	500	`13.0	800	7-E-2	2,3	8,14	1 <b>T</b>
Carrier	Aft	30		30		70		<b></b>	<b></b>	
	Fwd	20	1	20		60	7 10 0		ł	
Containership	1.2	100		100		360	/-E-2			
	AIT		<u> </u>					┟╴╴╴╸	ł	1
Tenker	"N	300		300		500	7-E-2		1	
IGHTET	Aft	40		40		100	,			<b> 4</b>
·	Fwd	20	{	- 20		50			}	1
Bulk Carrier	ซ	20		20			7-F-1			ተ
	Aft	50	]	50		100		ł		ł Ť
	Fwd	20	i	20		50		1	1	1 🔺
Combination	<b>v</b>	60	1	60		200	· 7-F-1	}	1	I T
Carrier	Aft	40		40		100				
	Fwd	30		30		80		1		1 1
Containership	X	150	1	150		500	7-F-1	1		
	Aft	120		120		270				1
	Fwd	20		20		40		1 -		
General Cargo	N N	60	1	60		300	7-F-1	1		<b></b>
	14.44	60	1			1 100		1	•	

-155-

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SH	ПΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
[	4	Sound	Failed	Number	Failures	Details	Family	Mode	Cause
SHIP TYPE	ו 1	Details	Details	Details		on Shin	Jumber		
	1	Observed	Observed	Observed			maneter	i i	[ ]
	Fwd	10		10		20			_
Miscellaneous	ŭ	60	1	60		150	7-F-1		
	Aft	40		40		60			
	Fwd	10		10	1	50		+	
Neval	Ϋ́	80	4	êñ.		300	7-F-1		
	Aft	60		60		100			
····	Furd	10				50	· · · ·		
Tanker	<b>'</b> <del>'</del> <del>'</del> <del>'</del>	220	1	220		400	7-F-1		
Idinici	λ <sub>f</sub> τ	150	1	160	6	250	, , , ,	1 1	
	AL 0	1.17	/	100		2.50			
	rwu W	10		10		20	7_6_2	1	
BULK Carrier	싰	50		50		180	/-r-2		}
	AIT	50		50		100		4	<b> </b>
	rwa	20		20		50		1	
Combination	<u>R</u>	150		150		250	/-1-2	ļ	
Carrier	Aft	60		60		150			
	Fwd	20		20		50			
Containership	I Ø	80		80		400	7-F-2		L
	Aft	115	5	120	4.2	200		11	10
	Fwd	10		10		30			
General Cargo	מן	70		70		300	7-F-2	1	
	Aft	80		80		150			
	Fwd	10		10		20			
Miscellaneous	) X I	90		90		200	7-F-2	1	
	Aft	40		40		80		1	
	Fwd	20		20		60			
Naval	) X	600		600		1400	7_〒_?	1	
	Aft	90		- ăn		300	1-1-2	1	ſ
<u> </u>	Fwd	20		20		60		- <u> </u>	
Tanker	8	120		120		300	7-F-2		
	Aft	140		140		300	1 5 2		
	10 m - 1	<u></u>		+				4	
Dealls Commission	ur wou M	10				20	7_〒_3		
Bulk Carrier	1 X	40		40		90	(-1-3	· · · ·	
	AIL			20		40			
~	rwa	10		10		30	^	1	
Combination	XI	30		30		90	/-1-3	1	} ∔
Carrier	Ait	40		40		80			
	Fwd	20		20		40		1	
Containership	8	30		30		110	7-F-3	·	
	Aft	50		50		100		<u> </u>	
	Fwd							1	
General Cargo	X	20		20		30	7-F-3		
_	Aft	20		20		40			
•	Fwd							1 1	
Miscellaneous	x	10		10		20	7-1-2		L
	Aft	10		10		30	/= <u>r</u> J		

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, [m] , and fwd refer to locations along the ship length. The

midship symbol row covers the mid-length

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  - 7. Combined Tension

and Shear

- 8. Design

15. Collision 9. Fabrication/Workmanship 16. Other - See Notes

13. Questionable 14. Heavy Seas

10. Welding

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON S	HIP	Number of	Number of	Total	Percent	Estimateã	Detail	Failure	Failure	l
	.	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	¥	Details	Details	Details		on Ship	Number			
	<u> </u>	Observed	Observed	Observed						
	Fwd	20		20		60			1	·
Naval	9	200		200		720	7-F-3		1	$\circ$
	Aft	50		50		160				_
L.	Fwd	10	[	10		40			1 1	•
Tanker	D A	50		50	1	120	7-F-3		1	
1	Aft	38	2	40	5.0	90		1	10	
	Fwd	_						1	1	
General Cargo	X									-
	Aft	10		10		10	7-F-4			-
	Fwd	· -· · · ·		···				+		
Tanker	<b>T</b>			]		1		1	] [	
	Aft	8	2	10	20.0	10	7-F-5	1	8.9	ے
{	Evid				20.0			+	+	
Containership	18							1		$\sim$
oonoarner snip	1,×+	30		20		100	7-8-6		1	<del>ر</del> ب
<u> </u>	5						<u> </u>			
Conoral Conco	1.20									
Guerar cargo	2			•		-	7 7 4	1		
<u> </u>	AIL	10		10		20	/-1-0	<u>+</u>		
	1Wa				-			1	1 [	
Ma scellaneous	1.2						7 7 7		1	
<u> </u>	AIT	10		10		20	/-1-0			
	Fyd								1	
Naval	🎗	50		50		200	7-F-6	1	1 L	
	Aft	50		50		200		1		
	Fwa								1	
Tanker	I ¤ (									
	Aft	30		30		100	/-F-6		1 1	
	Fwd							1		
Bulk Carrier	¥	20		2Ó		40	7-G-1		1 1	0
1	Aft	40		40		160			1 1	
	Fwd							1		
Combination	ן ען	-10		10		30	7-G-1	1		<b>≜</b>
Carrier	Aft	40		40		150	,	1	l F	
	Fwd							+	+	
Containership	ש	20		20		80	7-6-1			1
•	Aft	60		60		240.	7-0-1		↓ <u></u> }	
	Fwd							+	<u>+</u>	
General Cargo	โช ไ	10		10		20	7 0 1			
	AT+	20		20		40	/-6-1		! F	
	Fwd			20		40		†	·	
Miscellaneous	1 8 1	10		10		20	7 . 1			
	Δ <sub>ft</sub>	20		20		20	/-G-1			
	Ewa I	100					· · · · · ·	+	<u> </u>	
Moren 1	' Wu	100		100		300	7 0 1			
Havar		200		200		900	/GL	4	1 I	——————————————————————————————————————
	AIU	200		200		900			·	
	Ir Wa									
Tanker	쓰	150		150		200	7-G-1		I F	J
	Art	200		200		600		1	1 1	
	Fwd									
Bulk Carrier	夏	10	]	10		40	7-G-2	1	1	0
	Aft	50		50		110		ł	1	
	Fwd						7		11	
Combination	ا <del>بر</del> ا	150		150	ļ	800	/-G-2	1		T
Carrier	Aft	250		250		700		ł	1 · F	
	Fwd							1	+	
Containership	🛛	50 İ		50 l		250 İ	7-G-2			
-	Aft	90		- <u>60</u>	ļ	250		1	1	
								-		

LOCATION ON ST	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ł
	1	Sound	Failed	Number	Failures	Details	Family	Node	Cause	
SHIP TYPE	าไป	Details	Details	Details		on Shin	Number			
	T	Observed	Observed	Observed			number		1	
· · ·	Fwd		1				· · ·	<u> </u>		
General Cargo	1 Ø	10	1	10		60	7-6-2	1		0
j č	Aft	30		30	1	70	/ 0 -	1		
	Fwd				1			1		
Miscellaneous	۲Ŭ -	40		40	1	150	7-6-2	1	ļ	•
	Aft	40		40		100	1-6-2	1		
	Fwd	60		60	<u> </u>	200		1	l	
Naval	Ø	200		200		700	7-G-2			
	Aft	220		220		700	,			
	Fwd			<u></u>						
Tanker	ÎΫ́	10	]	1 10	1	80	7-6-2	ļ		
	Aft	60	1	60		100	7-0-2	1		
	Fwd	20	<u> </u>	20	<u> </u>	40		+	<mark>}</mark>	
Bulk Carrier	ំ អ	110		110	f	460	7-6-3	1		0
DULK CALIFEI		200		1 200		700	1.6.5	1		
·····	Dud	300	<u> </u>	1.300				<u>↓</u>		
Combination	m	200		200	1	100	7-6-3	1		. ♠
Combination	X	200	í	200	{	300	7-6-5	1	l -	
Carrier	Eurol	000	<u> </u>	40		1400		<u> </u>		
Containanahin	rwu mi	.40	! .	40		150	7 0 3		7 74	
concarner ship	<u>ж</u> лғ+.	159	1 1	1 100	••	1100	7-6-1	<del>*</del>	1,14	
	E A	500	<b> </b>	1. <u></u>		1100	····		···	
Conorol Corre	רשים ד	20		20		120	703	1		
General Cargo		30	<u>}</u>	30		130	/-6-5	1		
	AIU	80	<u></u>	80	<u> </u>	200		l		
	Гwu	10	1		l	20	7 9 9		ļ	
MI BCELLAREOUS	X A	30	1	30	1	100	/-G-3	1		
·	AL U			70		120		<u> </u>	· ·	
	L M J	500		500		1600		1	1	
Maval	N.	1800		1800	l _	5000	/-G-3	1.		
	ALU	2197	3	2200	•••	5600		<u>↓                                     </u>	/,8	
The places	rwa Y	50		50	·	170		1		
Tanker	H H	200	l .	200		400	/-G-3	.		<b>L</b>
	AIT	299	<u> </u>	300	3	800	· · · · · · · · · · · · · · · · · · ·		ΤŲ	
	Fwd						1			$\sim$
containersnip	<u>, M</u>	20		20		30 .	/-G-4			
	Ait							Į		
	rwd	10	ł	10		20			1	
Bulk Carrier	R	20	Ļ	20		60	7-G-5	1		0
	Ait	30	[	30	<b></b>	60		L		
	Fwd	•						1		
Combination	R		•	1			7-0-5	1		Ē
Carrier	Ait	20		20		40	7-6-5	I		
	Fwd		-							
Containership	<u>R</u>		4	1			705		1 1	
	Aft	80		80		200	1-6-5	1		

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

7

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, § , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

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5. Shear

6. Tension

- 7. Combined Tension and Shear
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

11. Neglect

15. Collision

8. Design 9. Fabrication/Workmanship 16. Other - See Notes

10. Welding

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SH		Number of	Number of	Total	Fercent	Estimated	Detail	Failure	Failure	
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	11	Details	Details	Details		on Ship	Number		{	
	ן ין	Observed	Observed	Cbserved	1	ļ — — <b>-</b>			[	
	Fwd		1	1		1		1		
General Cargo	) Ø		]		[	[				
-	Aft	20		20	•	40	7-G-5	ł		
	Fwd						<u></u>			
Miscellaneous	ช					ļ	Į.	1		
	Aft	20	i i	20		50	7-G-5	1		
}		<u> </u>	<u></u>	+	Í	ł	· · · · · · · · · · · · · · · · · · ·	- <del>{</del>		
	L.M.C			1	· .	ļ			1 1	
ranker			ŀ				7-0-5			
	AIT	60		60		120	7=0=5			Į
	Fwd	300		300	-	600		1.	1	
Bulk Carrier	ואן	1496	4	1 1500	-3	4800	7-H-1	1	9,14	T
	Aft	600	Ĺ	600		1400	_			1
	Fwd	366	34	400	8.5	900		1	18,10,15	
Combination	ע	1878	22	1900	1.1	6000	7-H-1	1	10,13,1	ь Т
Carrier	Aft	894	6	900	.7	1600	1	1	10,11	<b> </b> →→→→
· · · · · · · · · · · · · · · · · · ·	Fwd	271	29	300	9.7	1000	<b>1</b>	1	14.15	1
<b>ontainership</b>	ថ	3965	35	4000	.9	118000	7-H-1	ī	19.10.14	
······································	Ant	884	16	900	1 8	2440	,	1 1	9 10 14	
	5-0-1	900		900-		2000	÷			1
Ceneral Cargo	រ អ ា	1960	10	2000	20	2000	7 11 1	1	14 15	l i
ocherar cargo	1.2	1300	<b>TU</b> .	12000	2.0	3000	/-п-1	1 <b>-</b> .	14,13	
	<u> <u> </u></u>			1300		1.3000		· ·		
	TWO.	300	j	300		700			[	
misceilaneous	<u>, N</u>	1500	]	1500	ł	4500	7-H-1			d
L	AIT	400	l	400		1000	L			
	Fwd	60		60		200				
Naval	<b>Q</b>	797	3	800	.4	[ 1600	/-H-L	1	15	
	Aft	200		200	ł	300				
[	Fwd	597	3	600	.5	2000		1	5,15	
Tanker	۱X	6468	32	6500	.5	12000	7-H-1	1	5.7.8.9	
	Aft	1700		1700		3700				
	Fwa	120	· · · · · · · · · · · · · · · · · · ·	120	·	300	1			}
Combination	1 m	700	ĺ	700		2100	7 77 9			
Carrier	Aft.	200		200	1	2100	/-H-Z			1 -
	<u></u>	200	}	200	<u></u>	800	<u>م</u>	4	l	
	rwa	100		100	1	500	7 11 0	1		T
Naval	Щ	900	1	900		3500	/-H-2			
	Art	300		300		1000		1		Į
	Fwd	100		100		400			1	ł
Containership	N N	792	8	800	1.0	3300	7-H-3	1	14	
	Aft	200		200		800		1	1	
	Fwd	200		200		600				1
Naval	8	1200	1	1 200	1	3800	7 <b>-</b> H-3	1	ŀ	ΙT
	AFt	1200	2	1 200	10	0000		1 2 2	15	
}	5.7	20	<u>}</u> €	<u>+</u>		500	+	+ <u></u>		
Tenker	หั	20		20	1	100	7-H-3	1		I Ì
IGHNEI	1.6+	30		30		100		1		
	HLL L	20		20	Į	50			<u> </u>	
L	h Mq	1 2 2 2 2	[ ·	1 1 2 2 2	1	2000	7.11_/	1		
Tanker	본	1200		1200		2000	/-n-4		-	
	LAIT.			<u> </u>	L		L	I	<u> </u>	Į
	Fwd	260	40	300	13.3	2000		11	15,14,15	
Bulk Carrier	14	•4800	1	4800	1	24000	/−H−5	1	1	
	Aft	784	16	800	2.0	4000	Ì	1	14	j
	Fwd	600		600		3000	1	1	1	1.
Containership	ថ	2600		2600	1	13000	7-H-5	1	1	1
····· •	Aft	1200	l	1 1200	[	6000	1	1		
h <del></del>	Tv3	600	1	600	t	3000	<u>†                                    </u>	· †· · · · · · · · · · · · ·		1
Miscellaneous	1	2600	1	2600	1	113000	7-H-5	1	1	1
	Ar+	1200	1	1200		6000		1	1	I
<u> </u>	104.0		· · · · · · · · · · · · · · · · · · ·	1 1200	1	T_0000	1	1	]	J

