# SSG-294

# FURTHER SURVEY OF IN-SERVICE PERFORMANCE OF STRUCTURAL DETAILS

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An Interagency Advisory Committee Dedicated to Improving the Structure of Ships

> APRIL 1980 SR-1258

In 1978, the Ship Structure Committee published a report entitled In-Service Performance of Structural Details(SSC-272). That report catalogued and defined the types and location of structural detail failures on a variety of merchant and naval vessels. This present report describes the results of a Ship Structure Committee project that continued the examination of failed or damaged details on an additional 36 ships undergoing repairs or periodic surveys. The purpose was to expand the previous 50-ship data base, with emphasis on the midship section, to determine the different type and frequency of use of structural details and to pin-point those areas where problems have occurred.

This and similar projects provide feedback to design and construction offices for increased confidence in existing design methods as well as for future improvements. When a substantial data base is formed, meaningful statistical analyses can be conducted to provide useful information to shipowners, designers and builders for proper detail selection, proper repair and maintenance, and proper fabrication.

Bell

Rear Admiral, U.S. Coast Guard Chairman, Ship Structure Committee

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This report is a continuation of Ship Structure Committee Report SSC-272, "In-Service Performance of Structural Details," dated 1978.

#### 16. Abstroct

This project is an adjunct to the Ship'Structure Committee report SSC-272. Using the same survey techniques and data analysis procedures described in that report, the midship/cargo areas of an additional twelve bulk carriers, twelve containerships, and twelve general cargo ships were surveyed under Project SR-1258. The goal of both projects 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 on ships of all types. The data from both surveys are combined and summarized for ready use by design and repair offices.

Structural detail failure data were collected for twelve detail families (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) to provide guidance in the selection of structural detail configurations. Plots of percent failures versus ship type allow an engineer/designer to establish failure trends for a specific ship type.

A total of 607,584 details were observed with a total of 6,856 failures. Failures were attributed to either one or a combination of five categories design, fabrication, welding, maintenance, and operation.

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NOTES

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#### INTRODUCTION

Newport News Shipbuilding received a contract on December 6, 1977, from the United States Coast Guard to perform the Ship Structure Committee Project SR-1258. This project titled, "Structural Details Failure Survey, Part II," is a continuation of the Ship Structure Committee Project SR-1232, "Structural Details Failure Survey,"<sup>1</sup> completed in June, 1977, by Newport News Shipbuilding. In Part II, structural detail failure data and percentages of failures for twelve families of details were collected from surveys of the midship/cargo sections of thirty-six ships. The thirty-six ships included three ship types, bulk carriers, containerships, and general cargo ships. This project, under the advisorship of the National Academy of Sciences, Ship Research Committee, is intended to extend and confirm the conclusions of the report titled, "In-Service Performance of Structural Details."<sup>1</sup>

In project SR-1232, Newport News Shipbuilding surveyed fifty ships of various types while undergoing maintenance or repairs at various shipyard/repair facilities from which the structural details obtained were grouped into twelve typical families. Using the same survey techniques and data analysis procedures developed in that project, an additional twelve bulk carriers, twelve containerships, and twelve general cargo ships were surveyed in the midship/cargo area under project SR-1258. Sketches of configurations, discussions on noteworthy observations, and summary tables for the structural details observed in this second survey is contained in the text of this report. In addition, the data collected in the continued survey has been combined with the data from project SR-1232 to expand the data base in the midship sections of the three ship types and serves to confirm or refute any conclusions that were arrived at in the first survey. This combined data from both surveys is tabulated in Appendix A.

This report serves two purposes: It is an adjunct to SSC-272<sup>1</sup> by increasing surveyed data in the midship/cargo sections of three of the ship types; and, it summarizes the data of the two surveys for ready use by design and repair offices. It must be remembered that the often overlooked structural detail is the key link in providing structural continuity for the primary structural components throughout the entire ship and if that link fails, it could mean a costly lay-up in a repair yard or even the loss of the ship.

#### SHIPS SURVEYED

Table 1 is a summary of general information for the ships in the survey. The ships ranged from 428 to 847 feet (length between perpendiculars) in length, from 18,000 to 90,000 tons in displacement, and from five to twenty-six years in age. Five of the ships, ranging from twenty-four to thirty-five years of age had been converted, lengthened, and/or deepened seven to seventeen years ago and were still in use. Twenty-four of the surveyed ships were built or converted in sixteen domestic shipyards and twelve were built or converted in ten different foreign shipyards. When combined with the first survey, this brings the totals of the three ship types to sixteen bulk carriers, twenty-four containerships, and seventeen (17) general cargo ships.

#### LOCATIONS OF SHIPS SURVEYED

The majority of the ships surveyed were in repair yards on all three coasts of the United States. It quickly became apparent that bulk carriers were not as

1. Jordan, C. R.; Cochran, C. S., "In-Service Performance of Structural Details," Ship Structure Committee Report SSC-272, dated 1978.

	1999		TABLE 1	<u> </u>		
		SUMMARY O	F SHIPS SURVEYED			
No. of Ships	<u>Classification</u>	Average LBP (Feet)	Average Displacement (Long Tons)	Average Age Years	Numb	er Built Foreign
12	Containerships	630	29,600	10	10	2
12	General Cargo	518	21,200	18	12	0
12	Bulk Carriers	639	44,900	13	2	10
36	Average/Total	596	31,900	14	24	12

easy to locate as the other types of ships since the majority of the bulk carriers fly foreign flag and, thus, have their repair work done in foreign yards. Therefore, four of the bulk carriers surveyed were located at loading facilities. Although this was not as convenient for the surveyors as having the ship in a repair yard (because of loading or unloading), the shipowners were very cooperative by opening holds, wing tanks, etc., that were normally closed.

Nineteen of the surveyed ships were at Newport News Shipbuilding. The remaining seventeen ships, eight general cargo ships and nine bulk carriers, were surveyed elsewhere.

The following is a list of survey locations:

Newport News Shipbuilding, Newport News, Virginia Norfolk Shipbuilding and Drydock Corporation, Norfolk, Virginia Bethlehem Steel Corporation, Sparrows Point, Maryland Alabama Dry Dock and Shipbuilding Company, Mobile, Alabama Tampa Ship Repair and Dry Dock Company, Tampa, Florida Two loading facilities near San Francisco, California One loading facility near Perth Amboy, New Jersey Norfolk and Western Coal Piers, Norfolk, Virginia

#### SHIPBOARD SURVEYS

The same twelve typical structural detail families that were selected in the first survey (project SR-1232) were used in this survey. The family groups are beam brackets, tripping brackets, non-tight collars, tight collars, gunwale connections, knife edge crossings, miscellaneous cutouts, clearance cutouts, structural deck cuts, stanchion ends, stiffener ends and panel stiffeners. Figure 1 shows the typical configuration for each family group and a description of its principal function.

The following procedures were used in conducting this survey:

- o Review data and interview sheets from project SR-1232
- o Review the final report of project SR-1232 (This was to assure the same approach and/or techniques were used in both surveys.)

# TYPICAL DETAILS SURVEYED

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Detail Family <u>No.</u>	Family Name	Function	Typical Configuration
1	Beam Brackets	Provide designed end constraint for primary framing and stiffening members.	
2	Tripping Brackets	Provide lateral support for framing and stiffening members.	
3	Non-Tight Collars	Provide a shear connection for framing and stiffening that are continuous through support plating.	
4	Tight Collars	Same as 3 above with the additional function of ensuring a tight condition for the penetrated plate.	
5	Gunwale Connections	Join the strength deck stringer plate to the shear strake.	
6	Knife Edge Crossing	Has no useful function. It is a potential problem area that should be avoided.	,

	<b>Typical</b> Configuration						
SURVEYED (Cont'd)	Function	Provide a wide variety of holes for access, drainage, ease of fabrication, cableways, pipes, air holes, etc.	Provide passage of one member through another member.	Provide passage through decks for access, tank cleaning, piping, cables, etc.	Provide path of transferring forces between stanchions and deck supporting members.	Develop the designed end restraint of the stiffener.	Provide stability to large panels of bulkhead plating and deep girder webs.
E 1, TYPICAL DETAILS	Name	<b>Miscellaneous</b> Cutouts	<b>Clearance</b> Cutouts	Structural Deck Cuts	Stanchion Ends	Stiffener Ends	Panel Stiffeners
FIGURE	No.		8	თ	10	I	12
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- o Obtain and review a copy of the ship's repair specifications, when possible
- Receive approval from Port Engineer (or owner's representative) and Captain to survey the ship
- Interview Port Engineer, Captain, First Mate or Chief Engineer for present and historical structural problems, as well as any other in-performance incidents that would affect the project
- o Inspect the detail families in all accessible compartments in the midship/ cargo section of the ship
- o Record all data and take photographs of unusual conditions, where allowed.

Identical ready reference data sheets used by the surveyor for the first fifty ships were used and included such data as:

Ship

- o Type
- o Size (but not name)
- o Age
- o Whether domestic or foreign built
- o Shaft horsepower

Each Configuration

- o Detail family number
- o Geometrical sketch
- o Location on ship
- o Number of details observed
- o Estimated number of failed details
- o Failure mode
- o Corroded condition
- o Weld condition
- o Workmanship
- o Conformity of parts to shape intended
- o Manual or machine preparation
- o Material type
- o Alignment
- o Probable cause of failure

Access to the ships was by the shipowner's permission only. The surveyors were, therefore, careful not to disrupt any repair work that was in progress or to jeopardize the lay-up schedule of the ship in anyway. Thus, only the structure that was visibly accessible in the open compartments was surveyed. It must be noted that accessibility to cargo spaces greatly increased from the first survey. This was made possible by leaving out potential survey candidates because their holds were loaded or partially loaded with cargo. Table 2 lists the type of compartments surveyed and the percentage of accessibility for each.

#### SYNTHESIS BY FAMILY GROUPS

As the survey data were collected and analyzed, it became apparent that each family contained many types of configurations with unique geometrical features that

TABLE 2	
COMPARTMENT ACCESSIBILITY	<u>(</u>
Compartments	Number Open (%)
Cargo Spaces	85
Inner bottom	5
Box girders (fore and aft passageways)	95
Transverse box girders	80
Wing tanks	20
Ballast tanks	5
Fuel oil tanks	3
Potable water tanks	· _ 0
Voids	5

could significantly affect the stress patterns within and around the structural detail. However, some of these configurations were only observed a few times on one or several ship types. Therefore, emphasis was placed on the individual detail configuration and how it and its family group performed in service, without regard to which ship type the configuration came from. This method provides design and repair offices a ready reference to the maximum available information of each individual detail.

In project SR-1232, there were 490,210 details observed and placed into twelve detail families. Each family was then separated into groups which contained related configurations, but differed geometrically. Out of the fifty-six groups that were formed, there were 553 distinct configurations.

The details observed in this survey that were similar to those seen in the first survey have been assigned the same detail family/group/detail numbers shown in SSC-272. For those configurations that were different, new detail numbers are assigned. There were eighty-one new configurations identified in the second survey, bringing the total for both surveys to 634 distinct variations as shown in Table 3.

Each of the twelve family details is discussed. There are sketches of configurations, discussions on noteworthy observations, and summary tables. Figures of details include both new and previous details observed. The summary tables give observed data for the second survey, plus combined results from both surveys. Since estimated data are purely subjective with no factual value, only the actual observed data are used in the summary tables.

#### FAMILY NUMBER 1 - BEAM BRACKETS

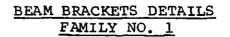
There were twenty new beam bracket configurations identified, thus, increasing the total to 145 for both surveys. This makes this family the most diversified of all. Also, beam brackets maintain their lead in the detail failure category by contributing a total of 1,364 failures. This is an increase of 476 over the first survey. The leading causes for this high rate of failures, particularly in the midship/cargo section, continues to be heavy seas and collisions with tugs, large floating objects, and piers.

	TABL	<u>E 3</u>	
	DISTRIBUTION OF DET	AIL CONFIGURATIONS	
		•	
Detail	· · · · · · · · · · · · · · · · · · ·	Number	Number
Family	Detail	of	of
Number	Family	Groups	Configurations
1	Beam Brackets	14	145
2	Tripping Brackets	3	82
3	Non-tight Collars	3	49
4	Tight Collars	4	33
5	Gunwale Connections	2	21
6	Knife Edges	0	0
7	Miscellaneous Cutouts	8	72
8	Clearance Cutouts	5	39
9	Deck Cutouts	3	23
10	Stanchion Ends	3	94
11	Stiffener Ends	5	35
12	Panel Stiffeners	6	41
12	TOTAL	56	634

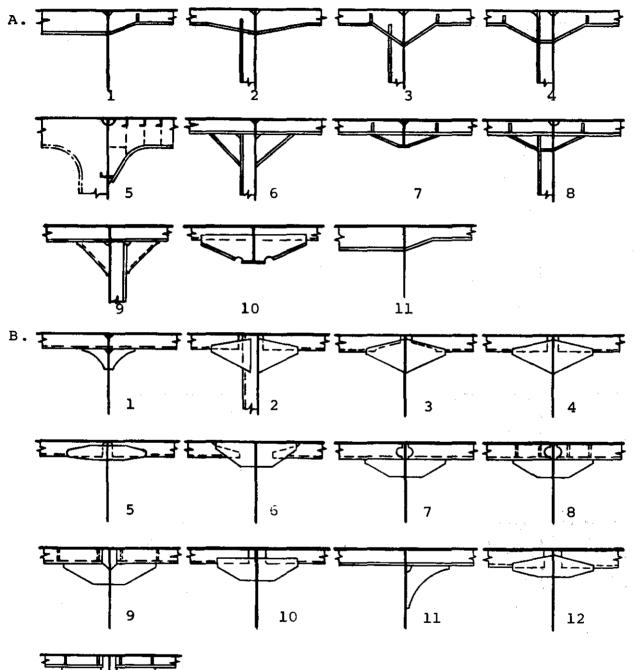
Figure 2 shows the 145 variations in configurations included in the 68,586 beam brackets observed in both surveys. The configurations that occur most often in the midship/cargo section of containerships and general cargo ships are the corner bracket configurations 1-C-1, 1-C-25, 1-C-2, and 1-E-1. They also have a high failure rate, ranking number one, two, four and eight, respectively, in the top ten most prevalent failure details. In the first survey, detail 1-C-1 ranked third and detail 1-C-2 ranked eighth in the same category. Many of the group "C" corner bracket failures could be attributed to instability of the bracket plate panel. This was especially true on containerships where long spans of shell framing were supported at the ends with unflanged triangular plate with very high breadth/thickness ratios. It was interesting to note that on general cargo ships where wood framing was attached to the shell framing flanges to protect the cargo there were less failures among the group "C" brackets. This was because the tightly wedged wood framing served as intermediate lateral supports for the shell framing and prevented the flanges from tripping under minor local collisions. The wood framing also assisted by forming a grid on the shell framing. Stability was not the problem with the group "E" flanged-plate brackets, because the shell framing or deck framing member usually cracked or buckled near the bracket connection first. Again, the major cause of these severe loads is collisions. It is realized that accidents do happen, but a lot of preventative measures, such as reinforced areas in the ship's hull designated as tug stations, and the use of heavy duty rubber fenders at piers and loading docks, could be applied.

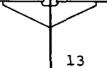
Several failures occurred to the end bracket details 1-H-13 and 1-H-15. These two details served as end brackets for transverse main deck stiffening running from the side shell to the hold openings in main deck. The brackets buckled under excessive loads on main deck where containers were being stowed. The main deck stiffeners had been reinforced with doublers and rider plates for the increase in loads but no attention had been given to the existing brackets.

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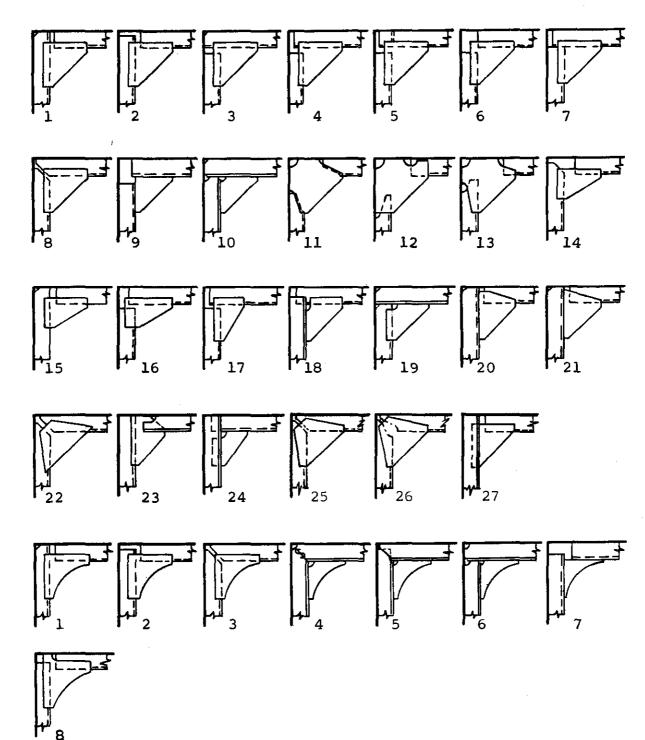


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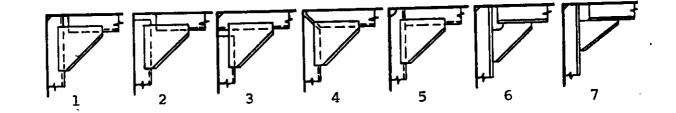
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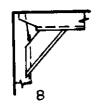
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FIGURE 2 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)

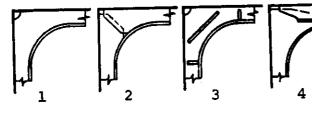
CORNER (Cont'd)

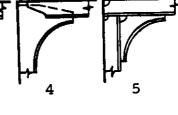
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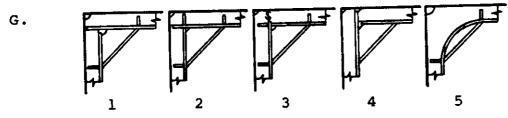








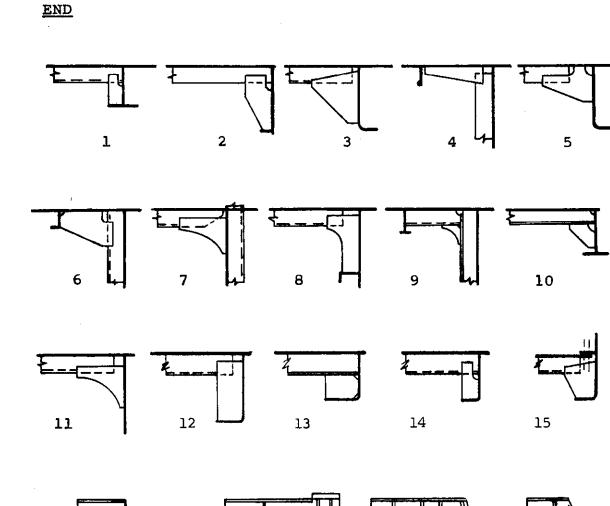




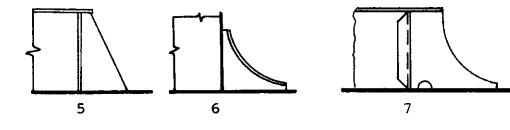
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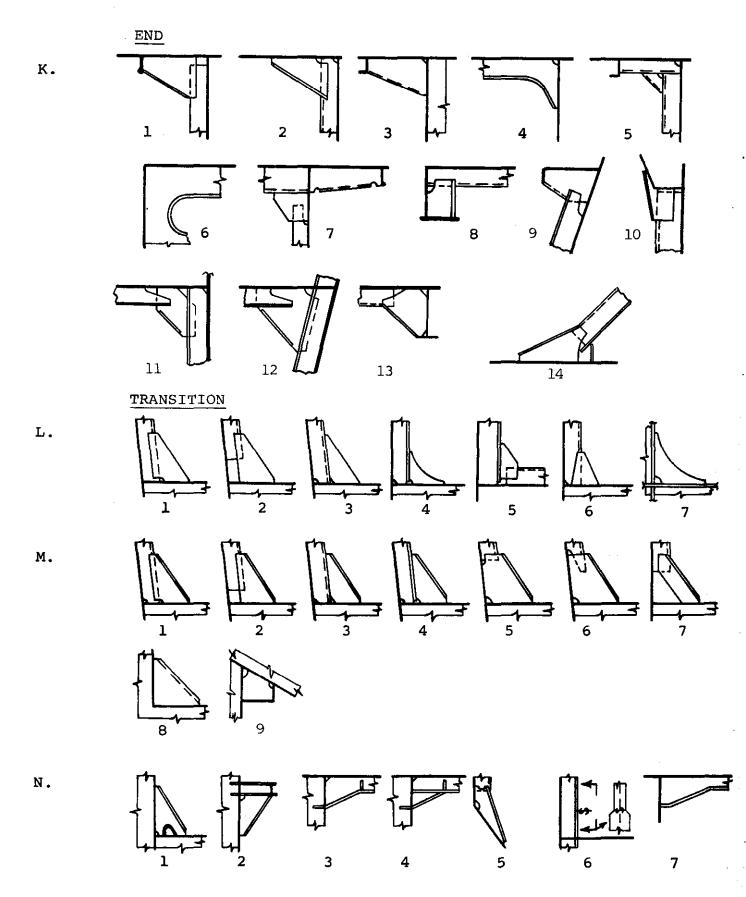






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FIGURE 2 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)

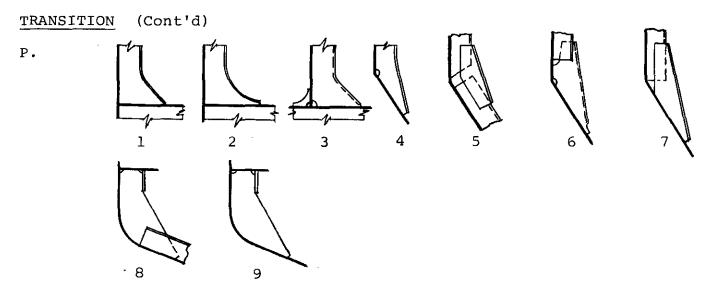


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#### FIGURE 2 - BEAM BRACKETS DETAILS, Family No. 1 (Cont'd)



The transition brackets of family group "M" were quite common near the turn of the bilge and, thus, were quite susceptible to corrosion. Proper design, such as drain holes to prevent standing water and elimination of inaccessible areas, coupled with a regularly enforced maintenance program, would have prevented failures in this area.