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SI	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	]
	_ 1	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	1
SHIP TYPE	ו גר	Details	Details	Details		on Ship	Number		]	
	'_	Observed	Observed	Observed		-		Į		
	Fwd	60		60		300		f	(	1
Tariker	X	1400		1400		7000	7-н-5	i .		-
	Aft	140		140		700		i		
	Fwd	500		500		2000		<u>}</u>		1
Tanker	1 หื	10000	1	10000	1	24000	7-н-6			
1000101	A P+	10000		10000	ł	24000	,	!		
··· ··· · · · · · · · · · · ·	EWA	800		800		4000		{	·	1
Concerci Conco	ਜਿੱ	100		1 100		600	7-8-7	i i		ł
Seller ar Cargo		100		100		600	/ 11 /			-
	AIU	/9	<u> </u>	80	1.2	200			8,12	1
Be velo est	L MU						~ ~	1		! '
Lanwer	냈	600	1	600		1200	/-n-/	[		
	TIA	50		50		200		1		
	Fwd	40	1	40		100	7-H-8	1	1	
Bulk Carrier	🎗			]	1	(	7-11 0	l	• ·	-
	Aft		L						J	[
	rwd	30		30		100	· · · · · · · · · · · · · · · · · · ·	f		
[anker	[)ĭ ]	400		400		800	7-H-8	1		
	Aft	60		- 00- - 00-		200	,	1		
·····	Fwd	200	<u>⊧</u>	200		1000		<u>}</u>	<u> </u>	1
ulk Carrier	η Π	1200		1200		7000	7_H_Q			-
	A ++	1200		1200		2000	7-11-5			ļ
	5.4	400		400	· ··	2000				
	Two I	200		200			7 77 0			
compination	1.2	700		700		3500	/-H-9			-
arrier	AIT	300		300		1000				
	rwa	1800		1800		8800				
containersnip	12	10000		10000		51000	7-H-9			
	AIT	3000		3000		15000				
·	Ŀ₩а	500		500		2500		1		
eneral Cargo	9	4000		4000		18000	7-H-9			
	Aft	1000		1000		4500				
	Fwd	300		300		1000				
fiscellaneous	X	1500		1500		7000	7-H-9			
	Aft	7.00		700		2000				
	Fwd	1000		1000		3800	· _ · _ · _ · _ · _ · _ · _ · · _ · · _ ·			
aval	X	7000		7000		22000	7-H-9			
_	Aft	2000		2000		6000	· •	1		
·	Fwd	2000		2000		8000				
anker	∦	25000		25000		65000	7_H_Q			
	Aft	4000		4000		17000	7-11-9	(		
	Fwd	200		200		600		[		
ulk Carrier	โ ซ โ	1000		1000		4200	7-11-10			· ·
		500		500	1	1200	/-n-10			
	Evd	- 300		- 300		1200				
embinetics	r wu Yy	3000		400		1000	7			
ompination	X	3000		3000		11000	/-H-IO			L
arrier	ALU	800		800		3000				
	rwa	400		400		2000	_			
ontainership	N I	2500		2500		12800	7-H-10			
	Aft	900 l		900		3000 L	-			•

NOTES:

- (A) The above continued table gives information related to individual detail designs
- in the 50 ship survey.
- (B) The rows labeled aft, ), and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for
- failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

  - 5. Shear 6. Tension
  - 7. Combined Tension
  - and Shear
- 13. Questionable 14. Heavy Seas

11. Neglect 12. Misuse/Abuse

- 10. Welding
- -160-
- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes

DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SI	HTP	Number of	Number of	Total	Percent	Estimatei	Detail	Failure	Failure	
		Sound	Failed	Number	Failures	Details	Family	Hode	Cause	1
SHIP TYPE	]↓	Details	Details	Details		on Ship	Number			1
	'	Observed	Observed	Observed		-				
	Fwd	200		200		800		1		1
General Cargo	🕅	1284	16	1300	1.2	6000	7-H-10	1	12	। <del>ज</del>
	Aft	400		400		1800		_	_	1
	Fwd	100		100		200	•••••			
Miscellaneous	) X	300		300		1000	7-H-10	{ }		♠
	Aft	100		100		300				
( · · · ·	Fwd	400		400		2000				
Naval	) X	2800		2800		14000	7-H-10			
	Aft	800		800		4000		1		
	Fwd	200		200		680	·			
Tanker	X	2500		2500		5600	7-H-10			l
	Aft	500		500		1500				
	Fwa	9	1	10	10.0	20	711	1	8,14	
Tanker	X					í	/			<del>-</del>
	Aft					ļ				ר
	Fwd				·				·	
Combination	D I					] [				
Carrier	Aft	47	3	50	6.0	100	/-H-12	1	13	
	Fwd									
Containership	Į X					[	10			
	Aft	100		100		200	/-H-12	•		
	Fwd									
Tanker	X									_ل
	Aft	50		50		100	7-H-12		1	•

## TABLE A-8

DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON ST	ΠP	Number of	llumber of	Total	Percent	Estimated	Detail	Failure	Failure	
	. !	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE		Details	Details	Details		on Ship	Number			1
		Observed	Observed	Observed			· · · · · · · · · · · · · · · · · · ·		l	ł
General Cargo	Fwd M Aft	234	36	270	13.3	300	8 <del>-</del> A-1	1.	8	
Containership	Fwd M Aft	150		150		400	8-A-2		-	
Bulk Carrier	Fwd X Aft	150 300		150 300		500 1500	8 <del>-</del> B-1			
Containership	Fwd M Aft	100		100		200	8-B-1			Ļ
Combination Carrier	Fwd X Aft	19	1	20		30	8-B-2	1	8,9	.
Containership	Fwd Ø Aft	39	1	40	2.5	50	8-B-2	1	9	
General Cargo	Fwd X Aft	30 100		30 100		200 300	8-в-2			<u> </u>

-161-

DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON SI	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	]
	_ 1	Sound	Failed	Number	Failures	Details	Family	Node	Cause	1
SHIP TYPE	]↓	Details	Details	Details	1	on Ship	Number	1	1	
l	<u>} '</u>	Observed	Observed	Observed				i		Į
	rwd	150		150	•	400				
Tanker	)¤	1958	22	1980	1.0	3870	8-B-2	1,2	8,11,1	2 7
	Aft	496	4	500	.8	1300		1	8	
	Fwd			1				1		1 ♠
General Cargo	I X		[	l			8_B_3	1		
	Aft	50	l	50		100		<u> </u>	ļ	ł
	Fwd					53.00		1	1 .	
Tanker	D :	2400	ļ	2400		5100	8-8-3			
	Aft	100	l	100	l	200		4	ļ	Į
1	Fwd			Ì				1		
Bulk Carrier	R		1			100	8-B-4			1 $1$
ļ	Aft	40	l	40		100	<u> </u>	1	l	{ -
L .	Fwd		}	]				1		
Naval	8		ł		1	200	8-B-5			
	Aft	70	l	/0	<b> </b>	200	<u> </u>		L	
L	Fwd			1	1	<b>i</b> 1		1		
Containership	1 2	100		1 100	]	400	8-8-6			
ļ	AIT	TRR	2	190	<u></u>	400	010	<u>}                                    </u>	5,10	
	Fwd	80		80		200	8-C-1	1		
Tanker				1 I						
l	Ait		L	<b> </b>						لى ا
L .	Fwd	300		300		900	000			
Tanker	12	628	72	700	10.3	3000	8-0-2	1 1	14	
L	TIA	70	l	70		100				7
	Fwd	300		300		900	000			- 4
Containership	<u>,                                    </u>	1100		1100		5500	8-0-3			
	AIT	59	1	60	1.7	100		<u>[ 1</u>	9	
]	Fwd	100		100		400	8-C-4			
Containership	9			í		1				
	AIT		l	l			·	L		
	Fwd	68	2	70	2.9	200	8-C-5	1	14	
Containership	1.2									1 1 /
	Art	650		650		1400		L		
	Prwal	40		40		100		1		
Bulk Carrier	쓰	400		400		1800	8-C-6	]		]]
	AIT	40		40		100				60
	[Fyd]	80		80		200	8-C-6			
Miscellaneous	민씨						000			T
	AIt					ļ		I		
L .	Fwd									
Tanker	빈원						8-0-6	1		
	Aft	200		200		500	0-0-0			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 50 ship survey.
- (B) The rows labeled aft, ♥, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for
- failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.
- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
  - 5. Shear
  - 6. Tension
  - 7. Combined Tension
  - 14. Heavy Seas C. Design 9. Fabrication/Workmanship 16. Other - See Notes 10. Welding

12. Misuse/Abuse

13. Questionable

DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON ST	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ר
	<u> </u>	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	ו גו	Details	Details	Details		on Ship	Number			1
	1	Observed	Observed	Observed				1		
	Fwd	400		400		1000				1
Bulk Carrier	) y	3200		3200		16000	8-C-/		1	
	Aft	1100		1100		3000				
	Fwd						0 0 Ż			1 ♠
Containership	N N	150		150		800	8-0-7			1
·	Aft			<u>.                                    </u>				<b>I</b>		
	Fwd							1.		
Containership	( P	146	4	150	2.7	400	8-D-1	1 1	9	1 1
	Aft	50	· ·	50		100		ļ		
Ł.	Fwd		l i	1						•
Tanker	Д			150		300	0 1			
ļ	AIT	150		150		300	<u> </u>	<b></b>		
Mapleon	L MC	100	45	100		2000	0 7 2		89	
Tanker	1	/55	40	150	5.0	2000	0-D-2	<b>1</b> <sup>▲</sup>	0,5	
f	Trad	150	ł	1	ļ					4
Bulk Carrier	ĥ		[							
DULK CATILLY	Δft	80	5	80		200	8-D-3	1		ΙU
<u> </u>	L. rd		· · · · · ·			200		{	·	
Containership	π							1 1		
oomoarner sarp	Aft	60		60		100	8-D-3			┣┅────┛
·····	Fwd	60		- 00						l
General Cargo	ี ซั ไ									
Jeneral ourgo	ATt	60		60		100	8-D-4			ĮΘ
	Fwd	50		50		150	<u>_</u> ;;			
Miscellaneous	X I	240		240		800	8-D-4	•		1 1
	Aft	100		100		250				h4
	Fwd									
Containership	N	146	4	150	2,7	500	8-D-5	1 1	5,8	
	Aft									
	Fwd	170		170		600	÷ *			♠
Tanker	<u> </u>	1880	120	2000	6.0	8800	8 <b></b> D5	11	5,8	
ļ	JIA	400		400		1300			·· · · · · · · · · · · · · · · · · · ·	·
	Fwa	500	250	500		1400	9_D_6		E 0 31	┟╻╶╌┱╌╴
Combination	X	3850	350	4200	8.5	10300	0-0-0	-	<b>,,,,</b> ,,,,	Ľ, Ľ
Carrier	Ewd i	900		900		2000		ł		
Miscellaneous	Π	2100		60		200	8-D-6			▲ 1
- Decimente	Aft	2100		2100		1000	0 2 0		1	
······	Trud	300	·····	- 300.1			· · · · · · · · · · · · · · · · · · ·	\		
Tanker	''	50 5 <b>7</b> 0	70	600	11 7	1100	8	1 1	Q 14	
	Aft	100	10	100	11.1	100	0-0-0	1 1	0,14	
· · · · · · · · · · · · · · · · · · ·	Fwd	30						┟╍╴────╂		· · ·
Tanker	Ŭ	90		90		300	8-D-7			
	Aft	60		60		200				Ð
	Fvd					ł		├─── <b>┤</b>		
Miscellaneous	IX I					4	0 - 0			
	Aft	70		70		200	8-0-8			Ð
	Fwd									▲
Tanker	) X	300		300		800	8-D-8			T
	Aft				[	` ł			ł	
_	Fwd	90		90		300	_			
General Cargo	X	400		400		1600	8-E-1			
	Aft	30		. 30		100				