Table 4 is a summary table of beam brackets observed in the second survey, plus the total observed for both surveys. Although the number of observed details increased by only 35%, the number of failures increased 154%. This was expected since the first survey had shown that the majority of the failures were located in the midship portion of the ship, predominately in structure adjacent to the side shell, and this is where the majority of the beam brackets are located for containerships, general cargo ships and bulk carriers. For instance, the corner brackets of group "C" increased in failures from 2% to 18.3%. The 7.65% failure rate for the midship/cargo section survey of Part II brought the average failure rate up from 1.75% for 50 ships to 3.28% for all 86 ships making beam brackets second to tripping brackets for the highest failure rate.

Figures 3 and 4 are photographs of beam brackets with failures on two different containerships. Figure 3 shows three flanged corner brackets that have remained stable, but the framing that they support has buckled and cracked. Similar failure patterns are shown in Figure 4 where even the bracket itself has started to buckle.

#### FAMILY NUMBER 2 - TRIPPING BRACKETS

The three groups of tripping brackets, containing 82 different configurations, are shown in Figure 5. Sixteen new variations were found in the second survey with eleven belonging to group "C". Group "C" also continued to have the highest failure percentage rate of the three groups, thus, placing four details on the top ten most prevalent failure list and one detail on the top ten highest percentage failure list. Details 2-C-19, 2-C-11, 2-C-7, and 2-C-20 ranked third, fifth, sixth and tenth, respectively, under most prevalent failures. Details 2-A-20 and 2-C-27 were seventh and tenth under highest percentage failures.

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# TABLE 4

# SUMMARY OF BEAM BRACKETS

FAMILY GROUP	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS
A	-	-	-	4950	4928	99.6
в	216	213	98.6	4396	4286	97.5
с	6115	4996	81.7	28695	27129	94.5
D	50	50	100.0	3970	3967	99.9
E	3782	3657	96.7	5642	5514	97.7
F	178	176	98.9	1228	1198	97.6
G	74	74	100.0	5114	5114	100.0
H	4166	4120	98.9	5556	5486	98.7
J	214	213	99.5	474	424	89.5
K	1254	1252	99.8	1954	1918	98.2
L	306	305	99.7	1366	1297	94.9
М	1163	1119	96.2	3633	3568	98.2
N	-	-	_	630	593	94.1
P	318	297	93.4	978	912	93.3
TOTAL	17836	16472	92.4	68586	66334	96.7

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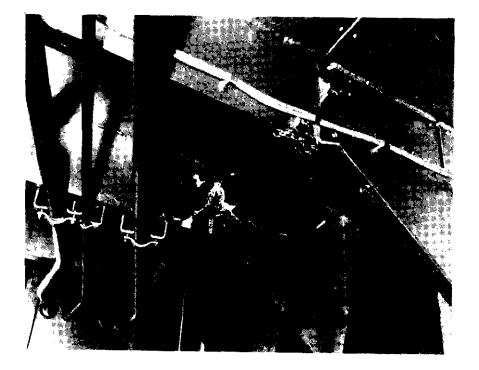
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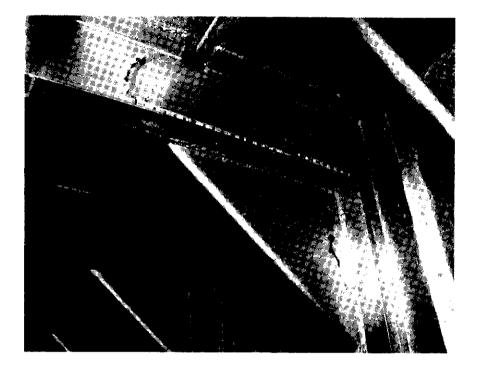
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#### FAILED CORNER BRACKETS ON A CONTAINERSHIP



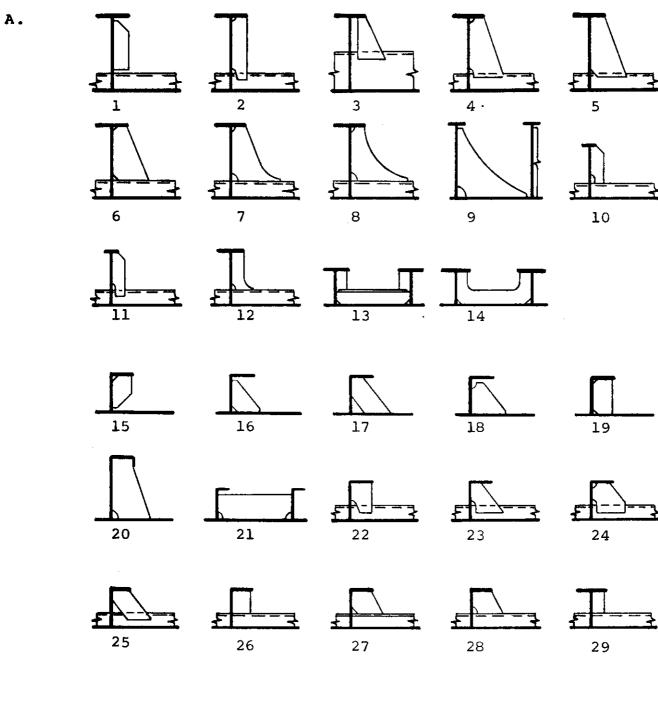
View of hold showing shell framing bracket connections with framing below fore/aft box girder. The shell framing has been subjected to heavy sea loadings and the loads transferred through the corner brackets have caused the box girder framing to buckle. Note the crack in the web of the framing member in the foreground where the cable clip was welded.

#### FAILED CORNER BRACKET ON A CONTAINERSHIP



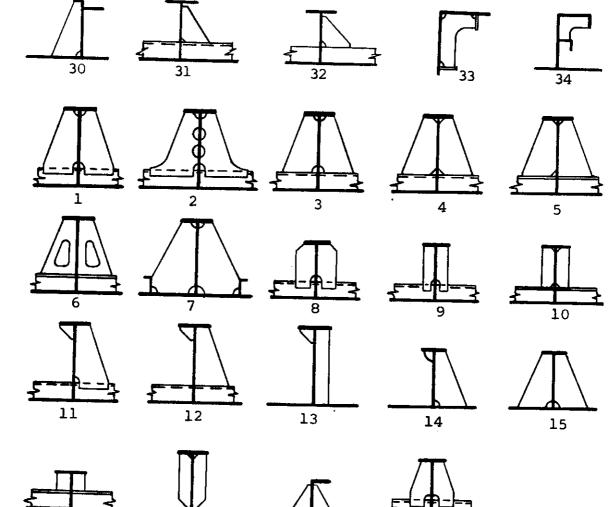
Another view of a shell framing bracket connection with a deck stiffener. The peeling paint clearly shows the high stress areas where buckling is about to occur. The weld clearance cutout for the butt weld in the deck above would have been a primary source for a crack if the cutout had not been a smooth cut.

TRIPPING BRACKET DETAILS FAMILY NO. 2



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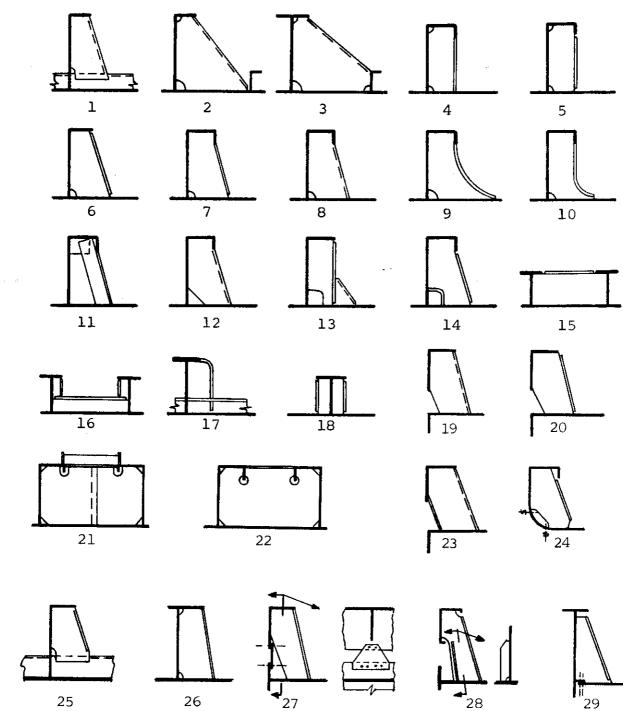
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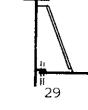
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FIGURE 5 - TRIPPING BRACKET DETAILS, Family No. 2 (Cont'd)

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Details 2-C-19 and 2-C-20 sustained a high number of failures for several reasons. Poor welding, neglect, cargo collisions, and misuse/abuse were a few causes, but a consistently high percentage of failures occurred where these details were used to secure the booms of general cargo ships when at sea. These details are typical of the tripping brackets used to support the bulwark that runs fore/aft just above the gunwale on both sides of the ship. Tie-down cleats welded to the top of this bulwark make very convenient securing points for the huge booms. When under heavy weather at sea, large shear and tensile forces are applied to the tripping brackets due to the athwartship "G" forces of the heavy booms. Failures even occurred when an extra flange was added to the bracket as in detail 2-C-23. The surveyors did find, however, that on ships where extra tripping brackets and larger scantlings were used under boom tie-downs, no failures occurred.

The high number of failures for detail 2-C-ll resulted primarily from poor fabrication/workmanship. On several general cargo ships, this tripping bracket was used to support the hatch coaming girder on main deck and was partially removed by the ship's crew in order to replace existing pipe that runs alongside the hatch coaming. In replacing the lower half of the tripping bracket, the crew's workmanship was poor. Poor lap welding, sharp notches and very rough cutouts for the pipe quickly developed corrosion and cracks.

Details 2-C-7 and 2-C-8 on both containerships and bulk carriers continue to contain failures when located on the transverse ends of the hatch coamings. Observed failures of details 2-A-20, 2-C-4, and 2-C-26 increase significantly the total list of failures observed for hatch coaming brackets. Heavy seas, welding, neglect and cargo collisions, combined with poor design, have made the task of supporting the hatch side girders a costly one. Additionally, it is necessary to design brackets to carry large lateral loads from rolling when the containers are stacked in four tier heights.<sup>1</sup> Proper design, as shown in detail 2-C-9, should also allow for a smooth transition for the load to travel from the tripping bracket to the back-up structure below. The surveyors noted on several occasions that detail 2-A-20 had been repaired by adding a radiused extension at the toe of the bracket to reduce subsequent failures. This smooth transition provided by the radiused extension is most important when the bracket lines up with the fore/aft hatch side girder. When the fore/aft header, forming the back-up structure for the bracket, reaches the coaming girder there is a significant increase in inertia. Such an abrupt change in stress flow increases crack susceptibility, as was the case 80% of the time.

Table 5 is a total summary of the tripping brackets observed in both surveys. The tripping bracket family had the highest percent of failures with 9.52%, and the second highest number of failures with 1,273 for the second survey. This brought the average failure rate up from 1.52% for the first fifty ships to 4.67% for the total eighty-six ships, making tripping brackets the leader in failure percentage. Much of this can be attributed to the many failures on the bulwark brackets of general cargo ships, and hatch coaming brackets on containerships and bulk carriers, especially in the midship/cargo area.

Figures 6, 7, and 8 are photographs of tripping bracket failures. Figure 6 shows the poor workmanship by the crew on a general cargo ship in the replacement of a pipe adjacent to a main deck hatch coaming. Figures 7 and 8 show failures of tripping brackets on the transverse ends of the hatch coamings on a containership.

<sup>1.</sup> Jordan, C. R.; Ward, W. C., "Structural Details of Ships In Service," presented at Hampton Roads Chapter, Society of Naval Architects and Marine Engineers, March 15, 1978.

# TABLE 5

## SUMMARY OF TRIPPING BRACKETS

	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS
A	2083	1953	93.8	12323	12132	98.5
в	126	126	100.0	7046	6991	99.2
С	11163	10020	89.8	14643	13302	90.8
TOTAL	13372	12099	90.5	34012	32425	95.3

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#### FAILED TRIPPING BRACKET ON HATCH COAMING OF A GENERAL CARGO SHIP



This is a view of a hatch coaming bracket on main deck. The lower end of each of the brackets were removed by the ship's crew in order to replace the large pipe at the right. Poor workmanship was evident in the replaced bracket as shown by the jagged cutout for the pipe and the sharp notch at the lap weld where a crack started and progressed the entire width of the web. Numerous failures were found among these brackets.

#### FAILED TRIPPING BRACKET ON HATCH COAMING OF A CONTAINERSHIP



View of a transverse hatch coaming bracket at about midship. The weld of the bracket to the deck had been rewelded once and has cracked again. A weld repair of a crack also extends from the corner of a drain cutout to the center of the bracket.

# FAILED TRIPPING BRACKET ON HATCH COAMING OF A CONTAINERSHIP



This transverse hatch coaming bracket is about two hatches forward of midship. A crack forms a "V" just above the sign and extends around the bracket flange at the weld to the hatch coaming, separating the bracket into two pieces.

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

Of the 4,724 non-tight collar details observed in this thirty-six ship survey there were only five failures. Incomplete welding on detail 3-A-16 resulted in two detail failures on a bulk carrier while poor workmanship and bad welding accounted for three failures of detail 3-A-25 on a containership. Thirteen new variations in configurations were observed in this survey, thus resulting in an overall total of forty-nine configurations for the three group family. Figure 9 shows the forty-nine configurations, and Table 6 summarizes the results.

For both surveys, group "A" had 48% of the failures, group "C" had 52% of the failures, and group "B" continued to be failure free. By maintaining a 99.8% rate for sound details in both surveys, the non-tight collar family has the lowest failure rate of all the twelve detail families. One other interesting observation on non-tight collars was noted; although 74% of the details were observed in the midship/cargo section, 79% of the failures occurred in the foreward and aft portions of the ship.

In summary, with proper fabrication, such as smooth, well radiused cutouts and sufficient scantlings on the collar to carry the shear load, united with correct welding techniques, the non-tight collar shall continue to be an economical and dependable structural detail used in building ships.

#### FAMILY NUMBER 4 - TIGHT COLLARS

Figure 10 contains the thirty-three variations in configurations observed for the family of tight collars. Detail 4-C-7 is the only new configuration identified in this survey. Table 7 is a summary of the number of sound details observed as well as the total observed for both surveys.

Although there were no failures reported in the first survey, there were forty-six or 1.73% failures observed in the midship/cargo area in this survey. Forty-five of the failures belonged to the group "A" configurations and the remaining failure was from group "C". Neglect and collisions were responsible for the forty-five failures of details 4-A-3 and 4-A-6 on three separate general cargo ships. In each case, the tight collar was located where the shell framing member interfaces with the deck. A lack of maintenance resulted in the collars becoming highly corroded in this area. When the shell framing came under heavy loading from collisions, the collars simply buckled due to their reduced thickness.

The only other tight collar failure observed occurred to detail 4-C-1. The detail was located on a containership at the intersection of a shell stringer and a transverse web frame in the fore/aft box girder. The collar and the local web frame were buckled but there was no apparent impact loading on the shell plating. Possibly a large gunwale load caused the subsequent buckle in the web frame.

With the 1.73% failure rate recorded in the second survey, the percent of sound details was lowered from 100% to 99.8%, but the tight collar, as well as the non-tight collar, still remains as one of the most trouble free structural details.