-163-

DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON SH	ΠΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	i
	1	Sound	Failed	Number	Failures	Details	Family	Node	Cause	
SHIP TYPE	111	Details	Details	Details		on Ship	Number	}		
	ן זן	Observed	Observed	Observed	f			1		
	Fwd	126	14	140	10.0	350		1	8,14	
Bulk Carrier	ש	900		900	, i	5000	8-E-2	4		
	Aft	200		200	Į	600	•	1		
}	Fwd	210	<u>}</u>	210		660	·	1		
Containership	<b>v</b>	949	1	950	1 .1	5700	8-E-2	1	5.10	•
, our of the second participation of the second participat	Aft	400	1	400	1	1240		-		
	Fwd	148	2	150	<u> </u>	500		1	14	
General Cargo	ซ	870	1 -	870	1	4000	8-E-2	-		
00.001 GE 000.80	A A	300		300	1	900		1	1	
	Twd	110	+ ~···	110		300	<u> </u>		f	
Tonkan	<b>T</b>	100	1 11	1 420	26	1400	8_8_2	1	8 14	
Taurei	1	409	1 11	720	2.0	300	0-6-2	-	0,11	
		90				350	·		<b></b>	
	Fwd	100	[	1 100			8-E-3		1 1	
Containership	[		Į							لے ا
	AIT		ļ				·			
	Fwd	60		60		100	8-E-3			•
Fanker	D D					1				ł
	Aft		· · · · · · · · · · · · · · · · · · ·							
	Fwd				•		0 - 1			
Bulk Carrier	I X I	120	Į.	120		400	8-E-4	1		
	Aft		1		}	1		j		
	Fwd	146	4	150		500		1,2	15	<del></del>
Tanker	M	2376	24	2400	1.0	5800	8-E-5	1.2	5,14	
	Aft	100		100		300	•	ł		
}	Fwd	200	· · · · · · · · · · · · · · · · · · ·		1			1		
Bulk Carrier	4								1	
	Aft	98	2	100	2.0	3.50	8-E-6	2	15	
┝╴ ────	5.00	220		230	4	700		f 1	15	
	Г Wu	229	16	2500	1 6	0000	8-8-6	2	14,15	
franker		2484	10	160		400	0-7-0	-		
}	AL U	100	1 1 1 1	100	100	200		<del>}</del>		·
	rwu	108	12	120	10.0	300	0 77 7	1,2	8,14	
Combination	X	110		110		300	0-E-/			
Carrier	AIT		ļ					ļ		
	Fwd	120		120		400			1	
Containership	1 2	1500	1	1500	ν.	9000	8-E-8			
	Aft	200	<u> </u>	200		600		<u> </u>	1	
	Fwd	140		140		400				
Containership	X	2200		2200	]	9000	8-E-9			
	Aft	260	1	260	1	600		1		U.
	Fwd		1	<b></b>						
Tanker	M	920		920	· ·	2100	8-E-10			- 4
	Aft							1		U
	Twa	·	<u>}</u>	<u> </u>	<u> </u>	<b></b>	·		<u>t</u>	
Tenker	17	800		800	1	1500	8-E-11			
1 44400	AF+				]	1 1000				U U
b	100-0		,	ł		<u> </u>			<b>•</b> i	
	L Ma	1200		1200	ł	2200	9	1	1	
Tanker	[쓰]	1200	l	1200	1		0-6-12	ł	4	U
1	IATtl		1		1		1			

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, M , and fwd refer to locations along the ship length. The

midship symbol row covers the mid-length

throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for

failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

5. Shear

6. Tension 7. Combined Tension

and Shear

- 11. Neglect 12. Misuse/Abuse
- 13. Questionable
  - - 14. Heavy Seas
- 8. Design
- 10. Welding
- -164-
- 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes

DETAIL FAMILY: STRUCTURAL DECK CUTS

TOCATTON ON SI	TP ]	Number of	Number of	Total	Percent	Fstimated	Detail	Failure	Failure	1
SHIP TYPE	וּוּן	Sound Details	Failed Details	Number Details	Failures	Details on Ship	Family Number	Mode	Cause	
Bulk Carrier	Fwd U Aft	20	00301104	20		30	'9-A-1			0
Combination Carrier	Fwd M Aft	10		10		10	9 <b>-</b> A-1			
Containership	Fwd M Aft	10 10		10 10		10 20	'9-A-1			
General Cargo	Fwd M Aft	10		10		10	9-A-1			
Tanker	Fwd M Aft	900		900 30		1230	9-A-1			
Combination Carrier	Fwd X Aft	20 10		20 10 10		40 30 10	9-A-2			D
Containership	iwd M Aft	10 10		10 10		10 10	9-A-2			
General Cargo	Fwd Ø Aft	10		10		10	9-A-2			
Miscellaneous	Fwd ∭ Aft	10 20 10		10 20 10		10 30 10	9-A-2			
Tanker	Fwd M Aft	20		20			9-A-2	·		
Bulk Carrier	Fwd X	20 20 20		20 20 20		30 40 30	9-A-3			
Combination	Fwd X	20 40 20		20 40 20		20 100 20	9-A-3			<b>•</b>
Containership	Fwd X	20 30 30		20 30 30		30 60 50	9-A-3			
Tanker	Fwd M	20		20 <sup>.</sup>	17	20	9-A-3	1	8	]
Combination Carrier	Fwd X	10		10		10	9-A-4			
Naval	Fwd M	10		10		10	9-A-4			<b>•</b>
Tanker	Fwd	10		10		10	9-A-4			
Combination Carrier	Fwd X Aft	20 90 30		20 90 30		30 140 40	9-A-5			$\bigcirc$
Containership	Fwd M Aft	30 50 30	-	30 50 30		40 110 50	9-A-5			

DETAIL FAMILY:

STRUCTURAL DECK CUTS

LOCATION ON S	HIP	Number of	Number of	Total	Percent	Fetimated	Detell	Trailung	Pailuna	<b>1</b>
	1	Sound	Failed	Number	Failures	Details	Detall Comile	Node	Cauco	ł
SHIP TYPE	ור	Details	Details	Details		on Shin	Number	1.0ue	Cause	1
	1	Observed	Observed	Observed	1		Number		[	
	Fwd	20	[	20		20	· ·		}	1
General Cargo	) Ø	30	•	30	l	60	9-A-5			
	Aft	30		30		40				$  \cup$
	Fwd	80		80		120				
Miscellaneous	ΙØ.	60		60		100	9-A-5			I T
	Af+	150		150		220	5 44 5	1		
	Fwd				····					4
Combination	ס	10		10		10	0_1_6	1		
Carrier	Aft						JAU			
	Fwa						·	<u>∤</u>		
Miscellaneous	5	10		10		10	0-1-6			♠
	Aft	10		10		10	9-A-0	1		
}	12.4									
Tenker	17	10		10		10	0 4 6			
Tartier	1 A F+	10		10		10	9-A-0	1 I		<b></b>
	141 L				AT 4000 000					ļ
David and and	гwа	30		30		40	o			
Bulk Carrier	시 것	30		30		60	9-A-7			
ł	JAIU									ţ
	H Ma									
containersnip	1.2.1					Í				LT
- <u></u>	AIT	10		10		10	<u>9-A-7</u>			
<b>L</b> 1	lr Wa					)				
Tanker	신신				i					
	AIT	10		10		10	9-A-7			
L.	l Mal									
Tanker	보	250		250		340	9-A-8			$\Box$
	Aft			·		1				
	Fwd	20		20		30				
General Cargo	I X	40	4	40	1	120	9-A-9			$\bigcirc$
	Aft	40	ļ	40		50				$\bigcirc$
	Fwd							· f		
Tanker	X	60		60		60 [	9-A-9			
	Aft	1	ł	ſ		1			1	
	Fwd	10	Ì	10		10				
Bulk Carrier	W I	50		50		80	9-B-1		1	$\circ$
	Aft	10		10	1	20				0
	Fwd									
Containership	ซิไ	26	4	30	133	40	9-B-1		10	<b></b>
r	ATL		-		13.5			-	10	
				·						-
Miscelleneous	<b>1 H</b>						0 0 1		1	
AT SCETTOTICOUS		10	1	tol	1	20	7-8-1		ł	
	RL U Trud		[							
Norml	r wu	30	l	30	l	50	·		1	
1104 Y 04-T		120	ľ	120	ļ	200	9-B-T		ł	
	AIT	40		40		60			Ĩ	

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, [m] , and fwd refer to locations along the ship length. The

midship symbol row covers the mid-length

throughout the entire cargo section.

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and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect

5. Shear

6. Tension

7. Combined Tension and Shear

13. Questionable 14. Heavy Seas

12. Misuse/Abuse

8. Design 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes

10. Welding

DETAIL FAMILY: STRUCTURAL DECK CUTS

LOCATION ON SE	ΠP ]	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	]
SHIP TYPE	3 [ ]	Details	Details	Details		on Shin	Numban			
	1	Observed	Observed	Observed	1		NG. DEL	1		}
<u> </u>	Fwd	10	0000000	10	<u>†</u>	20			<u> </u>	1
Tanker	X	10	1	1 10	1	20	9-B-1			
	Aft	10		10		1 10		1		
	5-4-1	10		10	<u> </u>	10			ł	4
Combination	1	10		10	1	10	Q_B_2	1		
Compliantion	1,44		1		ļ		1 2 2			
Carrier	Euro I		<u> </u>		<u> </u>		· · · · · · · · · · · · · · · · · · ·		<u> </u>	4
Containenshin	1 ซี ไ	40		40		60	0_12_2	1		
concarner surp	1	10	1	10		20	3D-2			
	200			<u> </u>	<u></u>	20		<u> </u>	<u> </u>	
Conomel Comao	l m	20	-	20	!	1 40	0 0 2	1		
General Cargo		20		20	!	40	9-6-2	[		h
	410							<u> </u>	I	1 1
L	I WO	20	ì	120	1	30	0 7 9			
Ivava⊥	냈	120		120		100	9-8-2			
	AIT	10		10	Į	++0	· · · · · · · · · · · · · · · · · · ·	I	[	
	rwa Y	10	ł	10	1		9-B-2			
Tanker	1.2	10		10		10	,	!		1
	AIT	10	ļ	10	ļ	20		<b>↓</b>	<u> </u>	4
	Fwa	10		10	1	10	9-B-3			
Combination	1 X	69	ſΙ	70	1.4	140	, , , ,	1 -	8	
Carrier	AIt	10		10	ļ	10		• • • • • • •		1
	Fwd	40		40	1	70	_		1	
Containership	<u>, x</u>	110	Į.	110		260	9-B-3	]		
	Ait	20		20		30		<b>_</b>		1 1
	Fwd	_	1					1	1	1 1
Miscellaneous	9	20		20	1	30	9-в-3		1	<b></b>
	Aft	10		10		10		l		
	Fwd	40		40	1	· 60				1
Naval	🎗	260		260	1	360	9-B-3			h
	Aft	80		80		110				
	Fwd	20	ľ	20	i	30			1	
Tanker	<b>A</b>		1				9 <b>-</b> B-3	1		<b>j</b> l
	Aft	40		40		50				1
	Fwd		1		1			1		
Bulk Carrier	N I	20	1	20		40	9-8-4	1		
	Aft			1				ļ	j –	
	Fwd	10	1	10		10				
Miscellaneous	X	10		10		20	9 <b>-</b> B-4		1	
	Aft									
	Fwd	10		10		20	4			1 1
Naval	X	20	1	20		20	9 <b>-</b> B-4			!
	Aft									
	Fwd		-							1.
Tanker	M I			ł						
	Aft	10		10		10	9-B-4			
	Fwd									
Bulk Carrier	N I	20	l .	20		30	0_9_5	1		
L	Aft	10	<b> </b>	10	L	10	<u></u>	L	1	1
	Fwd	10	1	10	1	20	_	1	1	▲
Combination	ĮΧ ∣	20	1	20		30	9-B-5	1	1	
Carrier	Aft	20	L	20		40		1	L	
	Fwd	80		80	1	100	0 = -		1	
Containership	ĮXI	70		70	1	290	9-B-5		1	
	Aft	90		90		160		<u> </u>		<u> </u>
	Iwd	10		10		20				
General Cargo	1 M I	30		30		40	9 <b>-</b> B-5	1	1	╞╌╍╾┩
t	<b>Aft</b>	10	1	1 10	1	1 20		I	ł	1