### FAMILY NUMBER 5 - GUNWALE CONNECTION

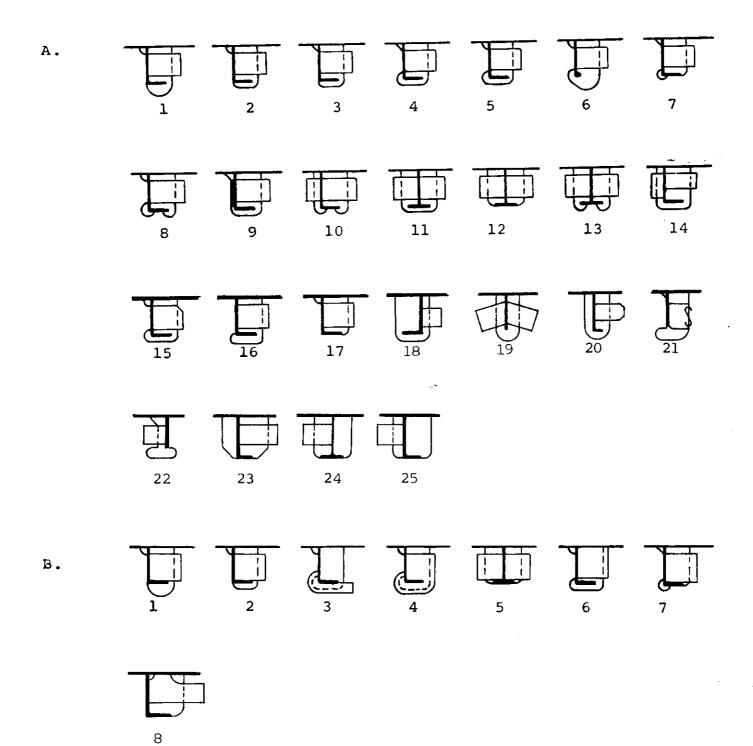
In the second survey, one new variation of riveted gunwale connections was observed. This increased the total number of riveted connections to thirteen,

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NON-TIGHT COLLAR DETAILS FAMILY NO. 3

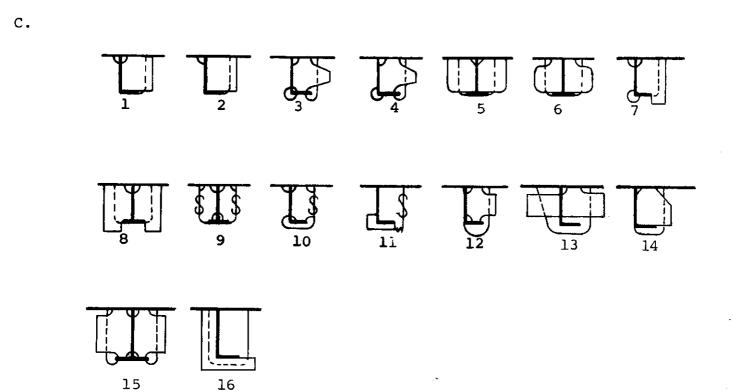


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NON-TIGHT COLLAR DETAILS FAMILY NO. 3 (Cont'd)



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## SUMMARY OF NON-TIGHT COLLARS

	OBS	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	
A	3406	3401	99.9	9956	9940	99.8	
в	903	903	100.0	6603	6603	100.0	
С	415	415	100.0	4415	4398	99.6	
TOTAL	4724	4719	99.9	20974	20941	99.8	

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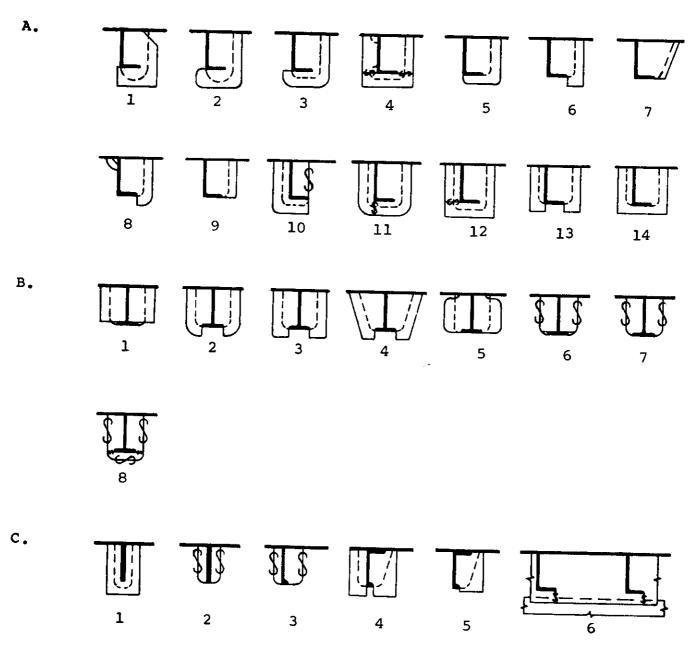
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TIGHT COLLAR DETAILS FAMILY NO. 4





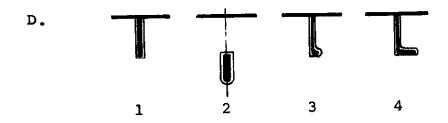
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TIGHT COLLAR DETAILS FAMILY NO. 4 (cont'd)



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## SUMMARY OF TIGHT COLLARS

,	OBS	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	
А	1851	1806	97.6	9071	9026	99.5	
в	418	418	100.0	4188	4188	100.0	
С	193	192	99.5	933	932	99.9	
D	192	192	100.0	6462	6462	100.0	
TOTAL	2654	2608	98.3	20654	20608	99.8	

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combined with the welded connections, the total number of configurations becomes twenty-one. The two groups are shown in Figure 11, and all summarized data are given in Table 8.

Only one failure was observed in the second survey as opposed to four found in the first survey. Detail 5-A-1 was the source of a local out-of-plane displacement in the vertically cantilevered portion of the shear strake just above main deck on a containership. This failure was similar to the four in the first survey except the plate displacement was outboard instead of inboard. Collision could not be ruled out, but since the displacement was outboard and located just forward of the aft deckhouse, excessive compressive stresses in the gunwale was a possible cause of failure. Further investigation did not reveal any other problems locally or in the gunwale connection on the other side of the ship. Figure 12 is a photograph of the failure.

As in the first survey, workmanship and welding was excellent on most of the gunwale connections although deterioration by corrosion was evident in some places. A few containerships contained drain holes on main deck very close to the gunwale connection. All the cutouts were reinforced with drain pipes and with proper fabrication/workmanship techniques employed, no cracks were observed. However, one historical crack existed on main deck on a containership that started near the gunwale connection and worked its way inboard. The crack kept reappearing in a butt weld on a doubler plate. The doubler plate was located on top of the fore/aft box girder at the connection of the new mid-body to the original ship. The area had been rewelded about five times leaving a butt weld bead about two inches wide.

In summary, there were only five failures occurring on three different ships for the total eighty-six ship survey. Four of the five failures were suspected to be due to exterior abuse rather than to the internal stresses from ship operations as surmised in the last failure. The total failure rate for gunwale connections is 2.91%.

### FAMILY NUMBER 6 - KNIFE EDGES

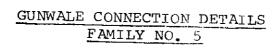
There were no knife edges found on any of the thirty-six ships. This was expected because as stated in the first survey, "to detect a definite "knife" requires a study of the detail structural plans used in the construction of the ship and in all subsequent structural modifications. This would be extremely time-consuming as well as impossible for a study of this type since the ships do not carry these drawings with them."<sup>1</sup>

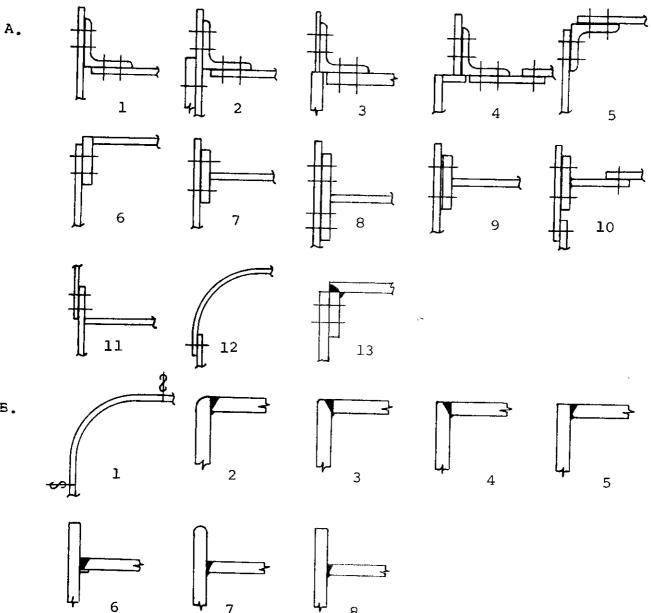
#### FAMILY NUMBER 7 - MISCELLANEOUS CUTOUTS

Miscellaneous cutouts are utilized extensively throughout the length of the ship. They vary in size from an air hole to an access opening but each one has a particular structural function. Figure 13 shows the seventy-two observed shape variations including the seven new ones observed in the second survey. The variations are grouped according to one of the following functional requirements:

- o Group 7-A access openings
- o Group 7-B air escapes
- 1. Jordan, C. R.; Cochran, C. S., "In-Service Performance of Structural Details," Ship Structure Committee Report SR-1232, March, 1977

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## SUMMARY OF GUNWALE CONNECTIONS

	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS			
FAMILY GROUP	NUMBER OF DETAILS	NC. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	
A	42	41	97.6	10 <b>2</b>	99	97.1	
В	30	30	100.0	70	68	97.1	
TOTAL	72	71	98.6	172	167	97.1	

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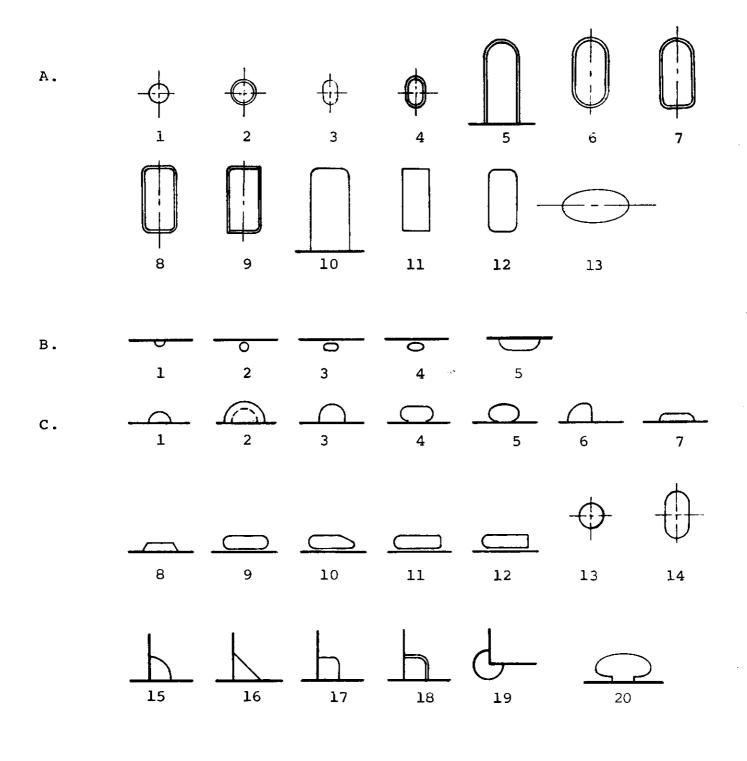
## FAILED GUNWALE CONNECTION ON A CONTAINERSHIP



This view shows a gunwale connection with the upper portion of the shear strake displaced outboard. Location was near midship just forward of the deckhouse. Collision was not ruled out, but excessive compressive stresses in the gunwale was highly suspected as the cause of failure.

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MISCELLANEOUS CUTOUT DETAILS FAMILY NO. 7

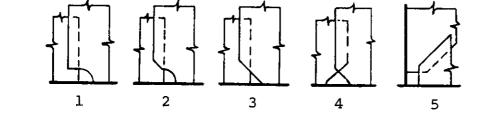


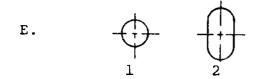
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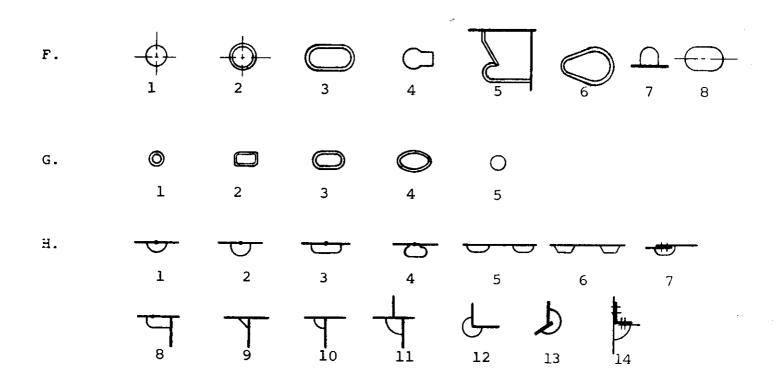
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FIGURE 13 - MISCELLANEOUS CUTOUT DETAILS, Family No. 7 (Cont'd)

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- o Group 7-C drain holes
- o Group 7-D lapped web openings
- o Group 7-E lightening holes
- o Group 7-F pipeways
- o Group 7-G wireways
- o Group 7-H weld clearances

Since each individual detail may have more than one primary function, some of the configurations may appear in more than one group. Table 9 contains a summary of the 296,689 details observed in both surveys.

There was one failure observed for the family of access openings in the second survey. Detail 7-A-10 had a three inch crack in the lower right corner of the cutout. The cutout, used as an access opening in the longitudinal bulkhead of a general cargo ship, should have possibly had a coaming to help protect it against secondary bending in this primary strength member. Many historical cracks were seen around the main deck doorways leading into the deckhouse as mentioned in the first survey, but no failures were recorded since all surveying was restricted to the immediate midship/cargo area.

No failures were reported for air holes, however, their location made them highly susceptible to neglect and subsequent corrosion. One new configuration was recorded as detail 7-B-5.

Three different details contributed to the fifty-one drain hole failures. Details 7-C-1, 7-C-15 and 7-C-16 failures were caused predominantly by rough cutouts and neglect. Figure 14 is a photograph of a typical drain hole that was cracked as a direct result of a rough cutout. This particular drain hole should have been given special attention due to its location in a high stress region. An excellent list of rules for fabrication is provided in "Structural Details of Ships In Service."<sup>1</sup>

Only 360 lapped web openings were viewed in the second survey with no failures reported. The majority of these were found in the fore/aft box girders on a German built containership. The cutouts had smooth, well rounded radii and ample clearance for welding.

Lightening hole details 7-E-1 and 7-E-2 were found in the midship/cargo area of each of the three ship types surveyed, but no failures were observed. In the first survey, of these three ship types the containerships had four failures, while 155 or 97% of the total failures occurred in tankers and combination carriers. Bulk carriers and general cargo ships showed no failures for lightening holes in either survey.

Ninety-one percent of the pipeway failures in group "F" were attributed to cutout configurations, such as 7-F-1, which do not have reinforcing rings around the hole Other reasons for failures were rough cutouts, defective welds, heavy seas, and improper location of hole cuts in high stress regions. Some good examples of typical pipeway failures are shown in Figures 15 and 16.

Wireways had only seven failures, five were detail 7-G-3. The cracks were due to poor fabrication/workmanship and lack of fusion in welding. Two cracks

Jordan, C. R.; Ward, W. C., "Structural Details of Ships In Service," presented at Hampton Roads Chapter, Society of Naval Architects and Marine Engineers, March 15, 1978.

## SUMMARY OF MISCELLANEOUS CUTOUTS

	OBS	ERVED SECOND SUR	VEY	TOTALS OF	TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	
A	959	958	99.9	4809	4780	99.4	
В	2130	2130	100.0	18940	18912	99.9	
с	9111	9060	99.4	59091	58954	99.8	
D	360	360	100.0	2550	2531	99.3	
E	2041	2041	100.0	19551	19392	99.2	
F	2565	2542	99.1	6575	6542	99.5	
G	620	613	98.9	10520	10508	99.9	
Н	26033	25908	99.5	174653	174217	99.8	
TOTAL	43819	43612	99.5	296689	295836	99.7	

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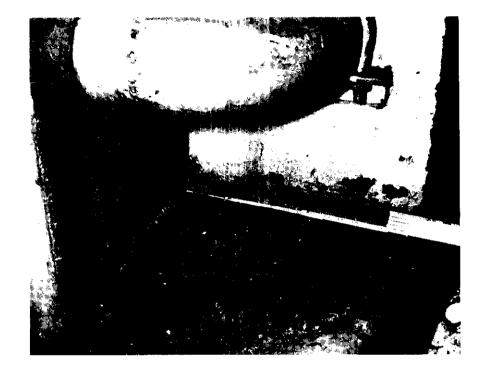
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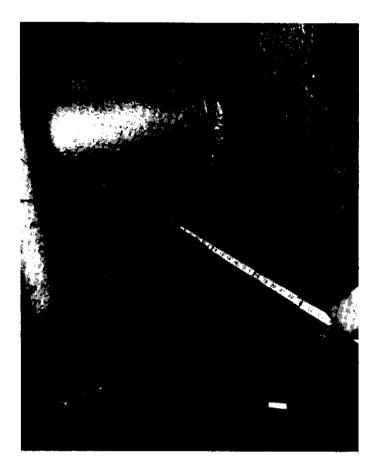
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# FAILED DRAIN HOLE IN A TRIPPING BRACKET ON A CONTAINERSHIP



This is a view of a cracked drain hole cutout located in a tripping bracket that supports the hatch coaming on a containership. If the cutout had formed a smooth semicircle instead of the irregular cut that is shown, the crack would probably have not occurred.

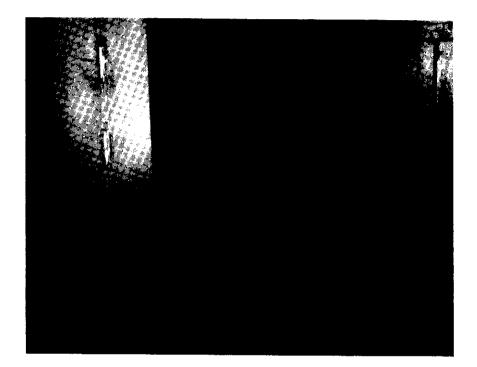
### FAILED PIPEWAY CUTOUT IN A HATCH COAMING BRACKET ON A CONTAINERSHIP



View of a pipeway cutout in a tripping bracket at the corner of a hatch coaming on main deck. Notice where previous cracks have been welded around the cutout in both the one and six o'clock positions. In the six o'clock position, the crack had extended to a drainage cutout in the corner. A reinforcing ring has been added to help strengthen the hole in this region of high tensile stress. Also, just above the hand in the picture, can be seen a radiused plate that has been added to the bracket in order to smooth the transition of the bracket with the deck. This is an area where cracks at the toe of the bracket are common.

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### BUCKLED WEB PLATE AROUND PIPEWAY ON A CONTAINERSHIP



View in hold showing shell framing on the left and a transverse bulkhead on the right. The shell has been loaded by heavy seas resulting in some permanent deformation. The peeling paint shows the stress patterns around the hole cut for the pipe and at the intermittent welds on the shell framing. The hole should have been reinforced with a face plate, however, proper design would have required the pipe to go through the bulkhead via the existing wireway cutout below. were found in a transverse box girder on a containership; and, five were found in the fore/aft box girder of a bulk carrier which had been converted from a Navy missile ship.

As in the first survey, weld clearances experienced more failures than any other group in this family. Configurations 7-H-9, 7-H-1, 7-H-10, 7-H-13, 7-H-11, 7-H-2 and 7-H-3 contained the defects in numerically descending order. Elongated cracks originating at the cutouts were the only failure modes and no one factor predominated the long list of failure causes. However, one new variation in configuration, detail 7-H-13, consistently showed a high percentage of failures on bulk carrier sister ships. The cutouts were in the transverse web frames in the wing tanks where the vertical and sloping hold bulkheads intersected. Although workmanship and welding were excellent, cracks existed at both the top and bottom of this cutout in an area of high stress.

Figures 17 and 18 are pictures of two weld clearance cuts with failures. Both failures were a direct result of poor fabrication and welding. In Figure 17, the existing weld clearance cutout was extended to meet a replaced shell framing member. The cutout was made smooth. However, because of the location and a bad weld, a failure was inevitable. Figure 18 shows a large crack extending from a cutout similar to 7-H-1 in a main loading carrying girder on a general cargo ship.

As was found in the first survey, no one group of miscellaneous cutouts could be singled out as having more failures than the others. Three groups had 100% sound details and each of the remaining five groups had less than a 1% failure rate. The second survey had 207 failures for a 0.47% failure rate which brought the totals up to 853 failures and a 0.29% failure rate for both surveys. This is a very low failure rate, but, by having 853 failures, the family is ranked third on the most prevalent failure list.

#### FAMILY NUMBER 8 - CLEARANCE CUTOUTS

The purpose of clearance cutouts is to maintain continuity of one member through another. There are thirty-nine variations in configuration for this family as shown in Figure 19. Details 8-A-3, 8-B-7, 8-E-13, and 8-E-14 are new configurations identified in this survey. The details are grouped according to geometrical shape or attachment to the impeding structural member. Results for this grouping are summarized in Table 10.

In the second survey, there were no failures observed in groups "A" and "D". Group "D" listed 593 failures in the first survey, but only eight of those were found aboard one of the three ship types investigated in the second survey. Detail 8-B-2 was the lone failure for group "B" and it could have been avoided with proper workmanship. Group "C" had three failures contributed to fabrication and welding and two failures contributed to high tensile and shear stresses around a stiffener cutout on a self-unloader gate on a bulk carrier. Twelve of the sixteen failures in group "E" were found in the wing tanks of a 90,000 ton bulk carrier. Only a few of the wing tanks were made accessible to the surveyors, however, the shipowner stated the cutouts had a history of problems throughout the ship. The owner felt that a lack of protective coating on the edges of the cutout during fabrication had resulted in stress corrosion, causing cracks in the radiused corners.

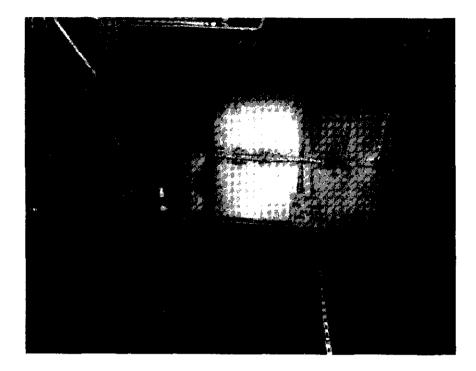
# FAILED WELD CLEARANCE CUTOUT ON A CONTAINERSHIP



This picture in the cargo hold of a containership shows the end connections of two shell framing members that have been replaced. The existing weld clearance cut was extended to meet the new framing member. The welding for this particular framing member was so bad that a crack had started in the center of the web.