-167-

DETAIL FAMILY:

STRUCTURAL DECK CUTS

LOCATION ON SH	ΠР	Number of	Number of	Total	Fercent	Estimated	Detail	Failure	Failure	1
[	F	Sound	Failed	Number	Failures	Details .	Family	Mode	Cause	J
SHIP TYPE	าไ	Details	Details	Details	ļ	on Ship	Number	1	i	Į
	11	Observed	Observed	Coserved	ļ				1	[
	Five	10		10		10	····	1		1
Miscellaneous	ี ซี	10		10	· ·	20	9-B-5	[	ĺ	$\square$
THE SCOTTONE OF ST	AF+	10	Ļ	10		10	•			
}	540		}	60				1		
	L MO	60		200	[	420	0_18-5	1		1 1
Naval	N N	300	<u> </u>	300	]	420	3-0-5		1	<b>}</b>
	AIt	110	ļ			140		<b></b>		4 1
l .	[Fwa]	50	í	50	ľ	60		1	1	1
Tanker	L D	50		50	1	60	9-B-5			<u>}</u>
	Aft	60		60		70				]
<u>}</u>	দিন্দুন							<u> </u>		
Combination	ί m̃	10		1 10		10	9 <del>-</del> 8-6	1		
Combination	AF+	10		, <b>*</b> *	Į		, , , ,	l		
Carrier	A - C		{	<b></b>	<b>∲</b>			{	<u> </u>	1
	1: Wa		[	1 30	ĺ	1 20	0 8 6	1	1 1	4
Containersnip	<u>×</u>	10	ſ	L TO		20	9-6-0			
	Art						 	<b></b>		1 1
[	Fwd		l	Ì	l	1 1		ł		
Tanker	M	20		20		20	9 <b></b> B-6			
	Aft							i		Į
}	Fvd							1		
Norm	Г н Т		1				_	1	[	
HAVAL	No.			10		1 10	9-B-7	1		-
	ALL	10	<u> </u>					<u> </u>	{	i 🔺
	r Wa	i i i i i i i i i i i i i i i i i i i	Í		Í	1		ł	ł	1
Tanker	μ.	1					9-B-7			<b> </b>
}	[Aft]	j 10	<u>ا ا</u>	10.	]	10	, , , ,			Į
	r vd					}		1		
Bulk Carrier	ען	30	l	30	ł	50	9-C-1	1		
	A Ct.	-	1	{						44
}	मि पत							1		
Combination	Γ'n Ι	20		30	{	30	9-C-1	1	1	[ [
Compination	X.	30	1	1 30			, U T	1		
Carrier	AL C	ļ	}		<b>}</b>	<u> </u>		╂─────	}	1
	FMG		-					1 .	6	
Combination	🗵 '	4	6	10	0.00	10	9-C-Z	1 -	0	1 11/
Carrier	Aft.	J	l	)	J	}	ļ	}	/	
	Fvd				}_	1		1		
Combination	ש	20		20		20	9-C-3			FV-
Carrier	A-+							j.		Ψ
Vallier	Fwd	<b> </b>		f				<u> </u>		1 🔺
Containanchin	ที่	40		40		100	0_0_3	[	[	( í
Containership	1.2	40	ļ.	40	l		9-0-5	1		
i	AIT				ļ	<u>}</u>		<u> </u>	┟┍─┈╼┙	
	Fwd		1	1	1		0.01	1	1	
Bulk Carrier	N N	40	l I	40	l I	80	9-0-4	1	ł	
	Aft							I		
	Fwd					1		1	ļ	IT
Combination	[ ซ ]	1 100		100		120	9-C-4	1	1	
Convior	AT+		1		1	ł		1		
•	10.4 0									-

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, **b**, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

11. Neglect 5. Shear

6. Tension 7. Combined Tension

and Shear

- 12. Misuse/Abuse 13. Questionable
  - 14. Heavy Seas
- 8. Design 9. Fabrication/Workmanship 16. Other See Notes
- 10. Welding

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted. respectively.

DETAIL FAMILY: STRUCTURAL DECK CUTS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
SHIP TYPE	ן	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Çause	
Containership	Fwd Ø Aft	260		260		850	9-C-4			
General Cargo	Fwd M Aft	180		180		320	9-C-4			<u> </u> ↑
Containership	Fwd Ø Aft	10		10		<u>,</u> 20	9-C-5			
Bulk Carrier	Fwd N Aft	30		30		40	9-C-6			
Containership	Fwd M Aft	30		30		70	9-C-6			†
General Cargo	Ewī M Aft	. 90		90		160	9-C-6			
Naval	Fwd M Aft	40		40		50	9-C-7			

TABLE A-10 DETAIL FAMILY: STANCHION ENDS

1

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Dode	cause	_
Combination Carrier	Fwd D Aft	10		10		10	10-A-1			រ
Containership	Fwd M Aft	8 14	2	10 20	20.0 30.0	10 20	10-A-1	1	8, 10 8, 10	Î
Containership	Fwd X Aft	99 20 20	1	100 20 20	1.0	120 30 30	10-A-2	1	6,10	T T
General Cargo	Fwd Ju	20		20		20 20	10-A-2			
Miscellaneous	Fwd M Aft	50 130 60		50 130 60		50 210 60	10 <b>-</b> A-2			
Tanker	Fwd M Aft	20 10 20		20 10 20		20 10 30	10-A-2			
Miscellaneous	Fwd M Aft	10		10	_	10	10 <del>-</del> A-3			Ţ
Naval	Fwd D	50 150 30		50 150 30		50 200 50	10-A-3			

-169-

DETAIL FAMILY:

STANCHION ENDS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	
1		Sound	Failed	Number	Failures	Details	Family	Node	Cause	
SHIP TYPE	ן ↓ר	Details	Details	Details		on Ship	Number		1	
	1	Observed	Observed	Observed	1	] -				
	Fwd	20	t	20		20		f	[	┯┅┱┯┷
Naval	۲Ų (	70		70		90	10-A-4	J		╵┶┽┥
	Aft	20		20		30				
	Rud	20		20		20		· · ·	<u></u>	8
Containership	ี ซี	20		20	1	20	10-4-5	1		<b>U</b>
Concarner surp	1				1		10-A-2	1		
	AL U							ļ	· · ·	ีน ม
L .	I'Wa	20		20		30				<b>1</b>
Tanker	1.2						10 <b>-</b> A-5	1		I T
	AIC	20		20		20			Į	¥
	Fwa			t	1	1				177
Bulk Carrier	N R					• •	10.00	1		H
}	Aft	20	ļ	J 20	[	] 20	10-A-6	1		
	Fwd							1	· · · ·	64
Bulk Carrier	∏ ∏ · I			1		1				
	Aft	10		10		10	10-A-7	[		Π
	Fwd	20		20		30				u
Combination	ס	_		1 -			10 4 7	1		
Carrier	Aft	20		20		20	10-A-7	1		
	Twd			(			···· ··· ···	{	f	
Torker	1 8						10 1 0			·
Talker	1.54	20		20		20	10-A-8			11
<u></u>	AI U	20	···· · · · · · · · · ·			20	· · · · · · · · · · · · · · · · · · ·	ļ'		6
	FWa									1 1 1
Buik Carrier	<u> </u>	• •				1.0	10 4 0			- H-
	Ait	10		10		10	10-A-9			
	Fwd					_				6
Naval	A	20		20		20	10-A-9			•
	Aft	20		20		20			l t	·····
	Fwd									<del>- 11</del>
Combination	ועו									
Carrier	Aft	10		10		10	10-A-10			11
	Fwal									
General Cargo	8								i l	•
Contract Con Bo	المتجدا	10		10		10	10-A-10			
<u>├───</u> ─────										
Netro 1	1	10		10		10	10 4 10			
haver	나았다	20		20		30	10-A-10			
		20		20	·	30				
	Fwg	20		20		<b>Z</b> 0				$\nabla D$
Combination	<u>[ R ]</u>	1	1				10-A-11			Π
Carrier	Aft	10		10		10				4
	Fwd	40		40		50				
Combination	) X	-					10 - A - 12			Ш
Carrier	Aft	40		40		40	20 11 10			H
	Fwd	10		10		10				ป
Containership	¥				1		10-4-12			+
-	Aft	4					10-n-14			

NOTES:

(A) The above continued table gives information related to individual detail designs

- in the 50 ship survey.

- midship symbol row covers the mid-length

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

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  - 7. Combined Tension

and Shear

13. Questionable 14. Heavy Seas

12. Misuse/Abuse

11. Neglect

- 15. Collision
- 8. Design 9. Fabrication/Workmanship 16. Other - See Notes 10. Welding

DETAIL FAMILY:

STANCHION ENDS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
	. 1	Sound	Failed	Number	Failures	Details	Family	Mode	Cause
SHIP TYPE	↓	Details	Details	Details	1	on Ship	Number	1	1
		Observed	Observed	Observed					<u> </u>
	Fwd	10	1	10		10			
General Cargo	Į Ø	14	36	50	72.0	50	10-A-12	1,4	12
	Aft	10		10		10			
	Fwd	30	1	30		40		h- /	
Miscellaneous	ជ				4		10 4 12	1	
[	Aft	1 10		1 20	1	10	10-A-12		1
	Furd	120		120				<u> </u>	{
<b>B</b> 1	L M	1 120		130		180	10 1 10	ł	
Tanker							10-A-12		ſ
	AIT	20		20		20		1	
1	Fwd			1		I		1	· · · · · ·
Containership	N I			]			10-A-13	1	
	Aft	10		10	4	10			
	Fwd	10	f	10	[	10	10-4-14	f	<u> </u>
Miscellaneous	1	1 10		1	ľ	l <u> </u>	TO U. 14	1	1
						l Ì		1	f
ŀ	11.1 6	┝ <u>──</u>	<u> </u>		ļ			l	L
L	l" Wa		l	• •				1	
ranker	[ 변	10		·10		10	10-A-14	ł	
ļ	[Aft		L		L			1	1
Containership	Fwd		I	T	[			<u> </u>	1
	<b>X</b>	10		10		10	10-A-15		1
	Aft	ł		ł	1	l		Į.	1
	Twit	30	f					{	
Tankor	Γ <del>Ν</del>	50		- 50		50	10-A-15	ł	
Tennici								[	
	HI L							L	
	1: Wa	20		20		30	10-4-16		
Combination	<u>  X  </u>						TOWIO		
Carrier	Aft								
	Fwd					Í		f	
Naval	ושו								
	AFt	10		10		10	10-A-16		
	5.0								
Combination	1	10					<b>.</b> .		
Compination	1 X I	10		10		10	10-A-1/		
Carrier									
	۱۳۳a								
Tanker	181						10. 1 17		
	Aft	20		20		20	10-A-1/		
	Fwd								
Miscellaneous	∣¥[	10		10		10	10-A-18		
i i	Aft								
	Fwd			· · · · · · · · · · · · · · · · · · ·					
General Cargo	١v١	10		10	-	10	10-4-19		1
	[	~~				-~	T0-V-T3		
	Thur a	· · · · · ·						<u> </u>	
Fankar	T W L							ŀ	
Tourer	[ 슈니	20	1	20		20	10-4-10	ł	
	AIT	20		20		<u> </u>	1044-13	<b>\</b>	· · · ·
	hwa						1.0		ļ
Combination	ואן	10	1	10		20	10-A-20	Į	ł
Carrier	Aft			1				l	J
	Fwd	10		10	·	10		l	
Naval	10	20		20		20	10-A-21	1 .	F
[····-	1 AFt	10	i	ไ เกิด		20			l .
	The c	40					· ·	<del>-</del> -	h
	₽₩a	40		40		50	1044-22	Į	1
Bulk Carrier	X	A -		· -			10-A-22	ł	1
	Aft	40		40	<u> </u>	50		1	L
	Fwd	20		20		20	1.0% + 0.0		
Miscellaneous	¥						10-A-22	1	
	Aft						:		
	• • •					· · · · · · · · · · · · · · · · · · ·			

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DETAIL FAMILY: STANCHION ENDS