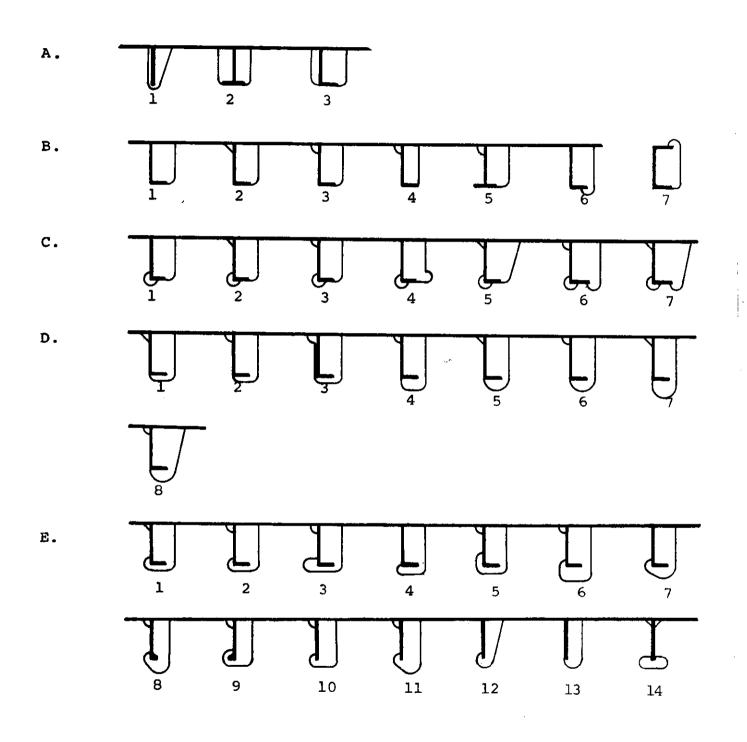
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FAILED WELD CLEARANCE CUTOUT ON A GENERAL CARGO SHIP



View in cargo hold looking up at a longitudinal girder under main deck. A crack extends from the butt weld clearance cutout to the transverse header on the right, and from the same cutout for a distance of about two feet on the left. The crack is mostly in the heat affected zone of the weld except for a small length at the left. Note pillar supporting girder at the far left. The cutout had been extended to reach the butt weld in main deck.

CLEARANCE CUTOUTS DETAILS FAMILY NO. 8



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## SUMMARY OF CLEARANCE CUTOUTS

FAMILY GROUP	OBS	SERVED SECOND SUP	RVEY	TOTALS OBSERVED BOTH SURVEYS		
	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS
A	252	252	100.0	672	636	94.6
в	537	536	99.8	6757	6726	99.5
С	773	768	99.4	9813	9733	99.2
D	1026	1026	100.0	15106	14513	96.1
E	6209	6193	99.7	24959	24856	99.6
TOTAL	8797	8775	99.7	57307	56464	98.5

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Figure 20 shows an attempt to repair a crack in the web plating at the heel of a through angle stiffener on a longitudinal bulkhead. The previous crack has been welded shut and a flat bar stiffener added to prevent future cracks; but, as shown in the picture, a crack has appeared again, this time in the heat affected zone of the weld.

In summary, there were only twenty-two failures observed for the family of clearance cutouts in the second survey. This was only about three percent of the 821 failures found in the first survey, however, 752 of those first survey failures were from tankers and combination carriers. The remaining sixty-nine failures on containerships, general cargo ships, and bulk carriers, represents a failure rate of 0.36% which is in line with the 0.25% failure rate for survey number two.

#### FAMILY NUMBER 9 - DECK CUTOUTS

Sketches of the three groups of deck cutouts are presented in Figure 21. There were twenty-one variations in configurations with no new variations observed in the second survey. Groups "A" and "B" are small deck openings normally used for access, and group "C" configurations are deck cuts at corners of large hatch openings. Table 11 is a summary of the collected data for the second survey and both surveys combined.

One hundred percent of the deck cuts in group "A" were functionally sound. In fact, there was only one failure among the group "A" configurations in the first survey. However, group "B", even with a coaming around the hole to help give some extra support, was the source of twelve failures. Eight of those failures were found in the main deck of a single bulk carrier. Thirty-two percent of the cargo hold access openings (detail 9-B-2) contained three and four inch cracks in their corners. The ship came into Newport News Shipbuilding for emergency repairs with a cargo of coal which was loaded on board in the Hampton Roads area. An interview with the Captain revealed that the cracks had appeared in the strength deck after "the worst storm I've seen in fifteen years," while crossing the Atlantic on the trip over. In addition to the rough seas, small radiused corners and corrosion were contributing factors to the failures.

Three of the five failures in the group "C" cutouts were caused by severe impact loadings, presumably while handling cargo. Corrosion was evident at the sharp cracks and buckles in the corners of several hatch cuts similar to detail 9-C-4. Detail 9-C-4 was also responsible for the remaining failures in group "C". One was on a general cargo ship and the other was on a relatively new containership. In both cases, in the curve of detail 9-C-4 there was a butt weld where the thicker deck plating near the gunwale joined a thinner panel of deck plating which extended to the centerline and beyond. The butt weld was too rough with a notch, which resulted in a crack in the weld. The crack on the containership had even extended beyond the hatch coaming. This is probably one of the worst places for a crack to appear due to the high primary stresses that "flow" around these cutouts.

In summary, deck cutouts are second to gunwale connections for least number of failures for both surveys, but, also like gunwale connections, any crack, no matter how small, could have catastrophic results.

#### FAMILY NUMBER 10 - STANCHION ENDS

Figure 22 shows ninety-four observed stanchion end variations which includes the fifteen new ones observed in the second survey. The variations are grouped

### FAILED CLEARANCE CUTOUT ON A CONTAINERSHIP

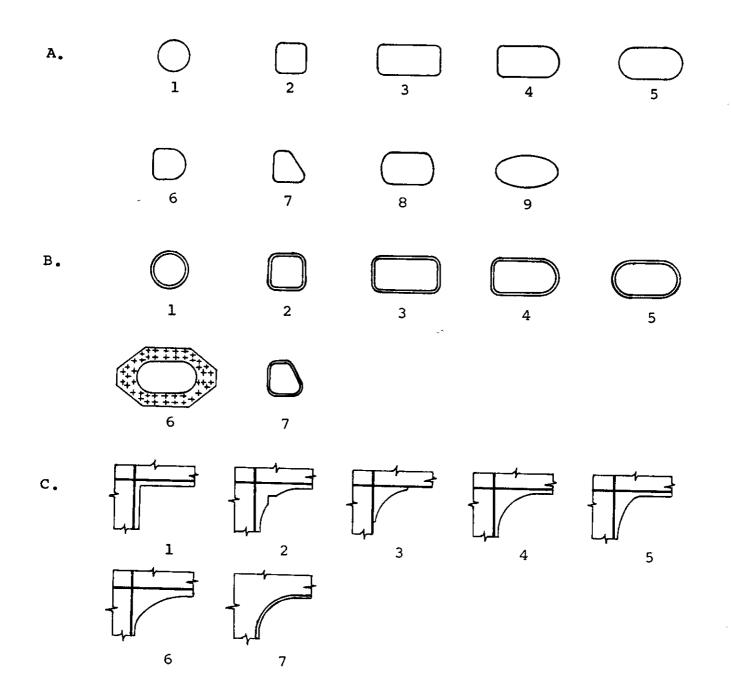


The view is looking aft at a clearance cutout in a transverse web frame for a longitudinal bulkhead stiffener. The cutout, similar to detail 8-C-3, has had a previous crack welded shut and a flat bar stiffener added in an effort to prevent future cracks. However, a new crack has started at the heel of the angle and traveled in the heat affected zone of the weld all the way to the face plate around the arch.

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DECK CUTOUT DETAILS FAMILY NO. 9



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## SUMMARY OF STRUCTURAL DECK CUTS

FAMILY GROUP	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	ء SOUND DETAILS
A	321	321	100.0	2951	2950	100.0
в	472	460	97.5	2962	2945	99.4
С	711	706	99.3	1621	1610	99.3
TOTAL	1504	1487	98.9	7534	7505	99.6

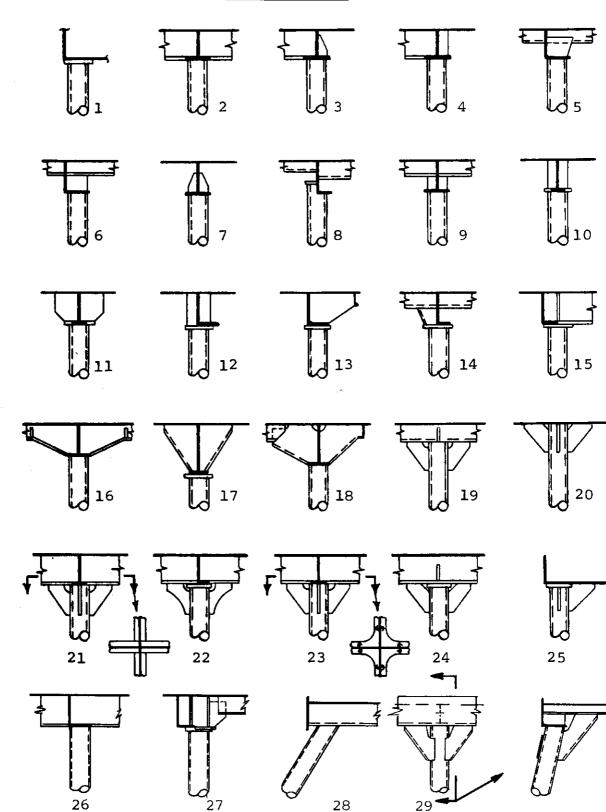
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STANCHION END DETAILS FAMILY NO. 10

A.

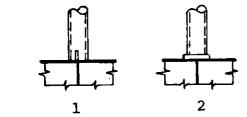


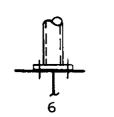
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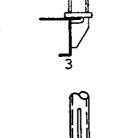
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FIGURE 22 - STANCHION END DETAILS, Family No. 10 (Cont'd)

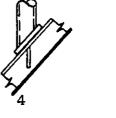


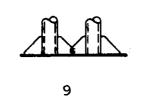


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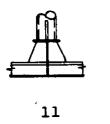
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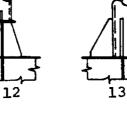


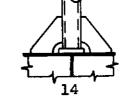


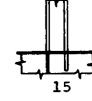


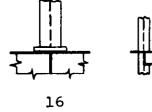


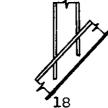


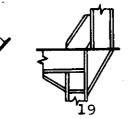




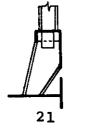


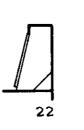




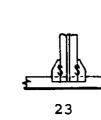


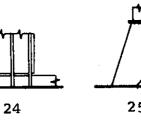






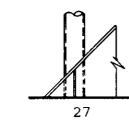
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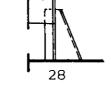






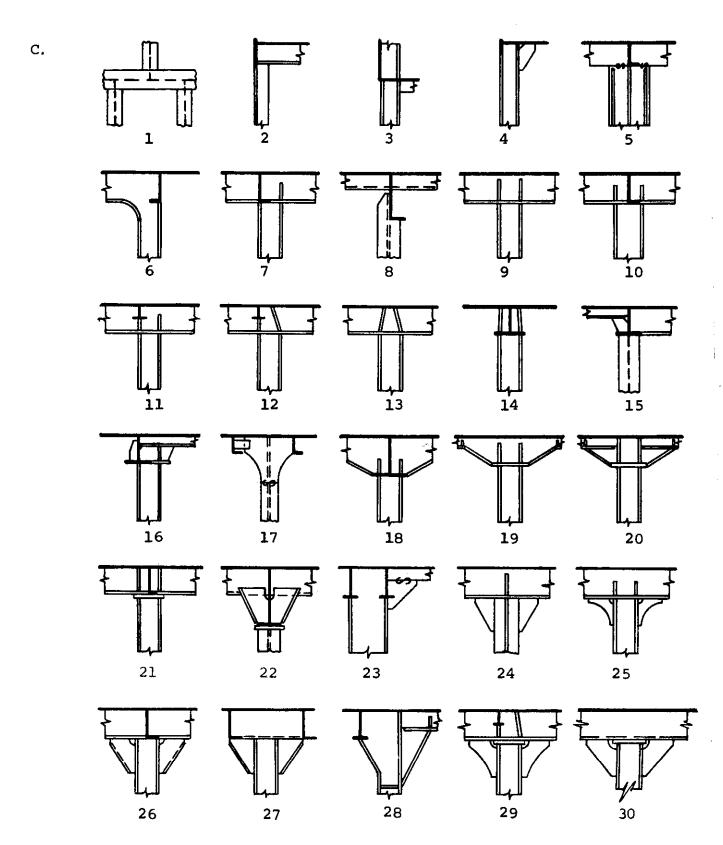
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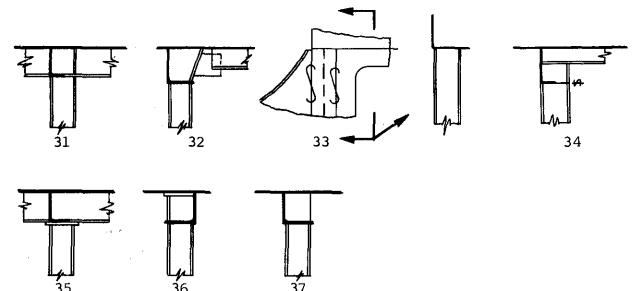
FIGURE 22 - STANCHION END DETAILS, Family No. 10 (Cont'd)



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C. Cont'd



into one of the following categories:

- o Group 10-A connections at the top of the circular stanchions
- o Group 10-B stanchion bottom connections
- o Group 10-C connections at the top of "H" stanchions

Table 12 contains a summary of 7,090 stanchion ends observed in both surveys.

The "V" notch design of detail 10-B-9 that resulted in many failures at the bottoms of container stands in the first survey were not observed in the second survey. Most of the container stands were joined to the deck similar to detail 10-B-2 and were 100% sound. However, stanchions supporting the deckhouse on containerships and general cargo ships continued to be a problem. Fifty percent of the total stanchion failures in the second survey were in either the top or bottom connections of these supports. Proper design would have provided tension brackets and tapered chocks to relieve the tensile and compressive stresses produced by the relative motions or "flexing" between the main deckhouses and the side shell. Figure 23 is a photograph of a deckhouse support stanchion similar to detail 10-B-26. Detail 10-B-26 was responsible for six of the twelve failures and details 10-B-28 and 10-C-33 accounted for the remainder.

Details 10-A-25 and 10-A-29 show the top end connections of four stanchions that hold up a cargo handling control platform above main deck on a general cargo ship. Since there were no braces on this frame to help carry the lateral loads on the platform when the ship is rolling, the moment formed in the corners at the top of the stanchions causing the chocks or brackets to puncture the thin walls of the stanchions. Other failures were caused by impact loads from cargo handling in details 10-B-15 and 10-C-35. The chocks in detail 10-C-7 had buckled due to a high breadth/thickness ratio.

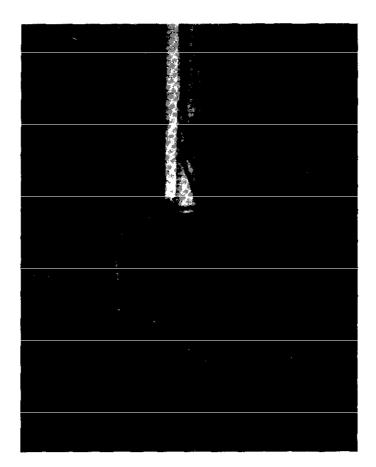
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## SUMMARY OF STANCHION ENDS

	OBS	SERVED SECOND SUR	.VEY	TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS
A	199	192	96.5	2239	2187	97.7
В	291	281	96.6	3431	3378	98.5
С	330	323	97.9	1420	1403	98.8
TOTAL	820	796	97.1	7090	6968	98.3

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This view shows the corner deckhouse stanchion attachment to the main deck bulwark. This connection continues to be a problem area with cracks in the welds at the bottom of the stanchion, at the top of the bracket, under the bulwark face plate, and at the bracket connection to main deck. Poor design, such as the sniped flanged on the bulwark bracket, has been the leading cause of failures. Seventy-five percent of the stanchion failures in the second survey belong to the newly identified variations in end connections. It appears design was the leading cause of failures, followed by collisions from handling cargo and misuse/abuse. In general, fabrication was excellent.

#### FAMILY NUMBER 11 - STIFFENER ENDS

The stiffener ends included in this family are the ends of load-carrying structural angles or tees that are attached to panels of plating. Thirty-five variations, including three new ones observed in the second survey, were placed in one of the five groups shown in Figure 24. Numerical data for the five groups are summarized in Table 13.

There were sixty-nine failures in the 9,969 stiffener ends observed in the second survey with a failure rate of 0.69%. This was only 0.05% less than the failure rate for the first survey. Fifty-seven of the failures were in group "A" and the remaining twelve were in group "B". Groups "C", "D" and "E" had 100% sound details.

Forty-five of the failures belong to detail 11-A-9. Neglect was the leading cause of failures, followed by shear and design. In some compartments of a general cargo ship, corrosion had eaten through the bulkheads where water had been standing on the deck. Quite often water was trapped by detail 11-B-6 causing severe corrosion. However, a failure was found on a containership where the use of detail 11-B-6 could have prevented it. A stiffener end similar to detail 11-A-3 was jammed into the shell plating which created a crack about an eighth of an inch deep and an inch long. If a clip had been added, the failure should not have occurred.

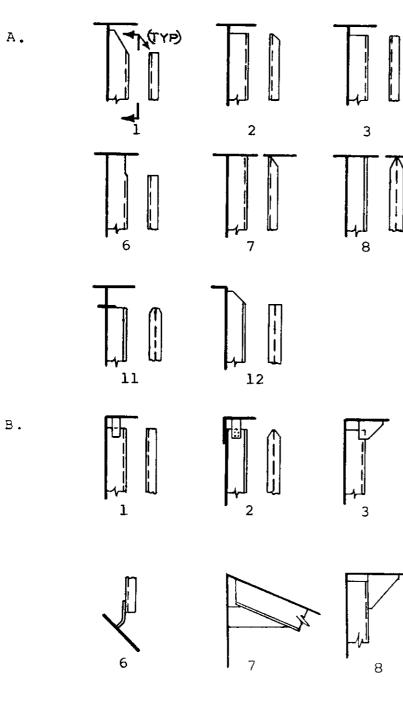
Figures 25, 26 and 27 are photographs of end failures on back-up headers for container support foundations on the main deck of a containership. Foundation headers were not included as candidates for the family of stiffener ends, but these pictures were taken to show that many of the same failures and failure causes exist for these structural members as well as for stiffener ends and panel stiffeners. Figures 25 and 26 show a few cracks and poor welding. Figure 27 shows a header under main deck that was cracked along one-third of its depth at its connection with a longitudinal bulkhead. The headers in Figures 26 and 27 were undersized for the in-service loads they received.

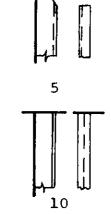
### FAMILY NUMBER 12 - PANEL STIFFENERS

In this family, panel stiffeners are defined as structural angles, tees, or flat bars welded to large panels of plate for the purpose of preventing local instability of the plate. They are not designed as direct load-carrying members. There was only one new configuration found in survey number two, which brings the total to forty-one as shown in Figure 28. Table 14 is a numerical summary, by family group, of the configurations shown in Figure 28.

The panel stiffeners had 527 failures which is a failure rate of 3.82% in the second survey. This failure rate is very high compared to the 0.65% failure rate recorded in the first survey. One possible explanation could be attributed to the more than two hundred panel stiffener failures by corrosion found on one general cargo ship. The captain explained that for five years during the Vietnam War, the ship carried nothing but ammunition and explosives. During that time, no maintenance, including painting, was performed by the crew due to the volatile

STIFFENER END DETAILS FAMILY NO. 11



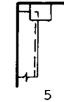


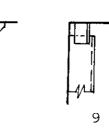
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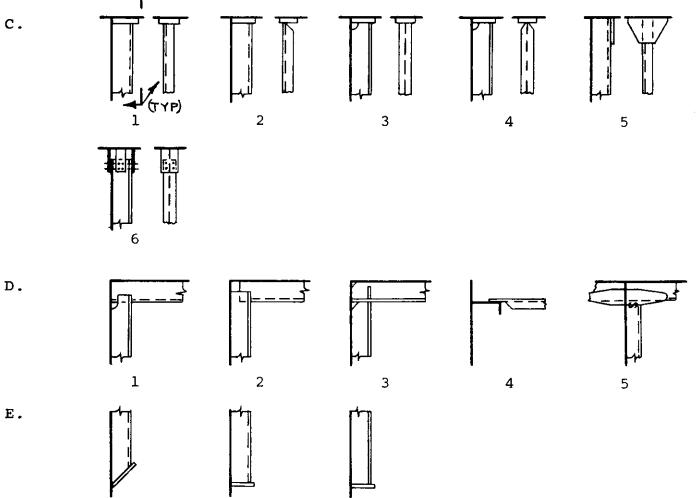




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## SUMMARY OF STIFFENER ENDS

	OBSERVED SECOND SURVEY			TOTALS OBSERVED BOTH SURVEYS		
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	ج SOUND DETAILS
A	6479	6422	99.1	28559	28360	99.3
В	2962	2950	99.6	6332	6284	99.2
С	215	215	100.0	825	818	99.2
D	205	205	100.0	4675	4631	99.1
E	108	108	100.0	338	338	100.0
TOTAL	9969	9900	99.3	40729	40431	99.3

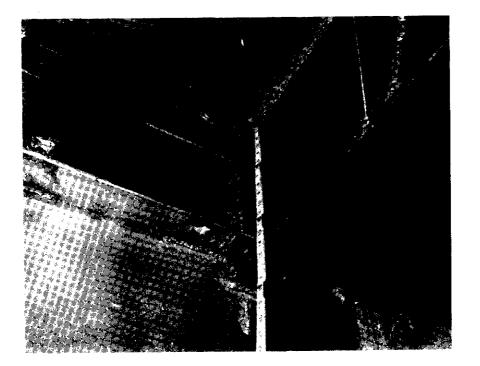
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## CRACKED WELD ON FOUNDATION HEADER ON A CONTAINERSHIP



View in starboard box girder looking up at a fore/aft foundation header ending on a transverse bulkhead. A crack has developed in the flange weld as shown. Excessive weld material has been used intermittently instead of a continuous bead.

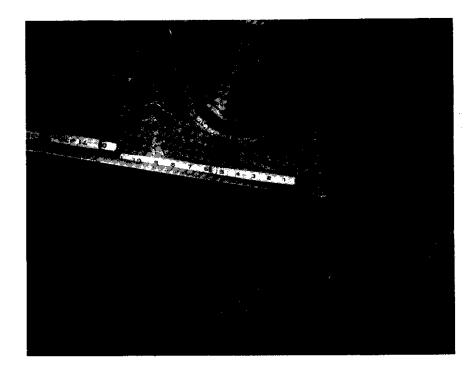
### FAILED FOUNDATION HEADER ON A CONTAINERSHIP



View is in port box girder looking up at a fore/aft header connection to a transverse bulkhead. The header backs up a support foundation for containers on main deck. A chock has been added at the support point as shown in upper right corner of photograph. The weld is cracked along the entire depth of the header's web. A weld at the flange on the main deck stiffener in the upper left, and the weld strike on the transverse bulkhead just below the header at the bottom center of the photograph indicates poor welding techniques.

#### FIGURE 27

# FAILED FOUNDATION HEADER ON A CONTAINERSHIP

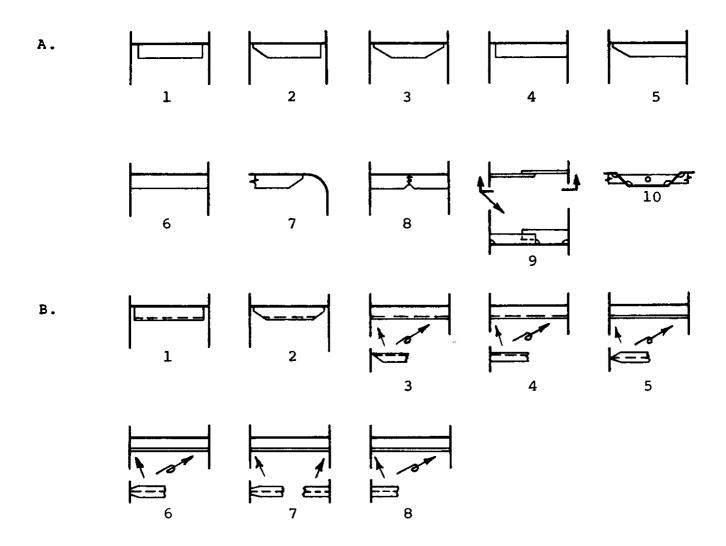


View looking aft showing connection of transverse header under main deck with longitudinal bulkhead at the right. This header carried loads from a container tie-down foundation nearby. Light can be passed through the crack for one-third the depth of the header.

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FIGURE 28

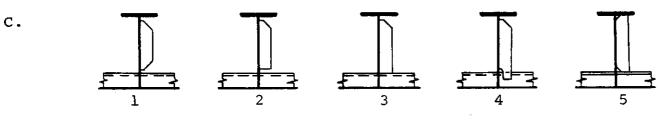
PANEL STIFFENER DETAILS FAMILY NO. 12

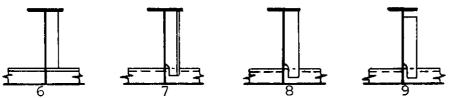


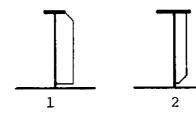
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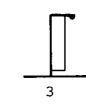
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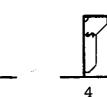
FIGURE 28 - PANEL STIFFENER DETAILS, Family No. 12 (Cont'd)

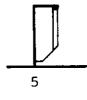


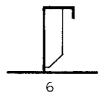










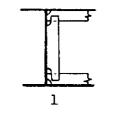


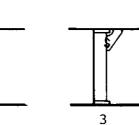


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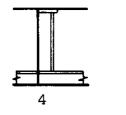
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# TABLE 14

# SUMMARY OF PANEL STIFFENERS

	OBS	ERVED SECOND SUI	RVEY	TOTALS C	BSERVED BOTH SUP	VEYS
FAMILY GROUP	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS	NUMBER OF DETAILS	NO. OF SOUND DETAILS	% SOUND DETAILS
A	6199	5999	96.8	19299	19014	98.5
В	4420	4150	93.9	14030	13742	97.9
с	1097	1094	99.7	16237	16194	99.7
D	1867	1813	97.1	3237	3083	95.2
Е	81	81	100.0	511	501	98.0
F	143	143	100.0	523	515	98.5
TOTAL	<b>13</b> 807	13280	96.2	53837	53049	98.5

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nature of the cargo. In addition, since the war no maintenance work has been done because of a "full delivery schedule" and only "necessary" repairs will be accomplished.

Eighty-one percent of the failures recorded in the second survey were on general cargo ships. Groups "A" and "B" led the failure list with 200 and 270 failures, respectively. Group "C" had three failures, while group "D" had fifty-four failures that were found mainly on the main deck hatch coamings. Groups "E" and "F" were failure free.

Many of the failures in this family were caused by corrosion, impact from large objects, and misuse/abuse. On the general cargo ship mentioned above, corrosion was the prevalent cause of so many failures on details 12-A-3 and 12-B-2. Fifty-six percent of the panel stiffener configurations that had failures in the second survey had at least one failure due to impact loading, presumably by cargo. Stiffeners with sniped ends with no restraints to help keep the flange from tripping were especially vulnerable. Details 12-A-6 and 12-A-10 had many failures due to misuse/abuse. These panel stiffeners often had holes drilled in them to attach cables for holding down cargo. One such stiffener is shown in the photograph in Figure 29.

Figure 30 shows cracked intermittent welds on a horizontal panel stiffener. These cracks were caused by a buckled transverse web frame just above an archway in the box girder of a containership.

In summary, the panel stiffener failures observed in the last thirty-six ships surveyed, decreased the percentage of sound details from 99.3% for the first fifty ships to 98.5% for the total eighty-six ships in both surveys. These failures were caused by collisions from handling cargo, misuse/abuse, and in one extreme case where a general cargo ship received only "necessary" repairs.

### SNYTHESIS BY SHIP TYPE

The previous section discusses "Snythesis by Family Groups," for the individual detail configurations of the family groups and how they performed in service. In this section, emphasis will be placed on the detail families and family groups and their performance in individual ship types. All of the data observed in the total eighty-six ship survey will be synthesized according to individual ship types. This method, used in "Structural Details of Ships In Service,"<sup>1</sup> enables design/repair offices to determine, at a glance, failure trends of structural detail families on specific ships.

The number of surveys for each ship type varied from two to twenty-four, therefore, comparable data are provided by normalizing the survey data. Seven ships, as was used in reference 1 below, will be used to normalize the data in order to continue that synthesis already accomplished on the first fifty ships. The normalized data are presented in Table 15 and Figures 31 through 41, with the ship types represented by capital letters in the following order:

 Jordan, C. R.; Ward, W. E., "Structural Details of Ships In Service," presented at Hampton Roads Chapter, Society of Naval Architects and Marine Engineers, March 15, 1978.

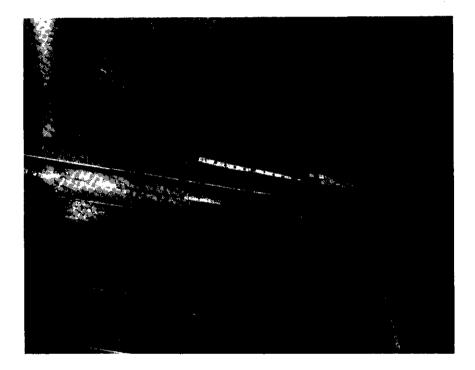
### FAILED PANEL STIFFENER ON A GENERAL CARGO SHIP



Photographer is standing in the cargo hold looking up at a panel stiffener on a longitudinal corrugated bulkhead. The weld cracks were due to poor welding and possibly buckling of the bulkhead while the ship was in a seaway. The hole drilled in the stiffener is sometimes used to tie down cargo. This often produces failures.

#### FIGURE 30

### PANEL STIFFENER FAILURE ON A CONTAINERSHIP

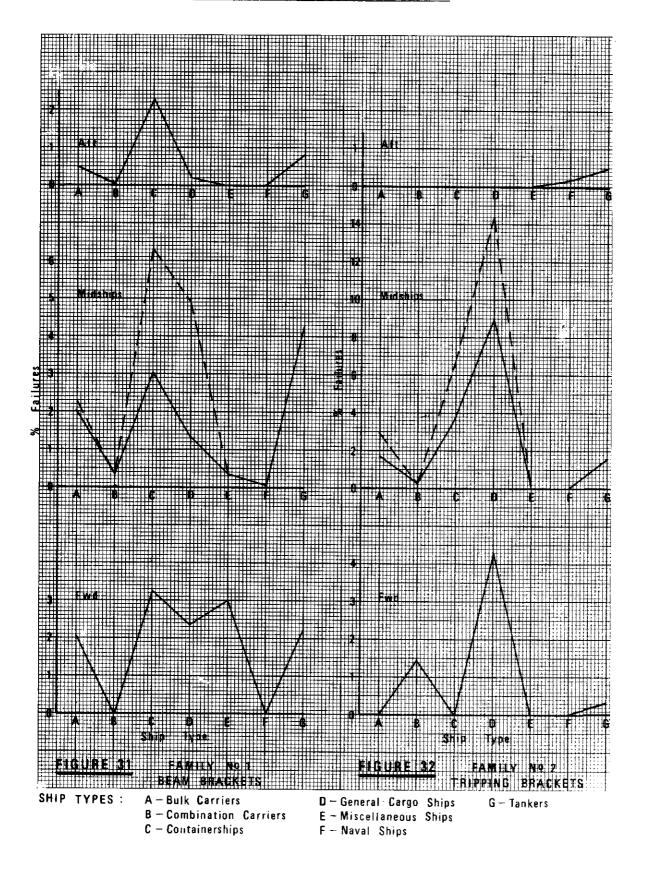


View in starboard box girder looking forward shows a container tie-down foundation header under main deck and an archway in the transverse web frame. Not shown in the photograph was a crack in the weld of the header web to the transverse web. The load, which was too much for the transverse web, caused a buckle and "popped" the intermittent welds on the horizontal panel stiffener just above the archway. The flanges of the continuous foundation header have been sniped.

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Į	BRACKETS	с	3257	181	222	2697	338	0	181	0	14	0	o	14	0	0	o	
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		D	506	11	14	156	336	0	0	11	18158	80	2674	10360	5124	0	56	2
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	z	F	3041	O	381	2038	622	0	0	0	34 <b>3</b> 47	45	3749	22812	7786	3	33	
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Į	TO	TALS	16174	42	1940	10005	4229	15	2	25	217968	619	22442	147213	48313	144	358	11

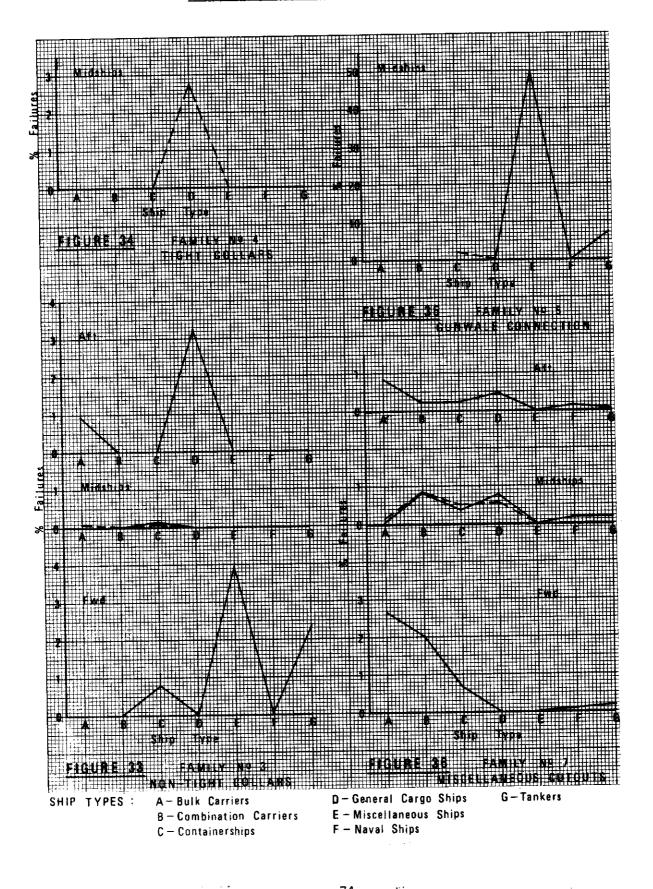
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	1	E	1505	0	385	490	630	0	0	` 0	3815	0	560	2275	980	0	0	1 1	1
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	ST	C	926	1	70	700	156	0	0	1	7850	12	775	5670	1405	2	<u> </u>	0 	_
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# PERCENT FAILURE VERSUS SHIP TYPE

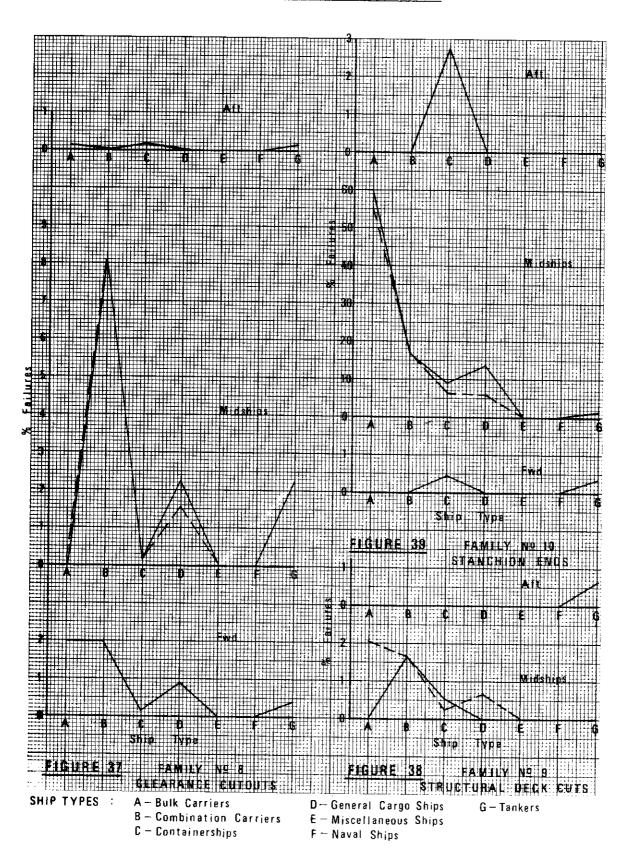


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# PERCENT FAILURE VERSUS SHIP TYPE

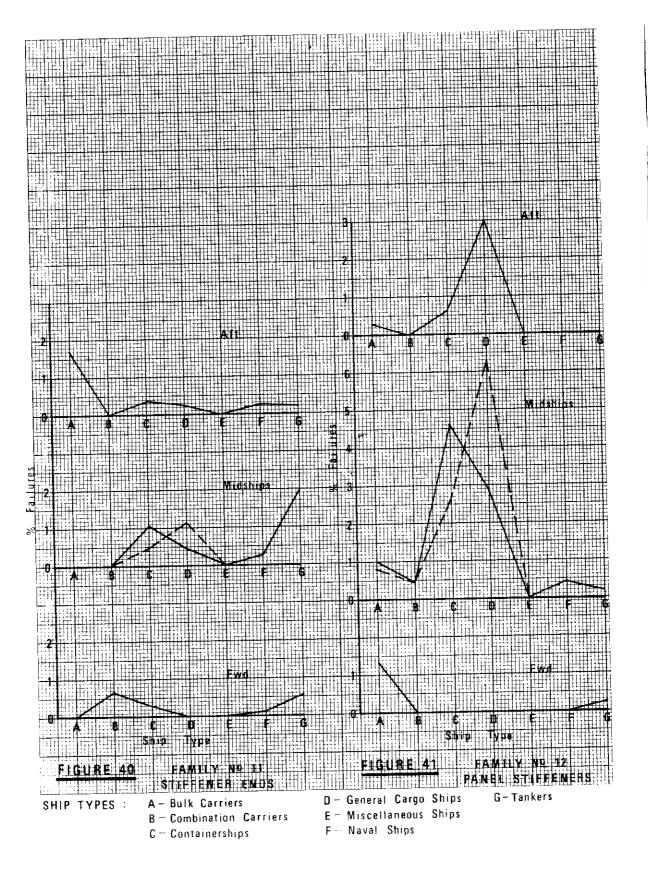


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# PERCENT FAILURE VERSUS SHIP TYPE

-75**-**



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- A Bulk Carriers
- B Combination Carriers
- C Containerships
- D General Cargo Ships
- E Miscellaneous Ships
- F Naval Ships
- G Tankers

The following is a list of the total number of ships surveyed. An asterisk denotes that twelve ships were surveyed in the midship/cargo section only:

\* 16 - Bulk Carriers
5 - Combination Carriers
\* 24 - Containerships
\* 17 - General Cargo Ships
2 - Miscellaneous Ships
9 - Naval Ships
13 - Tankers
86 - TOTAL NUMBER OF SHIPS SURVEYED

Data in the forward and aft sections of all ships, plus the data in the midship section of the combination carriers, miscellaneous ships, naval ships, and tankers were taken from the first survey. Data for the midship section of bulk carriers, containerships and general cargo ships were taken from both surveys.

Table 15 is a normalized data summary of the observed details and failures for each detail family. The data is listed by ship type and general location in the ship, i.e., forward of the cargo section (fwd); within the cargo section (midships); and aft of the cargo section (aft).