LOCATION ON SHIP		Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	J
	.	Sound	Failed	Number	Failures	Details	Family	Node	Cause	
SHIP TYPE	ו↓ר	Details	Details	Details		on Ship	Number	{		
	!'	Observed	Observed	Observed		]				1
	Fwd	10		10		.10				1
Tanker	1 X						10-A-22			╎╴╋┷┻┻┙
	Aft	40		40		60				
	Fwd	20	· · · · · · · · · · · · · · · · · · ·	20		20		1		ju
Bulk Carrier	N N	-	l				10-A-23			
	Aft	20		20		20		1		ا در الم
	Fwd	40	[·	40		50	10 4 92	f		NI/
Containership	1 X					-•	10-A-23			l °∎
-	Aft									i
	Fvd	20		20		20	70 1 01	}		1
Bulk Carrier	ิษ	20		20	1	20	10-A-24			<del>         </del>
	Aft						ļ			
·····	Fwd	40		40		50	<u> </u>	<b>{</b>	· · · · · · · · · · · · · · · · · · ·	4
General Cargo	Ĥ	40		-+0		50	10-A-24	1		▲
Cherter ourgo	1 44									<u> </u>
	Ewd.	20		20		20				{
Tanker	L H	20		20		20	10 - A - 24			
	A f+	10		10		10				
	5-10	<u>+</u> Y						<u>├</u> (		
Containership	័ដ	10		10		10	10 - A - 25			117
concarner surp	A ++	10		10			10 11 25			l ür
	134 U			20		30		<u>├────</u>	<b>_</b>	
Combinetion	Υ.	20		20		50	10 - 8 - 1			
Compliantion	1 A F+	20		20		20	10 0 1	[ ]	1	╶┲┷╋┷╤
Califer	543			20		20				
Containershin	Тп I									4
00110011101 0111p	ATT	20		20		20	10-B-1	[		<b>1</b>
	2 vA	20	<u>_</u>	20		30				
General Cargo	Ϋ́	10		10		10	10 - B - 1	! [		
Source our Bo	A ft	10		10		10	10-D-1	1 1		
·	E d	10			•	10		ŧ ····································		
Norml	'n	10		20		20	10			
navar		20		20		20	10-9-1			
	Furd	20				20		<b>└────</b> ┤		
Tankan	L R I	20		20		20	10-B-1			
Tautret										
	Part of							<u> </u>		-
Dull Commins	Γ WG	/0		· · · ]		80	10 0 3	1 1		n
buik carrier	2	70					10-8-2			┍╇┑
	RIG Dud					80		<u> </u>		تبلبة
Tombination	rwu W	00		00		10	10 5 6	1		
Compination Compier	1.X	60		I		10	TO-R-5			
varrier	AL U									
Contoinemetie	rwa H	120		120		120	10 0 0	[ ]		
Containership	1.X.	20		20		50	10-8-7			
	AIT	50		50		60				

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, Ø , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows:

- 5. Shear
- 6. Tension
- 7. Combined Tension
- and Shear
- 14. Heavy Seas

12. Misuse/Abuse

13. Questionable

11. Neglect

- 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes

10. Welding
DETAIL FAMILY: STANCHION ENDS

LOCATION ON SI	HIP	Number of	Number of	Total	Percent	Estimates	Detail	Failure	Failure	ו
	1	Sound	Failed .	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	ן גו	Details	Details	Details	1	on Ship	Number		1	1
	1	Observed	Observed	Observed	1	_				1
	Fwd	20		20	1	20	1	1	7	1
General Carco	ស	20	ļ	20		50	10_B_2	1		1
	1.24	30	1	30		40	10-0-2			-
						40	<u> </u>	ł	<b></b>	. <b>ĩ</b>
	L A C	40		40		50		ł	i	1
Misce⊥⊥anecus	18	10		10		10	10-B-2			
	Aft					ł				┢╼┈
	Fwd	60		60		80			1	1
level	ត្រ 🛛	210		210		260	10_R_2	1		1
	1	210		1 200		110	10-0-2			┣───
	MA C	90	<u> </u>	30		110		<b></b>		[
	FMa	208	2	210	1.0	250	1.0 - 0	1 1	6,9,13	ł
Tanker		10	t i	10		10	10-B-2			ļ
	Aft	130	1	130		150				
· · · · · · · · · · · · · · · · · · ·	Fwa			1			<del>  · · </del>	f		•
** eeo11eeo	1.4			í			1	·		
arscerratieous	다신						10-8-3		1	['
	Art	10	I	10		10	TO D=2	l	1	
	FwaT			1			1	1	1	1 1
Combination	וסן						!			
Carrier	]⊿r̃+ I	30	} 1	1 10		10	10-B-4			1
		± v		+ <u> </u>	· · · · · · · ·	<u> </u>			ļ	<
	]rwa				i l		1	1		، ا
Bulk Carrier	ותו						1 10	ł	1	
	Aft	10		10		10	1 TO-B-2	ſ		ł
				· · · · · · · · · · · · · · · · · · ·		<u> </u>		f	f	
	۲۳al							ł		<sup>-</sup> -
laval	1 14 1	20		20		20	10 <b>-</b> B-6	1	( I	
	Aft			Į				1	1 I	
	Fund					<u> </u>		t	<u>┼╌╍╌╌┍╴</u> ╢	
•7	[] <u>"</u> "	20	İ				10-2-7	1	ł I	
Haval	민원 [	20		20		20	1 10-0-1	[	i I	ļ
	Aft	20		20		20			L	
	Fwd							1		
ontainershin	10	10		10		10	10-B-8	l	i 1	
our derrier our h	1.2.1			- <sup>-</sup> (					1 1	
	AIT		· ·						Įį	1 t.
	Fwd	50		50	1	60	10 - 0			
Javal	F) I	190		190 l		210	10-B-8			
	Art	-40		40	j	50		i		
	The state	rv	····							
	r, ₩a				ļ	10	10_0_0			
ranker	. 쓰	10		10		10	10-0-0			
	Aft	10		10	[	10				
	Twd			1					<u>  </u>	_
ombination	m l		20	20	100 0	20	10-B-9	1		ิ สา
	[ 잖 ]	1	20	20	100.0	20		i -	°	
arrier	AIT									
	Fwd									•
Containership	🕅		10	10	100.0	10	10-B-9	1	8 1	
	ATT							-	l - 1	
		40							ŧi	
	h Ma	40		40		50	10-B-10			. J
General Cargo	ĮĮĮ				ļ				1. 1	1
	Aft							1		
	Furd								<u> </u>	
	r Wul	<b>*</b> -					10 5 10			
lava⊥	I M	20		20	ſ	20	TO-R-IN		1 1	
	Aft	10		10		10				~
	Fwd						· · · · · · · · · · · · · · · · · · ·			~
7	- <u>"</u> "	20		<u></u>	1	20	10_B_11			· 1
TRATT	문지	20		20	1	20	T0-0-TT			ہے۔
	Aft	20	I	20_		<u>ں د</u>			ll	
	Fwd						.,	<u>·</u>		
Combination	<b>n</b>	20		20		20	10-B-T2			1
lownion	[,주.]									<i>ــــــ</i>
arrier	AIT					·	L		L	᠂ᢆᢣ᠊ᡧ

DETAIL FAMILY: STANCHION ENDS

LOCATION ON S	ΗПΡ	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	}
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	ו גר	Details	Details	Details		on Ship	Hurben	1		
[	$\Gamma$	Observed	Observed	Observed			Humber	!		
	Fwd						[	1	f	Pn
Naval	X				]					I H
	Aft	10		10		10	10-B-12			
	Fwd	20		20		30				تملمه ا
Tanker	X						10 - B - 12	1		
	Aft								1	
	Fwd	40		40		50		<b>}</b>	<u> </u>	~
Containership	M I						10 - B - 13			l Aik
_	Aft									+ + + + + +
	Fwd					· · · · · · · · · · · · · · · · · · ·				
Naval	8	10		10		10	10 0 12		1	╇
	Art	10		10		10	T0-P-T2	1	t J	
}	200							{	<b></b>	
Bulk Convion	1 2 1	20		20		20	10 - B - 14			
Dans Carlier	1.44									
······································	[ <u></u> ]						·	Į	ļ	│ <del>╹╍</del> ݷ┸╌┯╝
  ///	l'wa	40		40		40		1		<b>1</b> 73
MEANT	냈	60		60		80	10 - B - 15			
ļ	AIT	50		50		60				्यम
L.	ŀ₩a	30		30		30			i	
Tanker							10 - B - 15	!		<b></b>
	AIT	20		20		20		<b>I</b>	L . 1	
	Fwd							1		
Bulk Carrier	R						10 0 15		1 1	
·	Aft	30		30		40	10-8-12	Í.	i 1	I
	Fwd									
Combination	N 1	10		10		30	10 - B - 15		1	
Carrier	Aft	10		10		10			l I	
	Fwd							1		
Containership		10		10		10	10-B-15		i l	
	Aft	30		30		30			i ł	· [
	Fwd									·
General Cargo	I X I	40		40		100	10-B-15	}	1 1	d
	Aft	10		10		10			i 1	
	Fwd	10		10		10				m
Bulk Carrier	I X I						10-B-16		1 1	[ ][]
	Aft	10		10		20			¦ }	TIJ
	Fwd	30		30		30			q	• •
Combination	D I	30		30		60	10 - B - 16			<b>▲</b> `
Carrier	Aft	10		10		10	20 2 10	1	1 1	
	Fwd	30		30		30				1
Containership	I)≬	20		20		40	10-B-16	[	1. 1	
	Aft	20		20	-	30			1 1	
	Fwd			1					I	
General Cargo	X	50	-	50 J	1	110	10 - B - 16			l
	Aft	10		10		20			ł <b>t</b>	····· •
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NOTES:

- (A) The above continued table gives information related to individual detail designs
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  - 5. Shear 6. Tension 11. Neglect 12. Misuse/Abuse

  - 7. Combined Tension
  - and Shear 8. Design
- 13. Questionable 14. Heavy Seas

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8. Design 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes 10. Welding

DETAIL FAMILY: STANCHION ENDS

LOCATION ON S	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ר
	٦ I - <sup>١</sup>	Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	🕴	Details	Details	Details		on Ship	Number		1	
	Eura	Observed	Ubserved	Observed	·	<u></u>	ļ	<u> </u>	- <b> </b>	1 _
Miscellaneous	The state		1	i i		[			1	
and accurate out	Aft.	10		10		10	10 - B - 16			1 <del></del>
·	Fud	30	<u> </u>	30		40	10 1 10		+	┨╶┶┸╼
Naval	I W	20				110				
1100107	Aft	50		50	1		10-B-16			
	Ewd		<u> </u>		ł	90				- i
Tenker	ี ที่	10		1 10	ł	10	10 P-16	1		)
	Aft	70		20	1	110	10-0-10	ł		
f	Fwd		{ ···	<u> </u>	<b></b>					1 _
General Cargo	ซื		1		1					l 🕅
	Art	40		40		50	10 - B - 17		i i	
}	Fwd		<u>}</u>		<u>}</u>		·	1	<b>}</b>	4
Combination	Îπ		i							1 Ph
Carrier	Aft	20	1	20		20	10 - B - 18			
	Evd.							Į	<u> </u>	
eneral Cargo	17	[	1	1	1			l	1	
Foreign Cargo	A++	30		30	1	50	10 - B - 18	1		
<b>├</b> ──────	TRUA		<u> </u>		ł			<u> </u>	l	<u>ا</u>
Naval	rwa Wa	20	Į	-	ł	200	10 5 10	1	1	1 /1
unava.	1 ×	20	1	20	ł	30	10-8-18	1		
{			(i		· · · ·			· · · · · · ·		
	Fwa								4	n –
Combination	181	10		10		10	10 - B - 20		1	} [4]
Carrier	AIt	10		10		10	10. 1 20	<u> </u>		] !
L	Fwd			3.0			· · - ·			
Containership	<u> </u>	28	2	30	6.7	30	10 - B - 21	1	8,10	
	Art									<u>р</u>
L.	Fwd									1 1
Tanker	0	10		10		10	10-B-21			
·	Aft						·			
	Fwd									
<b>Containership</b>	X	8	2	10	20.0	10	10-B-22	1	8	/]
	Aft								ļ	
	Fwd									-
Tanker	¤						10 0 22			
	Aft	20	l	20	1	20	10-2-23			
· · · · · · · · · · · · · · · · · · ·	Fwd							· · · · · _ · · · · · · · · · · · ·		
Bulk Carrier	夏	4	6	10	60.0	10	10-B-24	3	8	I m
	Aft								-	
	Fwd		<u> </u>							6
Tanker	X	9	1	10	10.0	10	10-B-25	1	12	ιл
	Aft								_	/
	Fwd									<u> </u>
Containership	μ	8	2	10	20.0	10	10 - C - 1	7	8	
_	Aft	-						-	-	
	Fwd									
Containership	X I	20		20		20	10-C-2			יבקו
-	Aft			-	ŀ	-				
	Fwd							i <i>n</i>		ц,
Tanker	M I	30	ļ	30	1	30	10-c-2			4
	Aft				1					
	Fwn							ii		
Naval	1	20		20		30	10-0-3			m
		20		20	1	20	TO O 2			∣.₩₽
	Twat									- <b>U</b>
Tanker	<b>"</b> א"	10	ſ	, n		10	10-0-3			<b>A</b>
	AFt	**		10		- <sup>1</sup> 0	T0 0-1			
										here as an and