Figures 31 through 41, were derived from Table 15 and are plots of the percent failures versus ship type for each detail family. Separate plots are provided for each of the three general ship locations - fwd, midships, and aft. The percentage given on each plot represents the failure percentage of the details observed in that general area of the ship only. The solid line in the plots represent data gathered from the first survey, and the broken line (shown only in the midship plots) represents data gathered from ships in both surveys.

Table 16 is a failure percentage tabulation for each ship type for individual family groups by general ship location. The data in this table shows percentages of actual observed data and has not been normalized. In order to attain the failure percentages, the authors divided the observed failures by the total details observed in each of the three general ship locations.

Using Figures 31 through 41, an engineer/designer could quickly establish failure trends for detail families on a particular ship type. Table 16 shows failures in the individual family groups and their location. Appendix A provides more specific data on detail variations and should aid the designer in finding failure modes and causes.

#### Family Number 1 - Beam Brackets

Twenty-three percent (145) of the 634 configurations observed in both surveys were in this family. The largest number of beam brackets appeared on containerships;

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	FAMILY									SH	ΙΡΤΥ	PE&L	.0CA1	TION								
-	GROUP		<b>A</b> "			B			С			D			E			F			G	<del>.</del>
	NO.	FWD	MID- SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID – SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID – SHIPS	A
	1 – A												3.33								6,56	
	1 — B		1.16												1,25						3.17	0
	1-C			2.35		0.03		2.51	7.60	2.67		10.89								2.40		0
	1 D			0.36								0.48					ļ					
2 2 4	1-E							1.25	6,28			1.18					ļ					C
4	1 — F	4.29							0.53	22.50										3,75	2,06	
	1 – G																Í					ŀ
	1-H	4.14	0.69					3.33			6.67		3.33									ŀ
	1-3		8.96			24.00			17.69			0.67						20.00			14.62	2
	1 – K		0.30						0.88	1 22	6. <b>67</b>			17.50				i.		5.71	14.02	
-78-	1 – L		5,56			0.57		11.08	0.27	1.33 0,18		6.67 3.64		17.50						0.71		0
ĩ	1-M		6.80			0.57			4.57	0,10		3.04						0.43				`
	1 N 1 P		22.50																		17.73	
•			7.76								١				1		<b> </b>					-
,	2 A		2.50		2.50				3.54		4.00									0.24	0.88	(
	2-B		2.00			0.25			0.56										0.32	0.59	2.15	ĺ
	20		3.71			1.43			9.02			15.59		l							2.86	
								-						1		<u> </u>	┟────					┢
	3 - A		0.19		!		•		0.13				2.86	1					1	8.33		}
	3 – B																					
	3 – C			2.58				10.00					6.67	3,75								
												2.07										
-	4 – A									-		2.97					1					1
	4 - B 4 - C								0.47													
	4-0 4-D								0.4/					l						· .		

		· · ·		N'T.)					AR		BY SI			<u>a 21</u>		UCAL	ION				<u> </u>
FAMILY		•			B	-	<u> </u>	с	<u> </u>		PE & 1 D	LUCA	T	E		<b>—</b>	F			G.	
NO.	FWD	MID- SHIPS	AFT	FWD	MID SHIPS	AFT	FWD	MID-	AFT	FWD	-	AFT	FWD	MID- SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID	AF
5-A								7.14	<u> </u>			-	<b> </b>	0,		<u> </u>	511175			10.0	
5 — B														100.00							
7-A								0.53			5.39						1.20		2.73		
7 B						1		0.46									1.10				
7—C				0.53				1.19	0.28		0.60	6.40				0,33	0.19	0.22		0.05	
7— D			12.31					0.30												0.15	
7-E					3.82			0,31												1.55	
7F		1, 80						0.67	1,56		0.25										1.
7-G		1.16						0.69										0,11			0.
7-H	3.85	0.12	<b>0.7</b> 0	3.04	0.35	0,40	0.91	0.36	0.25		0.56	0.04					0.02	0.06	0.12	0.07	
8-A											13.33										
8-8					5.00			0.56	0.91											0.50	Ο.
8-C		0.05					0.43	0.18	0.14											10.29	
8-D					8.33			1.13												6.20	
8 – E	10. <i>0</i> 0	0, 41	0.67	10.00				0.06		0.83									0.91	0.62	
9-A															:						ο.
9-8		5.26			1.00			1.03			1.32										
9-C					3,75			0.15			0.69										
10-A							0.59	4,00	12.00		16.60										
10-B		<b>60.0</b> 0			25.00			7.02			1.69								0.71	2.00	
10-C		60.00						4.00			2.09				1						

FAMILY							r		<u></u>		PE&L					r				G	
GROUP		A MID-			B			C MID-			D MID –			E MID –			F_				Т
NO.	FWD	SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID- SHIPS	AFT	FWD	MID – SHIPS	AFT	FWD	MID – SHIPS	AFT	FWD	MID- SHIPS			MID ~ SHIPS	_
11-A			1.67	0.71			0.37		0.14		1. 26	0.25				0.14	0.18	0.40	0.59		
11-8								0.61	1.03		0.96									0.80	2
11-C								ļ								j	2.80				ļ
11–D								0.79								ł				1,93	ĺ
11-E																					
12-A	2.73	1.27	0.51		0,63			0.33			4.37	1.61					1.18				
12B			••••					1.83	0.98		9.44						0.11		1.88		
12-C		0.39									14.29	15.00								0.20	
12-D	{			1				6.25									ļ				Į
12-E								3.32													
12—F	ļ			ļ				1.70	2.22								ŀ				
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tankers had the smallest number. The number of beam brackets that are used in the midship section of bulk carriers decreased by 59% of that used in the first survey, and the average failures decreased by 55%. However, the percentage failure rate remained about the same, as shown in Figure 31.

There were failures observed on all ship types. Containerships continued to maintain their lead for observed failures, followed by general cargo ships and tankers. Of the failures, 79% occurred in the midship area, 15% forward, and 6% aft. The eight percent increase in the midship area, as explained in the first section of this report, could be expected since the second survey was confined to the exact area on the three ship types where the majority of the failures occurred in the first survey. As shown in Figure 31, each of the ship types had beam bracket failures in the forward section of the ship, except for combination carriers and tankers. In the midship section, the percentage of failures greatly increased for containerships and general cargo ships, which placed them ahead of tankers in failure percentage. Containerships had the most failure problems in the aft section of the ship.

### Family Number 2 - Tripping Brackets

Distribution of tripping brackets varied from 2.37% on miscellaneous ships to 20.88% on combination carriers, with the largest number of failures occurring in the midship area of general cargo ships. In the forward section of the ship, failures were confined to three ship types; combination carriers, general cargo ships, and tankers. However, in the midship section, only miscellaneous ships and naval ships remained failure free. General cargo ships increased their lead in percentage failures in the midship area to 14.33%. All of the failures on general cargo ships in the midship area were in group 2-C (Table 16). Appendix A and the discussion on tripping brackets in the first section, indicate that the majority of the general cargo ship failures in family/group 2-C were contributed by the bulwark and hatch coaming supports. Tripping bracket failures in the aft section of the ship were limited to naval ships and tankers.

### Family Number 3 - Non-Tight Collars

Peak failure trends in this family appear in the forward area of miscellaneous ships, midship area of containerships, and aft area of general cargo ships. The failure peaks appear very small in the midship area. This is because there were only two failures observed in the sixteen bulk carriers and five failures observed in the twenty-four containerships surveyed which, after normalizing, amounted to a 0.05% and 0.09% failure rate, respectively.

#### Family Number 4 - Tight Collars

This family was free of failures except for the midship area of general cargo ships. There was one failure observed on one of the twenty-four containerships surveyed, but even after normalizing (using seven ships) only a fraction of a failure would appear in Table 15.

### Family Number 5 - Gunwale Connections

Failures in gunwale connections were observed in only three ship types. The midship area of containerships sustained 2.08% failures; the midship area of miscellaneous ships sustained 50% failures; and the midship area of tankers sustained 7.14% failures.

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#### Family Number 6 - Knife Edge Crossings

There were no knife edge crossings observed.

#### Family Number 7 - Miscellaneous Cutouts

This family contained 50% of all the observed details and 17% of all the failures listed in Table 15. All of the ship types, except miscellaneous and general cargo ships, experienced failures throughout. General cargo ships had no failures forward, and miscellaneous ships had no failures at all. Peak failure trends appeared in the forward and aft sections of bulk carriers, and in the midship section of combination carriers. As indicated in "Structural Details of Ships in Service,"<sup>1</sup> all of the failures in the forward and aft sections of the bulk carriers occurred in details 7-D-2 and 7-H-5. The lightening hole cutout, detail 7-E-2, and the weld clearance cutout, detail 7-H-1, accounted for all of the failures in the midship section of the combination carriers. The midship section of the containershi had failures in each of the eight groups of miscellaneous cutouts.

#### Family Number 8 - Clearance Cutouts

The largest number of clearance cutouts were used in tankers, miscellaneous ships and combination carriers. Naval ships had the least and they were found in the aft section only. As shown in Figure 37, bulk and combination carriers had the highest failure percentage in the forward section of the ship. Detail 8-E-2 accounted for all of the bulk carrier failures and detail 8-E-7 for the combination carrier failures. In the midship section, detail 8-D-6 was responsible for the 8.1% failure rate on the combination carriers. The failure rate for bulk carriers, containerships, and general cargo ships, changed very little from the first survey, as shown in the midship plot of Figure 37. Very few clearance cutout failures were observed in the aft section of any of the ship types.

### Family Number 9 - Structural Deck Cuts

This family was free of failures in the forward section of all ship types and only tankers experienced failures in the aft section. However, the second survey revealed a few problem areas in the midship area of bulk carriers and general cargo ships. The failures in detail 9-B-2 produced a higher failure rate in the midship area of bulk carriers as compared to combination carriers in the first survey. Details 9-B-5 and 9-C-4 were responsible for the few failures in the midship area of the general cargo ships.

#### Family Number 10- Stanchion Ends

Containerships and tankers were the only two ship types to sustain stanchion end failures in the forward section of the ships. At midship, the bulk carriers continued to lead the other ship types in percentage failures with a 55.56% rate. The only stanchion end failures in the aft section of any of the ship types occurred in detail 10-A-1 on a containership.

#### Family Number 11 - Stiffener Ends

Peak failure trends in this family appear in the forward area of combination

1. Jordan, C. R.; Ward, W. C.; "Structural Details of Ships In Service," presented at Hampton Roads Chapter, Society of Naval Architects and Marine Engineers, March 15, 1978. carriers, midship area of tankers, and aft area of bulk carriers. After the data from both surveys were combined, the percentage of failures in the midship area of containerships was reduced to 0.48%; and, the percentage of failures in the midship area of general cargo ships was increased to 1.12%.

#### Family Number 12 - Panel Stiffeners

Distribution of panel stiffeners varied from 8.32% on containerships to 25.69% of naval ships, with the largest number of failures occurring in the midship area of the general cargo ships. Only bulk carriers and tankers showed failures in the forward section of the ships. Peak failure percentage appears in the aft section of general cargo ships.

#### SUMMARY OF RESULTS

Using the same survey techniques and data analysis procedures developed in the Ship Structure Committee Project SR-1232, "Structural Details Failure Survey,"<sup>1</sup> an additional twelve bulk carriers, twelve containerships, and twelve general cargo ships were surveyed in the midship/cargo area. During a fourteen month period, repair yards and loading facilities were visited on all three coasts of the United States in order to obtain eligible candidates for the survey.

The second survey produced eighty-one new detail variations for the twelve existing structural detail families. This brings the total number of configurations for the eighty-six ship survey to 634 distinct detail variations. Table 17 is a listing for the second survey of the twenty detail variations that had either the most observed failures or highest percentage of failures. Table 18 is a summary listing the total number of details and detail failures observed for each family in the second survey as well as for both surveys combined.

A total of 117,374 details were observed with a total of 3,555 failures, yielding a failure rate of 3.03% for the second survey. In the first fifty-ship survey, the 3,301 failures of the 490,210 details observed, resulted in a failure rate of 0.67%. By combining the data in the two surveys, the results show 6,856 failures for 607,584 observed details or a failure rate of 1.13%.

The twelve detail families continued to follow many of the trends established in the first survey. Although some individual family failure percentages increased or decreased due to a number of reasons, the majority remained the same. Some observations on the twelve families performance in the second survey as compared to that in the first survey follows:

o Some of the same beam bracket details appeared on the ten most prevalent list in both surveys. Overall percentage of failures increased in the second survey. The failure percentage in the midship of bulk carriers remained the same.

o Tripping brackets showed an increase in failure percentage with increased failures on all three ship types, bulk carriers, containerships and general cargo ships. All of the failures in the midship area of general cargo ships continued to be in family/group 2-C.

1. Jordan, C. R.; Cochran, C. S., "In-Service Performance of Structural Details," Ship Structure Committee Report SSC-272, dated 1978.

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# TABLE 17

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# TOP TEN FAILED DETAILS

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		MOST PREVALENT		HIG	HEST PERCENTAG	E
RANK	DETAIL NUMBER	NO. OF FAILURES	۶ FAILURES	DETAIL NUMBER	NO. OF FAILURES	% FAILURES
1	1-C-1	538	19.2	10-A-29	2	100.0
.2	1-C-25	359	27.8	10-C-33	4	100.0
3	2-C-19	330	18.8	10-A-28	3	75.0
4	1-C-2	204	12.6	1-P-8	8	66.7
5	2-C-11	196	17.8	5-A-1	1	50.0
6	2-C-7	195	8.2	7-H-13	12	50.0
7	12-B-2	160	47.2	2-A-20	54	49.1
8-	1-E-1	125	4.0	12-B-2	160	47.2
9	12-A-3	105	3.9	10-B-26	6	42.9
10	2-C-20	98	12.6	2-C-27	50	42.4

# TABLE 18

# SUMMARY OF DATA FOR 12 DETAIL FAMILIES

		OBSEI	RVED SECOND	SURVEY	TOTALS O	BSERVED BOTH	SURVEYS
FAMILY NO.	DETAIL FAMILY NAME	NO. DETAILS	NO. FAILURES	% FAILURES	TOTAL NO. DETAILS	TOTAL NO. FAILURES	* FAILURES
1	Beam Bracket	17836	1364	7.65	68586	2252	3.28
2	Tripping Bracket	13372	1273	9.52	34012	1587	4.67
3	Non-Tight Collar	4724	5	0.11	20974	33	0.16
4	Tight Collar	2654	46	1.73	20654	46	0.22
5	Gunwale Connection	72	1	1.39	172	5	2.91
6	Knife Edges	0	0	-	_ 0	0	-
7	Miscellaneous Cutouts	43819	207	0.47	296689	853	0.29
8	Clearance Cutouts	8797	22	0.25	57307	843	1.47
9	Deck Cutouts	1504	17	1.13	7534	29	0.38
10	Stanchion Ends	820	24	2.93	7090	122	1.72
11	Stiffener Ends	9969	69	0.69	40729	298	0.73
12	Panel Stiffeners	13807	527	3.82	53837	788	1.46
	TOTALS	117374	3555	3.03	607584	6856	1.13

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o Non-tight collars maintained a very high sound detail percentage.

o The percent of sound details for tight collars was lowered from 100% to 99.8%, due to a few failures on three general cargo ships in the second survey.

o The workmanship and welding continued to be excellent on gunwale connections with only one new failure reported.

o No knife edge crossings were observed in either survey.

o As in the first survey, no one group of miscellaneous cutouts could be singled out as having more failures than the others. Weld clearance cutouts continued to lead the failure list, and each of the eight groups had less than a one percent failure rate.

o The family of clearance cutouts had a failure rate of 0.25% in the midship area of bulk carriers, containerships, and general cargo ships, as compared to a failure rate of 0.36% for the same three ship types in the first survey.

o The percentage of failures for deck cutouts increased slightly as a result of failures sustained on a bulk carrier during a severe storm.

o The stanchion ends supporting the corners of the deckhouses continued to be a problem. Seventy-five percent of the stanchion end failures in the second survey were new detail variations.

o The family of stiffener ends had almost the same failure percentage in both surveys. However, the failure percentage in the midship area of containerships decreased slightly, while the failure percentage in the midship area of the general cargo ships increased by about the same amount.

o Panel stiffeners showed a much higher percentage of failure due to one general cargo ship that had an extreme maintenance problem.

Appendix A is a tabulation of the numerical data for each detail variation observed in both surveys. The appendix for projects SR-1232 and SR-1258 were combined to provide the maximum available information on the 607,584 details observed in the eighty-six ship survey. On each detail figure is shown the location of cracks and buckles as indicated with a (-) and (+), respectively.

#### CONCLUSIONS AND RECOMMENDATIONS

This report analyzes and evaluates data collected from on board inspections of thirty-six ships. The data collected on twelve bulk carriers, twelve containerships and twelve general cargo ships, were combined with the data from Project SR-1232<sup>1</sup> to expand the data base in the midship sections of these three ship types. Besides confirming many of the failure trends established in the first fifty ship survey, distinctive service performances were identified for the twelve typical structural detail families in the second survey. The data from the two surveys were summarized to provide the maximum available information for ready use by design and repair offices.

1. Jordan, C. R.; Cochran, C. S., "In-Service Performance of Structural Details," Ship Structure Committee Report SSC-272, dated 1978. A total of 117,304 details were observed with a total of 3,555 failures, which produced a failure rate of 3.03% for the second survey. The failure rate for the first fifty ship survey was 0.67%. The 2.36% higher failure rate was probably due to the location selected for the second survey. Since the first survey disclosed that eighty-two percent of the detail failures occurred in the midship section of the ships, the second survey was confined to this problem area to confirm or refute the high failure rate. Thus, by concentrating in an area of high detail failure, and then summarizing the results, without including the data from areas with many sound details such as the forward and aft sections of the ship, a failure rate higher than the first survey resulted.

Failures continued to be attributed to either one or a combination of five categories - design, fabrication, welding, maintenance, and operation. In "Structural Details of Ships In Service,"<sup>1</sup> the authors' analyze each of these failure causes and provide not only how and why each of these items cause problems, but how to eliminate these failures by the use of proper techniques. Additional recommended reference material is also provided in that paper.

Data in the forward and aft sections of all ships, plus the data in the midship section of the combination carriers, miscellaneous ships, naval ships and tankers were taken from the first survey. Data for the midship section of bulk carriers, containerships and general cargo ships were taken from both surveys. This brings the total number of midship surveys for each of these three ship types to sixteen bulk carriers, twenty-four containerships, and seventeen general cargo ships. Any failure trends established for the structural details in the midship/cargo area of these three ship types could be regarded as being more representative of what actually occurs, as opposed to the ship types where failure trends have been established after having surveyed only a few ships.

The information collected in the two surveys provides an adequate data base for statistical evaluation of each family or family group. Evaluation of the effect of ship type on these groups or on all individual detail configurations is less reliable because of the smaller number of samples. The three ship types mentioned above, plus naval ships and tankers have enough candidates for evaluation, but combination carriers and miscellaneous ships have only five and two surveyed ships, respectively. Perhaps combination carriers should have been continued in the second survey instead of containerships, since there were already twelve containership candidates in the first survey. Also, it was noticed that twelve candidates were enough to establish accurate failure trends since the failure percentage rate for each detail family changed very little after adding the data from the second twelve containerships surveyed. As for miscellaneous ships, the category is too broad to establish any significant analyses with regard to individual ship types.

Projects of this type should be a continuing effort to provide feedback to design and repair offices for increased confidence in existing design methods as well as for future improvements. As more ships are surveyed, there is less need for estimated data as used in the first survey. Eventually, a substantial data base is formed from which meaningful statistical analyses can be conducted to provide useful information to ship owners as well as design offices. For instance, ship owners could use the information to evaluate the economics of ship maintenance, or the money saved by adding tug stations, etc. Design offices could use the analyses to select the proper detail configuration for a particular design situation and the waterfront trades could use the data as an adjunct in teaching proper fabrication and welding techniques.

Jordan, C. R.; Ward, W. C., "Structural Details of Ships In Service," presented at Hampton Roads Chapter, Society of Naval Architects and Marine Engineers, March 15, 1978.

### ACKNOWLEDGEMENTS

The authors are grateful to the personnel of the shipyards and repair yards who participated in this survey by allowing the surveyors access to their facilities. A special word of appreciation is extended to the owners and operators who permitted the survey of their ships and provided valuable information during the on board interviews. Also, the authors wish to thank the members of the ad hoc Project Advisory Committee of the National Research Council for giving their time and support to this project.