STANCHION ENDS DETAIL FAMILY:

LOCATION ON SA		Number of Sound Details	Number of Failed Details	Total Number Details	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure Cause	
Containership	Fwd M Aft	10	Observed	10		10	10-C-4			
Bulk Carrier	Fwd M Aft	4	6	10	60.0	10	10 <del>-</del> C-5	1	8	Įτ
Combination Carrier	Fwd X Aft	10		10		10	10-C-6			
General Cargo	Fwd M Aft	8	2	10	20.0	.10	10-C-6	1,2	12	 
Containership	Fwd J Aft	10		10		10	10-C-7			
Tanker	Fwd M Aft	20		20 .		40	10-C-7			
Tanker	FWA M Aft	20		20	 	20	10-C-8			
Combination Carrier	Fwd Ø Aft	10		10		10	10-C-9			ĮΕ
General Cargo	Fwa M Aft	20 20		20 20		50 20	10-C-9			 
Bulk Carrier	rwd U Aft	20		20		20	10-c-10			Ł 
Combination Carrier	Aft	10	 	10		30	10-C-10		 	<u> </u> _
Tanker	Fwd M Aft	20	· .	20		30	10-C-11			
General Cargo	Fwd M Aft	20	<u></u>	20		50	10-C-12	<u> </u>	 	
Naval	Fwd M Aft	20 20		20 20		20 20	10-C-12			╞

### NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

- (B) The rows labeled aft,  $\bigotimes$  , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section.
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- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
  - 5. Shear
  - 6. Tension
  - 7. Combined Tension
    - and Shear
  - 8. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes

12. Misuse/Abuse

13. Questionable

14. Heavy Seas

- 10. Welding
- -176-

TABLE A-10 DETAIL FAMILY: STANCHION ENDS

LOCATION ON S	SHIP	Number of	Number of	Total	Fercent	Estimated	Detail	Failure	Failure	3
SHIP TYPE	ןן	Sound Details Observed	Failed Details	Number Details	Failures	Details on Ship	Family Number	Mode	Cause	
	Fwd	OUSELVEL	Observed	Observed						$\frac{1}{1}$
General Cargo	Aft	40		40		50	10-C-13			
Naval	Fwd	30 70 20		30 70 20		40 80 20	10-C-13			
Naval	Fwd	50 30		50 30		60 40	10-C-14			-#
General Cargo	Fwd	20		20		20	10 0 15			्म चि
<b>Contai</b> nership	Aft Fwd X	40	<u> </u>	40		50	10-0-15			
General Cargo	Aft Fwi	<u>10</u> 20		<u>10</u> 20		10	10-C-16	· · · · -		Ţ
	Aft Fwd	10		10		10	10-0-16			<b>1</b>
Bulk Carrier	Aft						10-0-17			
Combination Carrier	) Aft			20		50	10-C-18			$\overline{\mathbf{P}}$
Naval	Fwd M Aft	20	- -	20		30	10-C-18			
Combination Carrier	Fwd M Aft	10		10		30	10-C-19			$\mathbb{T}$
Naval	Fwd U Aft	20 40 20		20 40 20		20 60 20	10-C-20			Ÿ
Bulk Carrier	Fwd M Aft	20		20		20	10-C-21			U E
Containership	Fwd M Aft	10 10		10 10		10 40	10-C-21			
General Cargo	Fwd Ø Aft	20 10		20 10		50 10	10-C-21			
Tanker	Fwd M Aft	30		30		40	10-C-21		4	
Containership	Fwd M Aft	.10		10		20	,10-C-22			± ↓ ↓
Tanker	Fwd M Aft	10		10		10	10-C-22			
General Cargo	Fwd M	10		10		20	10-C-23			F

-177--

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DETAIL FAMILY:

STANCHION ENDS

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LOCATION ON SI	ΠP	Number of Sound	Number of Failed	Total	Percent Failures	Estimate: Details	Detail Family	Failure Mode	Failure Cause
SHIP TYPE	]	Details Observed	Details Observed	Details Observed		on Ship	Number		
Naval	Fwd U Aft	20		20		20	10-C-24		
Containership	Fwd Ø Aft	10		10		10	10-C-25		
Miscellaneous	Fwd M Aft	10		10		10	10-C-25		
Naval	Fwd J Aft	10 10 10		10 10 10		10 20 10	10-C-25		
Containership	Fwd M Afs	20		20		20	10-C-26		
Tanker	Fwd M Aft	10		10		10	10-C <b>-</b> 26		
Containership	Fwd M Aft	20		20		20	10-C-27		
Combination Carrier	Fwd Q Aft	10		10		10	10-C-28		
Bulk Carrier	Fwd U Aft	20		20		30	10-C-29		

TABLE A-11

DETAIL FAMILY: STIFFENER ENDS

LOCATION ON S		Number of Sound Details	Number of Failed Details	Total Number Details	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure	
	T	Observed	Cbserved	Observed				<u> </u>	[	
Bulk Carrier	Fwd X	200		200		450	11-A-1		5	
	Aft	190	10	200	5.0	450	L			
Combination Carrier	Fwd Q Aft	280 300 300		280 300 300		900 700	11-A-1			

NOTES:

(A) The above continued table gives infor-mation related to individual detail designs

in the 50 ship survey.

- (B) The rows labeled aft, § , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length
- throughout the entire cargo section. (C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
- 5. Shear 6. Tension
- 7. Combined Tension
- and Shear 8. Design

12. Misuse/Abuse 13. Questionable

14. Heavy Seas

- o. Design
  9. Fabrication/Workmanship 16. Other See Notes
  10. Welding

TABLE A-11 DETAIL FAMILY: STIFFENER ENDS

LOCATION ON SP	ΠP	Number of	Mumber of	Total	Percent	Estimated	Detail	Failure	Failure	1
SHIP TYPE	ן ∤	Details Observed	Details	Number Details	Failures	on Ship	Family Number	Mode	Cause	
Containership	Fwd M Aft	90 290 340	obseived	90 290 340		180 900 700	11-A-1	<u></u>	1	Tran
General Cargo	Fwd X Aft	70 173 118	7	70 180 120	3.9 1.7	130 510 280	11-A-l	1	5 5	
Miscellaneous	Fwd M Aft	50 60 80		50 60 80		100 150 180	11-A-1			
Tanker	Fwd M Aft	700 1523 650	77	700 1600 650	4.8	1350 4800 1200	11-A-1	1	5	J
Containership	Fwd M Aft	80 118 80	2	80 120 80	1.7	150 400 150	11-A-2	1	5	
General Cargo	Fwd M Aft	10		10		20	11-A-2			
Tanker	Fwd M Aft	20		20		30	11-A-2			
Bulk Carrier	Fwd M Aft	20		20		40	11 <b>-</b> A-3			Π
Containership	Fwd M Aft	290 207 110	3	290 210 110	1.4	610 700 280	11-A-3	1	5	
General Cargo	Fwd M Aft	30 50		30 50		100 100	11 <del>7</del> A-3			
Naval	Fwd M Aft	19	1	20 20	5.0	50 40	11-A-3	1	6,8,14	
Tanker	Fwd D Aft	30		30		60 140	11-A-3			
Naval	Fwd M Aft	50 120 70		50 120 70		130 300 170	11-A-4		1	ΤC
Containership	Fwd U Aft	19	1	20	5.0	20	11-A-5	1	5	ΤΠ
Tanker	Fwd M Aft	20		20		30	11 <b>-</b> A-5			
Containership	Fwd Ø Aft	97 18	32	100 20	3.0 10.0	300 20	11-A-6	1 2	5,7 8	] ]] []
Naval	Fwd M Aft	63	7	70	10.0	100	11-A <b>-</b> 6	1	7	
Bulk Carrier	Fwd M	170 430 210		170 430 210		350 1400 450	11-A-7			
Combination Carrier	Fwd ) Aft	375 360 250	5	380 360 250	1.3	820 1200 450	11-A-7	1	14	

>

DETAIL FAMILY:

STIFFENER ENDS

LOCATION ON SH	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	]
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE		Details	Details	Details		on Ship	Number	1		1
	1	Observed	Observed	Observed			ļ		<b></b>	
	Fwd	547	3	550	.5	1240	· · · _	1	14,15	
Containership	Ø	1104	6	1110	.5	3500	11-A-7	1	8	
_	Aft	660	Ì	660	I	1480		ł		
	Fwd	210		210		490	1		I	
General Cargo	X	1120		1120		3800	11-A-7			1
-	Aft	500	1	500	1	1110				
·	Fwd	110	1	110	1	190	_			1
Miscellaneous	D I	30	{	30	Į	100	11-A-7			
	Aft	100	1	100	{	190		ł	1	
	ริษณ์	604	6	610	1 1.0	1280		1	7,11,1	14
Tonker	ำหื่	004		820	ļ <b>1.</b>	1620	11-A-7			
Tanver	بم ++	540	1	540		1580	1	ļ	Į.	
	2.2	240	<u>-</u>	<u> </u>	<u> </u>	<u> </u>		<b></b>	{- <b></b>	┆╶┯┯╶┯
	rwa	200	}	200		600	11-4-8			1 116
Combination		200		200	ł	000	11	1		
Carrier	AIT		<u> </u>	ļ				l	<u> </u>	
	Fwd	80		80	1	170	71.4_9			
Naval	<u>A</u>	420	]	420		1020				l
	Aft	166	4	170	2.4	380			8,14	ļ
	Fwd	80	T	80	1	200			1	TIT
Bulk Carrier	X		4	ļ.	1		11-A-9	ļ	1	
	Aft	170		170		400			I	ЦЦЦ
-	Fwd	40		40		100		T		
Combination	<b>v</b>			1	1		11-A-9	ł		♠
Carrier	Aft	90	}	90		200	1		Į	
····—······	Fwd	50		50		100		1	1	1
Containership	۲.	120	ł	120		400	11-A-9			
•	Aft	150	ļ	150	1	310			1	
	Fwd	60	·	60	<u>+</u>	160		1	1	1
General Cargo	ช	120		120	{	400	11-A-9			
	Aft	110		1 110	1	240		i		
· ·	5will	240	†	240	†	600		t	f	1
No. 100 T	1 2	1600	1	1 1600		4200	11-A-9	ľ	1	
TAGTA GT	A ++	300		300		1200		1		
	171.0		····	1	- 2 2-	200		<u>├</u>	+-17	1
Beelsen	rwa M	°′			1 3.3	200	11-4-9		**	
Tanker	<u>н</u>	120	1	130	1	250			1	<b>⊢</b> i
·	HIT.	130	<b>↓</b>		{		{	<u>}                                    </u>	<b>∤</b> ─────	1
	Fwd	230	1	230	ł	3500	1 1 1 1 1	4	1	
Naval	8	1500		1500	ł	1020	11-A-1	1		
	Aft	400		400	<u> </u>	1 1020		ļ	ļ	<sup>س مہر</sup> ا
	Fwd			1					1	T-
Containership	۱X –	_	t		1				1	
	Aft	20	ł	20		20		1	J	jμü
	Fwd	60	1	60	1	100	11			<b>`</b> ♠
Naval	D T		1		ł	ł	TT-W-TT	1	1	
	Aft				1	1	1	1	1	<u>├</u>

NOTES:

(A) The above continued table gives information related to individual detail designs in the 50 ship survey.