#### APPENDIX

### Compilation of Performance Data for 634 Observed Structural Detail Variations

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This appendix contains a table of failure data arranged by family groups for each of the detail variations observed in projects  $SR^{-1232}$  and  $SR^{-1258}$ . Only observed data 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. With each detail figure, the location of cracks and buckles is indicated with an arrowhead and a (-) and (+), respectively. 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.

The following is a list of the total number of ships surveyed in both projects. An asterisk denotes that twelve ships were surveyed in the midship/cargo section only:

\*16 - Bulk Carriers

17

5 - Combination Carriers

\*24 - Containerships

\*17 - General Cargo Ships

2 - Miscellaneous Ships

9 - Naval Ships

13 - Tankers

86 - TOTAL NUMBER OF SHIPS SURVEYED

BEAM BRACKETS DETAIL FAMILY TABLE A-1

LOCATION ON	SHIP	No. of	No. of	Total	Percent		Failure		
<u>,</u>	1	Sound	Failed	Number	Failures	- 1	Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
	¶•	Observed	Observed						
	Fwd	30		30					
Naval	X	140		140		1-A-1			
	Aft	40	1	40					
	Fwd	20		20				ļ	
Naval	Ø	110		110		1 <b>-</b> A-2		1	
	Aft	30		30					ֈպ
	Fwd	240		240			ļ		
Naval	200	1680	1	1680		1-A-3			
	Aft	490		490					
	Fwd	120		120					
Naval	亚	510		510		1-A-4	]		
	Aft	200	<u>i</u>	200					↓ <del>~</del>
Miscella-	Fwd								LI
neous	00	40		40		1-A-5			NK
	Aft								
	Fwd		]		ł		_		1
Tanker	<u>30</u>	198	2	200	1.0	1-A-5	1	11	<b> </b>
	Aft							l	
	Fwd								E
Tanker	DQ	45	15	60	25.0	1-A-6	1	8,11,14	NK
	Aft							Į	
	Fwd	50		50				1	
Naval	页	270		270		1-A-7		ļ	
	Aft	90	<u>/</u>	90					
	Fwd	1	1	40					
Naval	Q	240		240		1-A-8			
	Aft		<u> </u>	70	·		<b>_</b>	<u> </u>	-
	Fwd	1	1	20				0 12	E_
Tanker	Ø	56	4	60	6.7	1-A-9	1	8,13	121
	Aft			30			<b></b>	ļ	- ~ W
General	Fwd								
Cargo	DQ		_			1		1.2	スレ
	Aft		1	30	3.3	1-A-10		13	
_	Fwd		ļ	30		,			
Naval	QQ	90		90		1-A-11			
	Aft		<u> </u>	20		<u> </u>			↓ '
	Fwd		1	70		1-B-1			
Naval		70	1	4 70		11-8-1	1	1	

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{V}$ , 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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- (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. Shear6. Tension

7. Combined Tension & Shear

- 8. Design
- 9. Fabrication/Workmanship
- 10. Welding

13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

# TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SHIP TYPE		Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number	Failure Mode	Failure Cause	
Tanker	Fwd 20 Aft	26	4	30	13.33	1-B-1	1	13	T
Miscella- neous	Fwd 20 Aft	110 50		110 50		1-B-2			
Tanker	Fwd 30 Aft	30		30		1-B-2			<b></b> 1
Tanker	Fwd Ø Aft	39 20	1	40 20	2.5	1-B-3	1	8	
Tanker	Fwd Ø Aft	266 40	14	280 40	5.0	1-B-4	1	8	
Tanker	Fwd Ø Aft	394	6	400	1.5	1-B-5	1	8,9,10	
Miscella- neous	Fwd Ø Aft	160		160		1-B-6			EN CZ
Tanker	Fwd 20 Aft	1494 40	6	1500 40	.4	1-B-6	1	8,9	
Bulk Carrier	Fwd 20 Aft	204		204		1-B-7			
Bulk Carrier	Fwd Ø Aft	43		43		1-B-8			
Tanker	Fwd 20 Aft	515	45	560	8.0	1-B-8	1	8	
Tanker	Fwd Ø Aft	150		150		1-B-9			
Tanker	Fwd 90 Aft	288 40	12	300 40	4.0	1-B-10	l	8	
Bulk Carrier	Fwd SQ Aft	46	3	49	6.1	1-B-11	1	13	XX
Container- Ship	Fwd DO Aft	40		40		1-B-11			
Miscella- neous	Fwd Ø Aft	46	4 <b>4</b> ×	50	8.0	1-B-11	.2	12	

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LOCATION ON	SHIP		No. of	Total	Percent Failures		Failure Mode	Failure Cause	
		Sound	Failed	Number	rattures	Number	rioue	Cause	İ
SHIP TYPE		Details	Details	Details				[	(
		Observed	Observed	Observed				}	I
	Fwd								┝──┿╦
Tanker	<b>X</b> Aft	28	12	40	30.0	1-B-11	1	13	
	Fwd	<u></u>			1	1			
Tanker	Ø		{	l	{	{		1	602
	Aft	58	2	60	3.3	1-B-12	1	8	ſ
Bulk	Fwd			<u> </u>	1	[			
Carrier	QQ	49	1 1	50	2.0	1-B-13	1	14	
	Aft	]	}	ļ	j				<b>T</b>
	Fwd			<u> </u>	f			1	1
Tanker	Q	l	ł	ł	1	1	1		┝──┛
	Aft	40		40		1-B-13		l	
Bulk	Fwd			1	<u> </u>		1		CL-JA
Carrier	00	12	{	12	}	1-C-1	}		
	Aft		ļ	1			l		
Combination	Fwd	60	<b></b>	600	1	1	[		1
Carrier	00	2999	1	3000	.0	1-C-1	1	15	┼╌┥
	Aft	150	}	150				<u> </u>	
Container-	Fwd	100		100	[			1	
ship	XQ.	1885	560	2445	22.9	1-c-1	2	(8,12,14	
	Aft	110		110				15)	
General	Fwd	140		140		ſ	1	1	{ }
Cargo	Ø	1926	128	2054	6.2	1-c-1	2	12,14,15	┝╾╼┩
	Aft	230	J	230					
	Fwd	198	2	200	1.0		2	14	
Tanker	Q	{	1	1	1	1-C-1	}	1	┝╾╍┥
	Aft			400		<u> </u>	<u> </u>	<u> </u>	4
Container-	Fwd	1	12	500	2.4		2	11,12	AL-Z
ship	D D	2816	84	2900	2.9	1-C-2	1,2	10,14,15	
	Aft	·	58	600	9.7	<u> </u>	2	11,14	_L <sup>uy</sup> , `
General	Fwd	l i i i i i i i i i i i i i i i i i i i			1				. †
Cargo	200	1190	130	1320	9.8	1-C-2	2	12,14,15	' <b>  </b>
	Aft		1	_ <u></u>				<u> </u>	11
	Fwd	114	6	120	5.0		2	14	
Tanker	DQ I	1		1	1	1-C-2	j	1	<b>—</b>
	Aft			60					1
Bulk	Fwd		1	1	1		}	}	
Carrier	夏	<u>į</u> 20 -		20	}	1-C-3	}		
	Aft		1	1		1	[	l	149 `

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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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(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 & Shear
- 8. Design
- 9. Fabrication/Workmanship
- 10. Welding
- 15, Collision 16. Other - See Discussion

12. Misuse/Abuse

13. Questionable

14. Heavy Seas

A-4

TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details	No. of Failed Details	Total Number Details	Percent Failures		Failure Mode	Failure Cause
	<b>  ∳</b> .	Observed	Observed	Observed				
Combination	Fwd	20		20				
Carrier	300	260		260		1-C-3		
	Aft	30		30				
Container-	Fwd	48	2	50	4.0	1-C-3	2	14
ship	102	•-		{				
SUTA	Aft				1			
Container-	Fwd	70		70				1
,	100	450		450		1-C-4		
ship	Aft	130		130				
General	Fwd	90	<u> </u>	.90				1
		50	1	1	ļ	1-C-4		
Cargo	00	90	1	90	1			
	Aft	108	2	110	1.8	<u> </u>	2	14
	Fwd	109	2 ×	1 110	L	1-C-5	<b>1</b>	
Tanker	XX.	240	1	240		1-0-3		
A	Aft	240	4	120	3.3	+	2	14
Container-	Fwd	116	4	1 120	3.3	1-C-6	<b>1</b>	1
ship	DQ .	200	1	200		1-0-0		
	Aft	200	L	60	1.7	<u> </u>	<u>  1</u>	15
	Fwd	59	1	60	1 ***	1-C-6	1 -	
Tanker	D D			100				1
	Aft	100	ļ	100		ļ		
Miscella-	Fwd	80		80	1	1107	1	
neous	00					1-C-7	1	1
	Aft			40				14
Container-	Fwd	497	3	500	.6	1	2	I -
ship	00	4131	16	4147	.4	1-C-8	2	14,15
	Aft	900		900				
General	Fwd			1				1.0.14
Cargo	D.	200	30	230	13.0	1-C-8	2	12,14
	Aft							
Bulk	Fwd			30				
Carrier	<u> </u>	140		140	1	1-C-9		
	Aft		2	40	5.0	<u> </u>	2	15
General	Fwd		1	20				
Cargo	00	100		100		1-C-9		
	Aft			40				
	Fwd			1		1		
Tanker	30			ł				1
	Aft	50		50	1	1-C-9		
Container-	Fwd		1	T	1	T		
ship	D.			150	1	1-C-10	)	
-	Aft	1						
General	Fwd		1	1				
Cargo	00		1	40	2.5	1-C-10	2	9,14
-	Aft				1	1	1	1
Container-	Fwd		4	240	1.7	1-C-I	2	8
ship	100	1						
	Aft	1	1	1	1	1	1	1
	1	<u> </u>		1				1

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

LOCATION ON	GHTD	No of	No. of	Total	Percent	Detail	Failure	Failure	1
LOCATION ON		Sound	Failed	Number	Failures			Cause	
SHIP TYPE		Details	Details	Details	ratiutes	Number	Mode	Cause	
SHIT TIFE			Observed		[	numper			
	Fwd	Observed	Observed	Observed					
Bulk									الحسولة الم
Carrier	<b>XX</b> Aft			45		1 0 10			4
	Fwd	45		45		1-C-12			
				]					
Tanker	<b>DO</b> Aft	4 -		45		1 0 12			
	Fwd	45		45		1-C-12			
Container-	<b>300</b>					1 0 12			
ship	Aft	20		20	Į –	1-C-13			
	Fwd	30		30					
Container-	1	20	_	20	1 1 2	1 0 14	2	9,14	ليعجبهم
ship	Aft	158	2	160	1.2	1-C-14	2	9,14	
	Fwd	20	1.4	20	9.3		2	11,14	
Container-	1	136	14	150	9.3	1 0 15	2	11,14	
ship	Aft	100		100		1-C-15			
	Fwd			100	4.0		2	15	-
Container-	30	96	4	100	4.0	1-C-16	2	1 13	
ship	Aft	190	ł	190		1-0-10		Į	
D11-	Fwd	100		100					*
Bulk	X	300		300		1-C-17			ليسودهما
Carrier	Aft	300		300		1-0-1/			
Container-	Fwd	85	5	90	5.6		2	15	T 4
ship	Ø	340		340	1	1-C-17		-	
SHIP	Aft	90		90	1		1		
	Fwd	9	1	10	10.0	1-C-17	2	8,14	1
Tanker	Ø	_	1 –		1010		-		
Tumer	Aft		1		1				
Container-	Fwd	50		50	<u> </u>		t		In1
ship	Ø	300		300	1	1-C-18			17
T	Aft	90		90	1				լե
	Fwd	20		20	[		<u> </u>	†	·
Naval	Ø	100		100		1-C-19			
	Aft	20		20					
Combination	Fwd			1					
Carrier	Ø	120		120		1-C-20			
	Aft				ł		1		Ψ
Combination	Fwd				<b> </b>				
Carrier	X	50		50		1-C-21	l	ļ	
	Aft	170		170	ł				

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{D}$ , 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding

- 11. Neglect
- 12. Misuse/Abuse
- 13. Questionable
- 14. Heavy Seas
- 15. Collision
- 16. Other See Discussion

TABLE A-1 DETAIL FAMILY: BEAM BRACKERS

LOCATION ON	SHIP		No. of	Total	Percent	Detail		1	
ייטעראי איייייייייייייייייייייייייייייייייי		Sound	Failed	Number	Failures	-	•	Cause	1
SHIP TYPE		Details	Details	Details		Number			
	1 Tourd	Observed		Observed		+	+	+	-
Container-	Fwd		4	80	5.0		2	14	R
ship	20	530	122	652	18.7	1-C-22	2	(11.12,	
	Aft		·		4	+	+	14,15)	
General	Fwd	1		1					l∏2
Cargo	D ft	/					1		
, 	Aft			60		1-C-23	4	+	-l <u>·</u>
,	Fwd	,			1				IT.
Tanker	300	1			-				ШУ
······································	Aft		9	120	7.5	1-C-24	2	11	Ę.
Container-	Fwd								IN-
ship	<u>00</u>	424	161	585	27.5	1-C-25	2	8,14,15	
······································	Aft			i L		]		1	141
General	Fwd	1 1							1" 🛉
Cargo	DQ	508	198	<b>7</b> 06	28.0	1-C-25	2	8,14,15	, <del>  - 1</del>
, 	Aft								
Bulk	Fwd			•			<b></b>	+	TRE
Carrier	100	12		12		1-C-26			
ı,	Aft								ľ
General	Fwd		<b> </b>	<b>•</b>		+		1	ੱਸਿੰਦ
Cargo	Ø	22		22		1-C-27			111/
· _ ,	Aft					-			14
Bulk	Fwd		<u> </u> ,	140		+		+	
Carrier	00	790		790		1-D-1			
i'	Aft	1		180		-			l.¥
General	Fwd		<b>†</b> ,	40	ł	1		1	1 1
Cargo	00	310		310		1-D-1			
1	Aft	1 1		90					
Miscella-	Fwd		f	20	+	+			4 1
neous	Ω.	60		60	1	1-D-1			
i i i i i i i i i i i i i i i i i i i	Aft	30	1	30					
Bulk	Fwd	50	<u> </u>	50	+'		<b></b>	+	
Carrier	TWO TOO	1000	1	1000	1	1-D-2			
	Aft	1 1	ł	50	-				
Miscella-	Fwd	++	t	+	<u>+</u>	<u>+</u>	+	+	ן <sup>₩</sup> ,
neous	<u>v</u>	300	ł	300	1	1-D-2			
	Aft		1	300 80	1				
Miscella-	Fwd	20	ł	20	<u> </u>	·'	<b>+</b>	+	
neous	<b>T</b> WQ	120	1	120	1	1-D-3			In-
	Aft	30	1	120	1		1		↓∕
General	Fwd	+	÷i	÷'	<b>↓</b> ′	<u>+'</u>	<b> </b>	4	
Cargo	FWa D	70		70	1	1-D-4	1		$ \mathbf{r} $
	Aft	20	1	20	1	T-D. 3	1		<u>  .</u> ]/
Bulk		30	ļi	30	<b> </b> '	1-D-5	<b> </b>	+	<u> </u>
Bulk Carrier	Fwd	30 1	1	30	1	1-u-s ,		1	F
Carrier	D.	)	1	1	1	,	1		
//	Aft	<u> </u> ]	<b> </b>	<u>ا                                     </u>	ļ'	<u> </u> '	ļ		<u>_</u> \\
General	Fwd		1	1 1	1 = 1	['			
Cargo	DQ	38	2	40	5.0	1-D-6	2	9	
	Aft	1	É I	1	1/	1 /	1		<b> </b> L+

TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

					i *	r			3
LOCATION ON	SHIP		No. of	Total	Percent	•	Failure		1
	ĪI	Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Observed	Observed	Observed					]
Miscella-	Fwd	40		40					
neous	X	280		280		1-D-7			
	Aft	80		80		}			ļĻ¥ —
Bulk	Fwd								
Carrier	00	50		50		1-D-8			<b>III</b> >
	Aft	49	1	50	2.0	1	1	10	juy∕
Combination	Fwd				]				
Carrier	<u>x</u>								ミン
	Aft	60		60		1-E-1	,		ll K
Container-	Fwd	40		40		(			1 4
ship	00	1328	89	1417	6.3	1-E-1	3,4	14,15	
-	Aft			/					
General	Fwd								1
Cargo	X	1640	36	1676	2.1	1-E-1	4	15	
ourgo	Aft	1010		10/0	~··-	1-0-1		10	
	Fwd	20		20		· ····			4
Tanker	30	20		20		1			
tanker	Aft	30		30		1-E-1			
Bulk	Fwd	10		10					 
Carrier	X	60		60		1			
Callier	Aft	<b>i</b> .				1-E-2			
Combination	Fwd	30		30				L	Ψ.
									11
Carrier	<b>QQ</b> Aft	60		60		1-E-2			
~	Fwd								
Container-		20		20		1-E-2			
ship	Ø								
	Aft								
General	Fwd				ļ				
Cargo	Ø	296		296		1-E-2			H
	Aft								
	Fwd	30		30					]
Tanker	X					1-E-2			┝━┛
	Aft	40		40					
General	Fwd	20		20		1-E-3			1 <b>r</b>
Cargo	夏								ドラ
	Aft								
	Fwd	20		20					1 🖌
Tanker	DQ					1-E-3			
	Aft	50		50					

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

(B) The rows labeled aft,  $\mathfrak{D}$ , 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 15. Collision 16. Other - See Discussion

12. Misuse/Abuse

13. Questionable

14. Heavy Seas

11. Neglect

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- 2\* :

TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure	T
		Sound	Failed	Number	Failures		•	Cause	
SHIP TYPE		Details	Details	Details	14114105	Number	noue	cause	Ì
			Observed			mainer			1
General	Fwd	90	SNDOL Ved	90					<b> </b>
Cargo	20	820		820		1-E-4			10-7
cargo	Aft	130		130		1-0-4			
Combination	Fwd	130							<u>ا</u> یک
	<b>1</b> 00								
Carrier	Aft	-		50			-		
	Fwd	50		50		1-E-5			₩.
Miscella-		20		20					1
neous	30					1-E-5	-		
	Aft	80		80					1
	Fwd	20		20					
Tanker	QQ					1-Е <b>-</b> 5			┝╼╼┛
	Aft	80		80					
Bulk	Fwd								
Carrier	Q	20		20		1-E-6			12
	Aft	20		20					<b> ↓</b> <sup>*</sup>
	Fwd								1 1
Tanker	00								
	Aft	9	1	10	10.0	1-E-6	1	11	1
General	Fwd						-		¦
Cargo	<u>0</u> 0	253		253		1-E-7			╢╠┲
	Aft								ILY
	Fwd	<b> </b>						- in	
Tanker		40		40		1-E-7			1
Taurer	УЦ Aft	1 1				1-8-1			
Contrainer		30		30		1 1 1 0		E 0	I
Container-	Fwd	98	2	100	2.0	1-E-8	1,2	5,9	
ship	00								.Ľ
	Aft								4
Bulk	Fwd	20		20		1-F-1			+
Carrier	Q								
	Aft								j <del>u</del>
Container-	Fwd	10		10					1
ship	QQ	200		200		1-F-1			
	Aft	31	9	40	22.5		2	13	
	Fwd								
Tanker	DQ.	442	8	450	1.8	1-F-1	1	10	
	Aft								
Container-	Fwd							·	<b></b>
ship	202	176	2	178	1.1	<b>1-</b> F-2	2	13	l 🔀
<u>-</u> L	Aft	~	-				-		
	Fwd								
Tanker	<b>1</b> 90	175	5	180	2.8	1-F-2	1	9,10	
THINGT		τ, <del>,</del>	,	TOO	2.0	<b>⊥</b> -1 - Z	1	7,10	
	Aft					1 1 2 2			<u> </u>
	Fwd	30		30		1-F-3			11
Tanker	Ø		[						1
	Aft								إليمة
Bulk	Fwd	47	3	50	6.0	1-F-4	1	14	
		. 1							11 🕱
Carrier	Ø Aft	į į							