(B) The rows labeled aft, Ø, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect 12. Misuse/Abuse

- 5. Shear 6. Tension
- 7. Combined Tension
  - and Shear

10. Welding

- 13. Questionable 14. Heavy Seas

8. Design 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes

DETAIL FAMILY: STIFFENER ENDS

I 9 I	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
]	Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Details on Ship	Family Number	Mode	Cause	
Fwd D Aft	50 60_		50 60		100 100	11-A-11			1 1 1
Fwd X Aft	20		20		20	11-A-12			
Fwd D Aft	30 110 50		30 110 50		60 240 100	11-A-12			
Fwd M Aft	40		40		60	11 <b>-A</b> -12			• •
Fwd M Aft	30 30		30 30		50 50	11-B-1			10
Fwd M Aft	58 80	2	-60 80	3.3	200 180	11-B-1	1	5	
Fwd M Aft	20 195 16	5 4	20 200 20	2.5	20 400 20	11-B-1	1	7 5	
Fwd 'M Aft	60		60		200	11-B-2			150
Fwd Ø Aft	50 352 247	8 3	50 360 250	2.2	100 1200 500	11 <b>-</b> B-3	1 2	7 14	
Fwd Ø Aft	60		60		200	11-B-3			
Fwd Ju Aft	20 90 50		20 90 50		50 350 100	11-B-4			
Fwd )ú Aft	1908	12	1920	.6	3200	11-B-4	1	7	
Fwd X Aft	59	1	60	1.7	100	11-B-5	1	7	
Fwd ) Aft	9	1	10	10.0	20	11-B-6	1	8	Į
Fwd M Aft	30		30		60	11-C-1			<u>ו</u> זה[
Fwd M Aft	50		50		100	11-C-1			
Fwd M Aft	40	<u></u>	40		100	11-C-2			וח
Fwd M Aft	40 170 60	<b></b>	40 170 60		80 410 150	11-C-3			
Fwd M	40 60 40	<del> </del>	40 60 40		50 100 50	11 <b>-</b> C-4			
	H Y WA A ft WA	IP       Number of Sound Details Observed         Fwd       50         Aft       60         Fwd       10         Aft       20         Fwd       30         H       10         Aft       20         Fwd       30         H       40         Fwd       30         H       410         Fwd       30         M       110         Aft       30         Fwd       10         Aft       30         Fwd       50         Fwd       58         Aft       80         Fwd       50         Fwd       50         Fwd       50         Fwd       50         Fwd       90         Aft       50         Fwd       90         Aft       50         Fwd       9         Aft       30         Fwd       9         Aft       50         Fwd       9         Aft       30         Fwd       9         Aft       30	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	IPNumber of Sound Details ObservedNumber of Failed Details ObservedTotal Number Details ObservedFwd5050H6060Fwd2020Fwd3030H110110Aft5050Fwd3030H10110Aft5050Fwd3030H10110Aft5050Fwd3030H6060Fwd3030H582Aft80Fwd2020H1955200AftAft60Aft60Aft20Fwd20J352Aft20Fwd20J60Aft20J60Aft50J60Aft50J60Aft50Fwd1908J100Aft50Fwd10Aft30J50Fwd30J50Fwd50Fwd10Aft50Fwd50Fwd50Fwd50Fwd50J50Fwd50J60 </td <td>IP       Number of Number of Failed Details Details Details Observed Observed Observed       Percent Failures Details Details Observed         <math>Observed Observed Observed Observed       <math>Observed Observed Observed</math> <math>Observed Observed Observed Observed         <math>Pwd</math> <math>0</math> <math>60</math> <math>Failed</math> Number of SO       <math>Pailed</math> Number of SO         <math>Pwd</math> <math>0</math> <math>0</math> <math>0</math> <math>0</math> <math>Pwd</math> <math>0</math> <math>0</math> <math>0</math>       &lt;</math></math></td> <td>IP         Number of Sound         Number of Failed         Total Number         Percent Failures         Estimated Failures           Pwd         50         0bserved         0bserved         0bserved         0bserved           Market         60         60         100           Market         60         100           Market         60         100           Market         60         100           Market         20         20           Pwd         30         30         60           Market         50         100           Market         50         100           Market         50         100           Market         50         100           Market         60         30         50           Market         30         30         50           Market         20         20         20           Market         80         80         180           Pwd         50         200         2.5         400           Art         16         4         20         1200           Market         20         50         100         1200</td> <td>IP         Number of Number of Total Details         Percent Pailures         Details Details on Ship         Details Pailures         Details on Ship         Details Pailures         Details on Ship         Number Pailures           Pwd         50         100         11-A-11         Number         Number</td> <td><math display="block"> \begin{array}{c c c c c c c c c c c c c c c c c c c </math></td> <td><math display="block"> \begin{array}{c c c c c c c c c c c c c c c c c c c </math></td>	IP       Number of Number of Failed Details Details Details Observed Observed Observed       Percent Failures Details Details Observed $Observed Observed Observed Observed       Observed Observed Observed Observed Observed Observed Observed         Pwd 0 60 Failed Number of SO       Pailed Number of SO         Pwd 0 0 0 0 Pwd 0 0 0 Pwd 0 0 0 Pwd 0 0 0 Pwd 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0 0 Pwd 0 0 0       <$	IP         Number of Sound         Number of Failed         Total Number         Percent Failures         Estimated Failures           Pwd         50         0bserved         0bserved         0bserved         0bserved           Market         60         60         100           Market         60         100           Market         60         100           Market         60         100           Market         20         20           Pwd         30         30         60           Market         50         100           Market         50         100           Market         50         100           Market         50         100           Market         60         30         50           Market         30         30         50           Market         20         20         20           Market         80         80         180           Pwd         50         200         2.5         400           Art         16         4         20         1200           Market         20         50         100         1200	IP         Number of Number of Total Details         Percent Pailures         Details Details on Ship         Details Pailures         Details on Ship         Details Pailures         Details on Ship         Number Pailures           Pwd         50         100         11-A-11         Number         Number	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $

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DETAIL FAMILY:

STIFFENER ENDS

LOCATION ON SI	HIP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	1
		Sound	Failed	Number	Failures	Details	Family	Mode	Cause	
SHIP TYPE	]↓	Details	Details	Details		on Ship	Number			İ
	[']	Observed	Observed	Observed		_	{ · · ·	1	[	1
	Fwd							1	-	IΠU
Containership	N I		ł					1	ł	{ 1
	Aft	60		60		110	11-C-5	1		ιμu
	Fwd									াচার আ
Naval	」夏日	13	7	20	35.0	20	11-C-6	11	8	
	Aft							[		L LI U
	Fwd	20	ł	20		50	11_0_1		I	
Combination	X	<b>6</b> •	ł					1	ł	
Carrier	Aft	20	l	20		50		1		L LJ
L	Fwd								1	
Containership	12	<u> </u>	1	60		120				[]
	AIT	60	ļ	60		120	11-0-1	<u> </u>		
G	irwa H								ļ	
General Cargo	1.2	30	1	30		50	11_D_1		]	
	AIT					50	<u>11-D-1</u>	-{		
Slentren ***	rwa K									
Ishtrei.	A 44	110		110		200	11-D-1	!		
	R. C							╂╌╌╌╼╼┥		
Containership	ที่	60		60		200	11_0_2		[	l Grand
concarner surb	_× ∆ f+	00					11-0-2			
_ <u></u>	D.A	50		50		110				- <del>-</del>
Miccolleneous	rwu H	50		50		110	11_0_2			•
T SCELLONEOUS	<u>у</u> А <del>С +</del>	40		40		90	11-0-2			
	E.A							<b>\</b>		
Tanker	์ พี่	30		30		50				
Idunci	Aft	60		60		100	11-D-2			<b></b>
	Fvd	200		200	· · · · · · · · · · · · · · · · · · ·	560		1		· · · · · ·
Naval	ซ	1060	[	1060		2700	11-D-3			
	Aft	360		360	:	1250	11 0 3	1		
	Fvd		i			1230				
Containership	<b>u</b>	58	2	-60	1.7	200	11-D-4	1 1	7	
· -	Aft							_	Ī	
	Fwd						<u></u>		[	
Tanker	. X	2108	42	2150	2.0	4200		11	7	
	Aft	160		160		400 ·	11-D-5		1	
	Fwd					]		1		)
General Cargo	X	60	1	60	1	200	11-E-1	1	i	
	Aft		l							
	Fvd	10		10		10	I	1		1
Tanker	X	120	1	120	ļ	300	11-E-2	1		{
	Aft		L	<u> </u>	l	<u> </u>	1			IЦ
	Fwd	20	1	20		30	1			
Tanker	<u>A</u>		1	]	l I		11-E-3			
L	Aft	20	L	20		40		<u> </u>		

## NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

(B) The rows labeled aft, ♥, and fwd refer to locations along the ship length. The

midship symbol row covers the mid-length

throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect 12. Misuse/Abuse

- 5. Shear 6. Tension
- 7. Combined Tension
  - and Shear
- 13. Questionable 14. Heavy Seas

8. Design 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes 10. Welding

DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON SI	ПР	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure
		Sound	Failed	Number	Failures	Details	Family	Node	Cause
SHIP TYPE	וּוּן	Details	Details	Details	1	on Ship	Number	1	
	<b>!</b> '	Observed	Observed	Observed				1.	
	Fwd	_					12 4 1		
Naval	<b>X</b>	6	24	30	80.0	30	11Z-A-I	1 1	5,8
	Aft							}	!
	Fwd	150	1	150		300		T	
Tanker	X	60	1	60		100	12-A-1		
	Aft	330		330		600			
	Fwd			1			1		
General Cargo	<u>Q</u>		1				1	1	1
	Aft	20		20		30	12-A-2	<b></b>	<u> </u>
_	Fwd		[				1		
Tanker	<u>β</u>	• •		1 10			10 . 0		
	Ait	40	Į	40		50	12-A-2		<u> </u>
	Fwd	30		30		40	1		
Bulk Carrier	냈	156	4	160	2.5	490	12 <b>-</b> A-3	1	15
~	AIt	60	{	60		110	ļ		
7	rwd	120	[	120		240		1	ł
Jondination	[셨]	400	1	400		1220	12-A-3	1	ł
Jarrier	1 A _ U	210		+ <u>-<u>+</u></u>		440	<u> </u>	╉╌╴╼╍╼	┥
Containarchin	rwu M	120	]	120		320	1 1 2 1 2		]
Sourcarnersurp	<u></u> А <del>г</del> ч	220	1	800		2050	12-A-3		1
	540		<del> </del>	320	·		<del> </del>	{	
Ceneral Cargo	1	100		100	1	210	12_1-2		
where outer		290		300	1.3	1000			18,
·····	Fwd	40	<u>├</u> <sup>2</sup>	440		330	t	┟──┴───	┟┸┸┈╼╍
Miscellaneous	ี ซี ไ	40	1	40 60		100	12_1-2		
	Aft	70	1			180	12-A-3		
	Fwd	200		200		500	+	<u>+</u>	<u> </u>
Naval	] ซ ]	2100	1	2100		5500	12-1-2		
	Aft	400	1	400		1000	1 IZ-A-3		
	Fwd	.210	[	210		460	1		
Tanker	X	670	1	670		1310	12-4-3		
	Aft	490	ł	490		1070	17-W-2	1	
	Fwd		1	<u> ~~-  </u>			1	1	· · · · ·
Naval	1 X I		ŀ				1	1	
	Art	150	1	150		220	12-A-4		
	Fwd		1				1	1	
Tanker	۱X			1			I		
	Aft	90	l i	90		160	12-A-4		
	Fwd	60		60		100	10 4 5	T	
Combination	ואן			1 1		ŀ	12-A-5	1	
Carrier	Aft						1	I	
	Fwd						10 4 5	ľ i	
General Cargo	X	10	<b>!</b> :	10		30	12-A-5		1
	Aft						<u> </u>		
	Fwd			!					
Miscellaneous	N I							i .	
	Aft	40		40		50	12-A-5		
· · · · · · · · · · · · · · · · · · ·	Fwd						I		
fanker	M								
	Aft	40		40	1	50	12-A-5	1	

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DETAIL FAMILY:

PANEL STIFFENERS

LOCATION ON SH	ΠP	Number of	Number of	Total	Percent	Estimated	Detail	Failure Failure	
	1	Sound	Failed	Number	Failures	Details	Family	Mode	Cause
SHIP TYPE	14	Details	Details	Details		on Ship	Number	1	1
	[ '	Observed	Observed	Observed	5	}	•••		1
	Fwd	291	9	300	1	600		1 1	14
Bulk Carrier	ע	1187	13	1200	1	4240	12-A-6	1	15
	Aft	460		460	1	990		Į	
	Fwd	40	i	40		70			
Combination	<b>D</b>	160	1	160	]	550	12-A-6		
Carrier	Aft	-90		90	1	180		1	1
	Fwd	40		40	<u> </u>	60		<u> </u>	+
Containership	ซี	130	1	130	]	440	12-A-6	Į	1
r	Aft	60	1	60	ł	100		}	1
	Fyd		····	<u>~</u> ~	f		· · · · · · · · · · · · · · · · · · ·		1
General Cargo	۲U I	135	5	140	ŀ	400		1 1	8.13
	AT+	200	l	70		100	12 <b>-</b> A-6	1 -	10,10
	frwa	20	†	20		30		t	+
Miscellaneous	ซ	20		20			12-4-6	1	1
	Aft	30	ļ	30		40		1	1
	Fird	50	<u> </u>	50			·	<b>+</b>	+
Terre T	l n	400	Í	400		1020	12_1_6		1
.IGACT		400		400		1020	12-A-0		1
	Eval.		·····	80	<u> </u>	190		<u> </u>	
Tenker	T N	260		260		500	10 4 6	1	1
Terrer		200		200		300	12-A-0	1	1
	The	230 .	<u> </u>	230		390		<u> </u>	<u>}</u>
n 3	L M		1 10	1 10	1 100 0	1 10		.	
NEVEL	N.		10	10	1 100.0		12-A-/	<u>۲</u>	5,8
			<u> </u>	<u> </u>	<u> </u>		<u> </u>	<del></del>	<u> </u>
	u wa							]	
Bulk Carrier	L X		2	20	1 15 0	20	12-4-8		
	AIT	11		20	15.0	20	12 1 0	<u> </u>	<u> </u>
	FMG	50		50		120			
Naval	1 8	330		330	ļ	840	12-A-8	1	
	Aft	110		1 110	· · · · · · · · · · · · · · · · · · ·	240		<u></u>	<u> </u>
	Fwd			1	•		1	1	1
Bulk Carrier	开	30	ļ	30	-	100	12_4_9	ł	
	Aft	50	<u> </u>	50		100	12-A-3	l	L
	Fwd			1				].	1 - 10
Combination	1 🛛	702	8	710		2200	12-A-1(	1 1	15,10
Carrier	Aft		1	<u> </u>	<b>!</b>			<u> </u>	
····; ···_ ····	Iwd	50	T	50	[	100			
Containership	M I	200	1	.200	ļ	700	12-B-1		1
•	Aft	220	1	220	I	400			
	Fwd	20	F	20		20	r	1	T
Containership	۲ d						12 - B - 2	1	1
	Aft	40	Į.	40	l	60	1	}	1
	Fwd	50	1	50	1	80		1	1
General Cargo	ี ซี ไ	85	5	90	5.6	300	12-B-2	1 1	5
Noncrea out Bo	AP+	60	1 -	60		100		1	
	1011						the second second second second second second second second second second second second second second second se		

NOTES:

(A) The above continued table gives information related to individual detail designs

(B) The rows labeled aft, , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

throughout the entire cargo section.

(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks

and buckles, and twisted/distorted, respectively.

- (D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect
  - 5. Shear
  - 6. Tension
  - 7. Combined Tension
  - o. Design 15. Collision 9. Fabrication/Workmanship 16. Other See Notes 10. Welding and Shear
- 14. Heavy Seas

12. Misuse/Abuse

13. Questionable

-184-

DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON S	TP	Number of	Number of	Total	Percent	Estimated	Detail	Failure	Failure	ר
	-	Sound	Failed	Number	Failures	Details	Eamily	Mode	Cause	
SHTP TYPE	11	Details	Details	Details		on Ship	Number	1		ł
	Y I	Observed	Observed	Observed			Hunder			1
	Fwd								1	1
Naval	X	60		60	1	140	12 <b>-</b> B-2		i i	
	Aft		ļ			<b></b>	1		ļ	l ` <b>▲</b> '
Ĺ.	Fwd	30		30		50			1	
Tanker						1 1 0 0	12-8-2		1	┠───┙
<u></u>	AIT	50		50	<u> </u>	100			<u>{                                    </u>	4
	wa wa	30		30	1	60	12 0 2	ļ		
Bulk Carrier	X	20		20		30	12-0-3			
	1204				<u> </u>		<b></b>			↓ <b>~</b> ~
Combination	<b>m</b>	270		270	1	980	12_B_3	1		•
Carrier	Aft	190	1	190		430	12-0-5	1		<b>}−−−</b> 1
	Fwd	60	<u> </u>	60		130	<b></b>	+	ł	4
Containership	Τğ	120		120		480	12-B-3	1		
-	Aft	116	4	120	3.3	320		1 1	11,12	
	Fwd	50	<b></b>	50		100		1	1	1
General Cargo	IЙ	100		100	1	400	12-B-3		ł	L 1
· ·	Aft	. 80		80	1	170			1	
	Fwd	20		20		30			T	1
Miscellaneous	X	30		30		120	12-B-3			<b></b>
	Aft	30		30	l	50		<u> </u>		
	Fwd	20	1	20		30		1		
Naval	R	70		70	1	230	12-B-3		1	<b>k</b>
	Aft	20		20	L	40		I		1
L .	Fwd	110	1	110	ļ	340	10 0 0			f I
Tanker	1.2	210		210		450	12-8-3			<b>h</b>
	AIT	200		200	<b> </b>	000	{		·	4
	IFWa	10				20	10 0 /		1	
BULK Carrier	LX I	20	}	20		90	12-6-4		1	
·	THE L		<b> </b>	20	{	70-				$\mathbf{I}$
Combination	m l	70	ł	70		260	12_12_/			i 🕈
Compliant	157+	60	1	60		120	12-0-4			t·
	Fwd	20	<u></u>	20	<u></u>	30		+		1
Containership	<b>10</b>	30		30		100	12 - B - 4	1		
· · · · · · · · · · · · · · · · · · ·	Aft	30	1	30	[	50		1		
	Fwd	10	<u> </u>	10	<u> </u>	20				1
General Cargo	🕱	40	ļ	40		120	12-B-4			1
_	Aft	40	]	40	ľ	60			1	
	Fwd	17	3	20	15.0	30	12_8_4		14	1
Tanker	I X I			[	_		12-0-4		1	
	Aft	_	1	ľ	1	1			1	1
	Fwd	20	1	20		50			1	1
Naval	X	210		210		540	12-B-5			
	Aft	40		40		110			<u> </u>	
	Fwd	10	1	10	1	20				1
Naval	ĮXI	20		20	1	60	12-B-6		1	
	Aft	20	<u> </u>	20	1	40	l	<u> </u>	<u> </u>	
	Fwd	10		10		20			1	
Naval	🕅	1694	6	1700	•4	4000	1 TZ-B-/	1 1	1 15	
l	Aft		<u> </u>	<u></u>				┫	1	
	Fwd	330		330		1160	10 0 0		ł	
Naval	I A	3400	1	3400	1	8020	0-4-21	1	1	5-0-
1	IAft	1 700	ł	1 700	1	1 2570	1	ł	1	1 Jana

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DETAIL FAMILY:

PANEL STIFFENERS

LOCATION ON SH		Number of Sound	Number of Failed	Total Number	Percent Failures	Estimated Details	Detail Family	Failure	Failure Cause
SHIP TYPE		Details Observed	Details Observed	Details Observed		on Ship	Number		
Containership	Fwd M Aft	120		120		400	12-C-1	 	
General Cargo	Fwd Ø Aft	60	10	70	14.3	200	12-C-1	1	8
Tanker	Fwd M Aft	10 30		10 30		20 50	12-C-1		
Naval	Fwd M Aft	20 50 180		20 50 180		40 160 400	12-C-2		
Bulk Carrier	Fwd M Aft	90 60 190		90 60 190		200 200 400	12-C <b>-</b> 3		
Miscellaneous	Fwd M Aft	50 310 60		.50 310 60		120 950 130	12-C-3		
Tanker	Fwd M Aft	350 4882 370	18	350 4900 370	4	800 13000 700	12-C-3	1	7,10
Miscellaneous	Fwd X Aft	30 230 50		30 230 50		50 770 80	12 <b>-</b> C-4		
Combination Carrier	Fwd M Aft	50 120 50		50 120 50		100 400 100	12-C-4		ļ
Containership	Fwd M Aft	50 300 90		50 300 . 90		100 900 200	12-C-4		
Tanker	Fwd M Aft	240 2200 120		240 2200 120		500 5500 200	12-C-4		ļ
General Cargo	Fwd M Aft	68	12	80	15.0	150	12-C-5	1	14
Naval	Fwd J Aft	50 1000 110		50 1000 110		100 2700 200	12-C-5	ļ	ļ
Tanker	Fwd	90 740 180		90 740 180		200 1500 400	12-C-5		

NOTES:

(A) The above continued table gives information related to individual detail designs

in the 50 ship survey.

- (B) The rows labeled aft, \$\$\overline\$, and fwd refer to locations along the ship length. The midship symbol row covers the mid-length

- throughout the entire cargo section.
- (C) The numbers 1, 2, 3 & 4 in the column for

failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

(D) Probable detail failure causes are estimated to be a combination of fatigue and the other factors indicated in the table by appropriate numbers as follows: 11. Neglect

- 5. Shear 6. Tension
- 7. Combined Tension
  - and Shear

8. Design

14. Heavy Seas 15. Collision 9. Fabrication/Workmanship 16. Other - See Notes

12. Misuse/Abuse 13. Questionable

10. Welding

DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON SI	ΠP	Number of Sound	Number of Failed	Total Number	Percent Failures	Estimated Details	Detail Family	Failure Mode	Failure Cause	
SHIP TYPE	]	Details Observed	Details Observed	Details Observed		on Ship	Number			
	Fwd	30		30		60				
Bulk Carrier	) Aft	200 70		200 70		620 120	12-C-6			┍╧╧
	Fwd	20		20		30				<b></b>
Naval	R Aft	80 30		80 30		150 70	12-C-6			
Tanker	Fwd M Aft	110_		110		200	12-C-6			
Tanker	Fwd M Aft	400 60		400 60		800 100	12-C-7			
	Fwd	200	l	200		500			<u>}</u>	
Bulk Carrier	) A f t					100	12-C <b>-</b> 8	1		
	AL U EWG	60	{			100				
Combination	D D	30		30		140	12-C-8			
Carrier	Fund	. 80	<u> </u>	<u> </u>		140		····-		
Containership	) Aft	50		50		100	12-C-8			
	Fwd	50		50		100		<u> </u>	<u> </u>	
Tanker	) Aft	410		410		800	12-C-8			<b></b>
h <u>aa</u>	Fwd	<u> </u>		60		100				<b></b>
Tanker	) Aft	390 80		390 80		900 150	12-C-9			
Naval	Fwd M Aft	240		240		600	12-D-1			
Containership	Fwd Ø Aft	190	20	210	9.5	650	12-D-2	1	8,10,1	₅
Tanker	Fwd J Aft	20 290 40		20 290 40		40 650 60	12-D-2			
General Cargo	Fwd M Aft	80		80		100	12-D-3			
Containership	Fwd M Aft	320	80	400	20.0	750	12 <b>-</b> D-4	1	8,10,1	P
Combination Carrier	Fwd M Aft	70		70		130	12-D-5			
General Cargo	Fwd M Aft	20		20		20	12-D-5			
	Fwd	40		40		100	10 11		1	
Combination Carrier	Aft	110		110		200	17-8-1			╎┶┷
Containership	Fwd M Aft	40		40		50	12-E-1			
Containership	Fwd U Aft	90	10	100	10.0	120	12 <b>-</b> E-2	1	12	

-187-

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DETAIL FAMILY:

PANEL STIFFENERS

LOCATION ON SH SHIP TYPE		Number of Sound Details	Number of Failed Details	Total Number Details	Percent Failures	Estimated Details on Ship	Detail Family Number	Failure Mode	Failure Cause
Containership	Fwd U Aft	60 80	Observed	60 80		80 120	12 <b>-</b> E-3		
Containership	Fwd M Aft	59	1	60	1.7	100	12 <b>-</b> F-1	1	5,10
Containership	Fwd M Aft	69	1	70	1.4	100	12 <b>-</b> F-2	1	15
Containership	Fwd M Aft	76	4	80	5.0	100	12 <b>-</b> F-3	1	7,8
Tanker	Fwd M Aft	20 60		20 60		50 100	12-F-4		
Containership	Fwd M Aft	88	2	90	2.2	200	12-F-5	1	7

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- in the 50 ship survey.
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  - 5. Shear 6. Tension
  - 7. Combined Tension
    - and Shear
- 13. Questionable 14. Heavy Seas
- o. Design 9. Fabrication/Workmanship 16. Other See Notes 10. Welding

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Distribution of this document i	s unlimited.
1. SUPPLEMENTARY NOTES	2. SPONSORING MILITARY ACTIVITY
	Naval Sea Systems Command
	Washington, D.C. 20362
3. ABSTRACT	
This report includes the results of twelve families of approximately fi types were surveyed to determine wh actually occurred.	a structural detail survey of fty different ships. Seven ship ether or not predicted failures
The families are beam brackets, trip tight collars, gunwale connections, cutouts, clearance cuts, deck cutour and panel stiffeners. Fifty-six gr observed variations in structural c synthesized by family groups.	pping brackets, non-tight collars, knife edge crossings, miscellaneous ts, stanchion ends, stiffener ends, oups evolved with a total of 553 onfiguration. The data are
During the survey 490,210 details w Eighty-two percent of the failures predominately located in structure remaining 18% were distributed, 10% spaces.	ith 3,307 failures were observed. were in the cargo space and were adjacent to the side shell. The forward and 8% aft of the cargo
Feedback data of this type should b offices. It depicts, with sketches of structural configurations and ta (See att	e invaluable to design and repair and photographs, the variations bulates all of the data collected ached sheet for continuation)
DD FORM (PAGE 1)	UNCLASSIFTED
5/N 0101-807-6801	Security Classification

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## UNCLASSIFIED

Security Classification

14. KEY WORDS	LIN	КА	LINI	кв	LINK C		
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Detail Families structural detail failure survey detail failures cracks buckles design fabrication welding maintenance operation							

Continuation of Abstract

during the survey. As an aid to engineers and designers, failure causes such as design, fabrication, maintenance and operation are postulated. Systematic performance studies of this type should be conducted in all areas of ship construction.

DD FORM (BACK) (PAGE 2)

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# SHIP STRUCTURE COMMITTEE PUBLICATIONS

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