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

OCATION ON	SHIP		No. of	Total	Percent			Failure
	111	Sound	Failed	Number	Failures			Cause
SHIP TYPE		<b>Details</b>	Details	Details		Number		
		Observed	Observed	Observed				
iscella-	Fwd	20		20		1-F-4		
neous	X					Ì	1	ſ
	Aft				l			
	Fwd	47	3	50	6.0	1-F-5	1	14
lanker	Ø		Ì	]				1
	Aft			L			<u> </u>	<b></b>
	Fwd	480		480	· · ·			ſ
Javal	00	3400	ļ	3400		1-G-1		ł
	Aft	960	l	960	L		ļ	
	Fwd	10	1	.10	_	l	1	
Naval	页	50	ļ	50		1-G-2		
	Aft	_30		30		<u> </u>	L	ļ
	Fwd			30	1	1 <b>-</b> G-3		
fanker	Ø	ł	Į	}	1	ł	1	ļ
	Aft					<u> </u>	<u> </u> _	ļ
Container-	Fwd	T - · · · ·		1			1	]
ship	00	74	1	74	1	1-G-4		
-	Aft	1	·	<u> </u>	1			
General	Fwd		1		1	T T	]	}
Cargo	XQ.	20	1	20		1-G-4	1	
-	Aft							· · · · · · · · · · · · · · · · · · ·
	Fwd		1	1	ł	ł	}	
Naval	D D			4		1	1	
	Aft			40	L	1-G-4	<u> </u>	
Combination	Fwd	20		20	1	1-G-5		1
Carrier	DQ			1	1			
	Aft	<u> </u>					<u>                                     </u>	
Container-	Fwd		4	4			1	
ship	X	232		232	•	1-H-1	ļ	
_	Aft						1	[
General	Fwd		6	90	6.7		1	14
Cargo	図	466		466	}	1-H-1	}	1
	Aft							
Bulk	Fwd	1	1					
Carrier	00	56		56	[	1-H-2		1
	Aft							
Combination	Fwd		1			1		
Carrier	DQ	50		50		1-H-2		
	Aft	: [			1			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathbf{D}$ , 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
- 12. Misuse/Abuse
- 7. Combined Tension & Shear 8. Design
- 9. Fabrication/Workmanship
- 10. Welding
- 14. Heavy Seas
- 16. Other See Discussion

13. Questionable 15. Collision

TABLE A-1 DETAIL FAMILY: BEAM BRACKETS

LOCATION ON		•	No. of	Total	Percent		Failure	-
		Sound	Failed	Number	Failures		Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed					
Combination	Fwd			20				
Carrier	X	80		80		1-H-3		
	Aft	20		20				
Container-	Fwd	29	1	30	3.3	1-н-4	2	14
ship	Q							
	Aft							
Bulk	Fwd							·
Carrier	<u> </u>							
	Aft	90		90		1-H-5		
Container-	Fwd							
ship	<u>00</u>	473		473		1-н-6		
<b>-</b>	Aft							
	Fwd		1		·			
Tanker	102							
Iumer	Aft	30		30		1-H-6		
Bulk	Fwd	193	7	200	3.5	1 1 0	1	14
Carrier		236	4	200	1.7	1-H-7	2	14
CALLICE	00 Aft	230		240	±./	T-U-/	2	12
Bulk	Fwd	85	5	90	5.5		1	14
Carrier		116	5		5.5	1 11 0	L L	14
Carrier	Ø			116		1-H-8		
	Aft	40		40				
	Fwd	30		30		_		
Tanker	00					1-н-9		
<u> </u>	Aft	40		40				
Bulk	Fwd							
Carrier	QQ	25		25		1-H-10		
	Aft							
General	Fwd							
Cargo	Q							
	Aft	29	1	30	3.3	1-H-10	1	8
Combination	Fwd	20		20				
Carrier	Ø	1				1-H-11		
······	Aft	20		20				
	Fwd	20		20				
Tanker	20					1-H-11		
	Aft	20		20				
Container-	Fwd							
ship	<b>1</b> 00	260		260		1-н-12		
-	Aft	Í I		1				
General	Fwd							····
Cargo	TE.	935		935		1-H-12		
, ,	Aft	_						
Bulk	Fwd							
Carrier	Ø	144		144		1-H-13		
	Aft					13		
		·		··				
General	Furi	. <b>.</b>	1	1	1			
General Cargo	Fwd Ø Aft	1172	19	1191	1.6	1-н-13	2	8,12

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LOCATION ON	SHIP		No. of	Total	Percent		Failure		
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause	
General Cargo	Fwd X Aft	332		332		1-н-14			
General Cargo	Fwd MAft	139	27	166	16.3	1-H-15	1,2	8,12	对
Bulk Carrier	Fwd 20 Aft	16		16		1-J-1			
Container- ship	Fwd 20 Aft	36	4	40	10.0	1-J-1	1	8,14	H
General Cargo	Fwd 00 Aft	36		36		1-J-1			$\left  - \right $
Naval	Fwd X Aft	8	2	10	20.0	1-J-1	2	13	
Combination Carrier	Fwd 100 Aft	16	4	20	20.0	1-J-2	1	8	
Combination Carrier	Fwd ØØ Aft	22	8	30	26.7	1-J-3	1	8,11	E.
Bulk Carrier	Fwd Ø Aft	18	12	30	40.0	1-J-4	1	8,14	
Container- ship	Fwd Ø Aft	16	4	20	20.0	1-J-4	1	8,10	
General Cargo	Fwd 00 Aft	89	1	90	1.1	1-J-4	2	15	
Container- ship	Fwd Ø Aft	35	15	50	30.0	1-J-5	1	8	
Bulk Carrier	Fwd Ø Aft	88		88		1 <b>-</b> J-6			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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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- (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

1

- 7. Combined Tension & Shear
- 8. Design
- 9. Fabrication/Workmanship
- 10. Welding
- 13. Questionable

12. Misuse/Abuse

- 14. Heavy Seas 15. Collision
- 16. Other See Discussi(

LOCATION ON SHIP TYPE	ŀ	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details · Observed			Failure Mode	Failure Cause	
Container- ship	Fwd 20 Aft	20		20		1-J-6			EL
General Cargo	Fwd 30 Aft	24		24		1-J-7			
Container- ship	Fwd 30 Aft	26 90		26 90		1-K-1			Ţ
Container- ship	Fwd 00 Aft	88	2	90	2.2	1-K-2	2	8	সি
Tanker	Fwd Ø Aft	8	2	10	20.0	1- <u>K-</u> 3	1,2	14	75
Tanker	Fwd Ø Aft	24	16	40	40.0	1-K-4	1	11,13	
Container- ship	Fwd Ø Aft	168	2	170	1.2	1-K-5	1	13	<u></u>
Tanker	Fwd Ø Aft	87	3	90	3.3	1 <b>-</b> K-6	2	11	łC
Container- ship	Fwd 00 Aft	9	1	10	10.0	1-K-7	1	10	
Container- ship	Fwd Q Aft	120		120		1-к-8			
General Cargo	Fwd Ø Aft	112 232	8	120 232	6.7	1-к-8	1	14	
Container- ship	Fwd 90. Aft	76		76		1 <b>-</b> K-9			A
Bulk Carrier	Fwd 00 Aft	604	2	606	0.3	1-K-10	4	15	M.
General Cargo	Fwd Ø Aft	147		147		1-K-11			F
Container- ship	Fwd 00 Aft	76		76		1-к <b>-</b> 12			Ĭ
Bulk Carrier	Fwd 00 Aft	32		32		1 <b>-</b> K-13			Ţ

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LOCATION ON	SHIP		No. of	Total	Percent			Failure
	1	Sound	Failed	Number	Failures	-		Cause
SHIP TYPE		Details	Details	Details		Number		
<u></u>		Observed	Observed	Observed				
Bulk	Fwd							
Carrier	<b>XX</b> Aft	19		19		1-K-14		
Container-	Fwd							
ship	M Aft	46		46		1-L-1		
	Fwd	82	8	90	8.9	1-L-1	2	14,15
Tanker	Aft							
Container-	Fwd	279	41	320	12.8	]	1,3	7,14,15
ship	Ø	200		170	) 5	1-L-2	2	8,13
	Aft Fwd	266	4	270	1.5			0,13
General Cargo	Aft	56	4	60	6.7	1-L-2	1	7
Miscella-	Fwd	33	7	40	17.5		2	15
neous	00					1-L-2	ļ	
<u></u>	Aft	20	<u> </u>	20		<u> </u>	<u> </u>	
Container-	Fwd	237	1 1	238	0.4	1-L-3	2	13
ship	<b>XQ</b> Aft			230	0.4		2	13
	Fwd	50		50		1-L-3		
Tanker	<b>Q</b> Aft				[	(		
Bulk	Fwd		[	[		1	1	
Carrier	<b>Q</b> Aft	46	4	50	8.0	1-L-4	1	13
Container-	Fwd	50		50		1-L-5		
ship	<b>Ø</b> Aft			•	Į.			
Container-	Fwd			1		1	1	]
ship	Aft	30	]	30		1-L-6		
Bulk	Fwd		1	1	1	1	1	†
Carrier	<b>DO</b> Aft	22	r R	22		1-L-7		ļ
Container-	Fwd	J	†		†	†	†	<u> </u>
ship	D Aft	80		80		1-L-7		

NOTES.

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 2 , 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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- (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

8. Design

- 11. Neglect 12. Misuse/Abuse
- 6. Tension

7. Combined Tension & Shear 13. Questionable

- 14. Heavy Seas
  - 15. Collision
- 10. Welding

9. Fabrication/Workmanship

16. Other - See Discussion

		1			[]		(		ŗ
LOCATION ON	SHIP		No. of	Total	Percent		Failure		
	·	Sound	Failed	Number	Failures	-	Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			1
	<u> </u>	Observed	Observed						Į
Container-	Fwd	260		260					5
ship	X	200		200		1-M-1			ILL)
_	Aft	320		320					<u>ا</u> ت
Container-	Fwd	90		90					172
ship	Q	180		180		1-м-2	1		ILĽ)
-	Aft	120		120					
General	Fwd								
Cargo	Q	[							
	Aft	60		60		1-M-2	·		
	Fwd	1							1
Tanker	<u>00</u>	1						ĺ	
	Aft	39	1	40	2.5	1-M-2	1	11	
Combination	Fwd	1		<u>-</u>			<u> </u>		1
Carrier	Q	200		200	1	1-M-3			$\  \mathbf{N} \ $
	Aft					•		ļ	
General	Fwd			<b>{</b>					
Cargo	<b>X</b>	ł	Į				1		$\  \mathbf{V} \ $
Caryo	Aft	10		10	1	1-M-4			
	Fwd	<u>+ 10</u>			<u>}</u>	- 11-4			
Tanker					1	]		ł	
Taurer.	Ø Aft	30		30	ļ	1-M-4		1	1
Conora 3		+				<u></u>	<u> </u>		
General	Fwd	E 0		50		)_M_E			
Cargo	QQ	50		50		1-M-5			<b> </b> -
m71-	Aft	110		110			<u>+</u>	<u> </u>	
Bulk	Fwd			242		1		Ì	
Carrier	00	243		243		1 <b>-</b> M-6			
	Aft				<b> </b>		<b> </b>		┥ ̄
Container-	Fwd			0.50					
ship	Q	354	16	370	4.3	1 <b>-</b> M-6	2	14	1
	Aft	109	1	110	0.9		1	7	-
General	Fwd				}			1	1
Cargo	QQ	480	20	500	4.0	1-M-6	1	11	
	Aft	ļ	ļ	<b>_</b>			<u> </u>	ļ	1
General	Fwd		ł		1				ra -
Cargo	X		ł		l				[[]
	Aft	220		220		1-M-7			
	Fwd	90	1	90					]
Tanker	QQ	1	ļ		1	1-M-7			<b> </b>
	Aft	160	1	160	1				1
Bulk	Fwd	1		1	t	1		1	1~
Carrier	TE	24	1	24		1-м-8			<b>  </b>
	Aft		1						
Combination	Fwd	1			†	<b></b>	<u> </u>	· ·	1
Carrier	Œ	148	2	150	1.3	1-M-8	2	13	
	Aft		_						1
	Fwd	+	<u> </u>	+	<u> </u>	<b> </b>	<del> </del>	<u> </u>	1
Tanker				1					
TAULET	Aft	9	1	10	10.0	1-M-8	1	11	
	MLL	<u> </u>	L	<u> </u>			l	L	1

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TABLE A-1 BEAM BRACKETS DETAIL FAMILY:

LOCATION ON	SHIP		No. of	Total	Percent		Failure		
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause	
Bulk Carrier	Fwd X Aft	62	24	86	27.9	1 <b>-</b> M-9	1	7	H
Bulk Carrier	Fwd Ø Aft	15	15	30	50.0	1-N-1	1	8	
Combination Carrier	Fwd 00 Aft	90		90		1-N-1			
Container- ship	Fwd <b>DO</b> Aft	30		30		1-N-2			Ð
Naval	Fwd XX Aft	10 30 10		10 30 10		1-N-3		·	
Naval	Fwd <b>30</b> Aft	20 180 30		20 180 30		1-N-4			F
Bulk Carrier	Fwd XQ Aft	109	21	130	16.2	1 <b>-</b> N-5	3,4	15	R
Naval	Fwd <b>QQ</b> Aft			50		1-N-6			
Naval	Fwd Ø Aft	19	1	20	5.0	1-N-7	2	8,12	
Bulk Carrier	Fwd Ø Aft	ł		40		1-P-1			
Miscella- neous	Fwd X Aft	10		10		1-P-1			
Tanker	Fwd Ø	181	39	220	17.7	1-P-1	1	6,8,14	
Combination Carrier	Fwd Ø	310		310		1-P-2			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{D}$ , 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

12. Misuse/Abuse 13. Questionable 7. Combined Tension & Shear

14. Heavy Seas 8. Design

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

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause
Miscella~ neous	Fwd 20 Aft	50	Observed	50		1-P-3		
Bulk Carrier	Fwd 20 Aft	24	6	30	20.0	1-P <b>-</b> 4	3	15
Bulk Carrier	Fwd 302 Aft	19		19		1-P-5		
Bulk Carrier	Fwd Ø Aft	57	13	70	18.6	1-P-6	1,4	7,15
Bulk Carrier	Fwd Ø Aft	155		155		1-P-7		
Bulk Carrier	Fwd XQ Aft	4	8	12	66.7	1-P-8	1	8,11,14
Bulk Carrier	Fwd Ø Aft	62		62		1-P-9		

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure	Ī
· · · ·	Ţ	Sound	Failed	Number	Failures	-	Mođe	Cause	
SHIP TYPE		Details	Details	Details		Number			ĺ
·	and the second se	Observed	Observed	Observed					
	Fwd	10		10					
Naval	30	20		20		2-A-1		1	
	Aft	20		20					
Container-	Fwd	20		20					
ship	D D	348	Į –	348		2-A-2	[	ļ	
	Aft	40		40					
General	Fwd	10		10					1 🔺
Cargo	30	100		100		2-A-2			!
_	Aft	40		40				1	
	Fwd	20		20					1
Tanker	<u>3</u>	160		160		2-A-2			╎───┘
	Aft	30		30					
General	Fwd	8	2	10	20.0	2-A-3	1	8,12	
Cargo	100 Aft								E -

TABLE A-2	DETAIL	FAMILY:	TRIPPING	BRACKETS	

LOCATION ON S	HIP		No. of	Total	Percent			Failure	
SHIP TYPE		Sound Details Observed	Failed Details Observed	the second se	Failures	Family Number	Mode	Cause	
Combination	Fwd	20		20					
Carrier	Ø	310		310	1	2-A-4			لمحتجمهم
	Aft	100		100					
Container-	Fwd		ļ	20		2-A-4		1	
ship	<b>X</b> Aft	30	l.	30		2-A-4			
General	Fwd		<u> </u>						1
Cargo	QQ	16		16		2-A-4		1	<b> </b>
	Aft						L		1
· · · · · · · · · · · · · · · · · · ·	Fwd			}					l
Tanker	DO Aft	30		30		2-A-4			
Container-	Fwd			1			Ţ		
ship	00	28	1	28	ł	2-A-5			<b> </b>
<b>L</b>	Aft	<u> </u>				<u> </u>			<u> </u> ┖ <u></u> ┹╼┲
	Fwd	1		ļ		ļ		1	} ♦
Tanker	00	145	5	150	3.3	2-A-5	1	8	[ <b>—</b> —
	Aft			ļ		<u>∔</u>	l		┨
Bulk	Fwd		ł	40					
Carrier	<b>X</b>	957	5	962	0.5	2-A-6	2	14	+>
	Aft		·	70	<u> </u>	2-A-6		· <del>{ · · · · · ·</del>	
Combination	Fwd	50	4	1 50	1	2-A-0	i i	1	1 1
Carrier	DO Aft	<u>.</u>			l.			1	
	Fwd		·				+	-{	-
Tanker	1 XX	632	8	110 640	1.2	2-A-6	2	11	\
TGUVET	Aft		0	140	1.2	L-4-0	<b>É</b>	1 **	
Bulk	Fwd		· <del> </del>	1 140		+	+	+	
Carrier	1 SQ	198		198		2-A-7	ł		
	Aft						1		E
	Fwd		•		+	+	+	+	1
Tanker	00			80		2-A-7			
	Aft								
Container-	Fwd		+	40	1	1	·	1	
ship	DO			230	1	2-A-8			
· ·	Aft	50	ł	50	}	1			E
Bulk	Fwd						1		<b>T</b> [
Carrier	DQ 1	35	15	50	30.0	2-A-9	2	15	
	Aft	: [.			. L			1	<u></u>

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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

9. Fabrication/Workmanship

7. Combined Tension & Shear 8. Design

10. Welding

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11. Neglect 12. Misuse/Abuse

- 18. Questionable
  - 14. Heavy Seas
  - 15. Collision
  - 16. Other See Discussion

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP TYPE		Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Bulk Carrier	Fwd XO Aft	50	1	51	2.0	2-A-10	1	7,11	
Container- ship	Fwd D Aft	10 200 40		10 200 40	,,,,,,	2-A-10			
Tanker	Fwd 300 Aft	10 260 20	10	10 270 20	3.7	2-A-10	1	6,10	
Container- ship	Fwd Ø Aft	20 100 40		20 100 40	<u></u>	2-A-11			<u>e</u> -]
Container- ship	Fwd Ø Aft	40 370 80		40 370 80		2-A-12			<u>e</u>
Naval	Fwd Ø Aft	60 160 70		60 160 70		2-A-13			
Tanker	Fwd Ø Aft	20 70 30		20 70 30		2 <b>-</b> A-14			<u>r_</u> r
Tanker	Fwd Ø Aft	20 30		20 30		2-A <b>-</b> 15			
Combination Carrier	Fwd 200 Aft	30		30		2 <b>-</b> A-16			
Bulk Carrier	Fwd D Aft	140		140		2-A-17			<u> </u>
Combination Carrier	Fwd Ø Aft	110		110		2-A-17			
General Cargo	Fwd Ø Aft	20		20		2-A-17		i	
Tanker	Fwd <b>300</b> Aft	40 80		40 80		2-A-17			
Combination Carrier	Fwd Ø Aft	40		40		2-A-18			<u> </u>
Container- ship	Fwd Ø Aft	12	1. A.	12		2 <b>-</b> A-19			_П_
Tanker	Fwd Ø Aft	110 1200 40	an a	110 1200 40		2-A-19			t

A-19

TABLE A-2	DETAIL	FAMILY:	TRIPPING	BRACKETS	

					· · · · · · · · · · · · · · · · · · ·			· · · · · · · · · · · · · · · · · · ·	
LOCATION ON	SHIP		No. of	Total	Percent		Failure		
	]	Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number		1 1	I
	1.	Observed	Observed	Observed					1
Container-	Fwd								<b>~</b> ~
ship	<b>DO</b> Aft	56	54	110	49.1	2 <b>-</b> A-20	1,2,4	(8,11,14, 15)	<u> </u>
······································	Fwd	9	1	10	10.0	2-A-20	2	15	. <b>↑</b>
Tanker	Aft								1
Combination	Fwd	56	4	60	6.7	2 <b>-</b> A-21	2	15	,
Carrier	<b>DO</b> Aft								
Container-	Fwd	80		80					
ship	00	150	1	150	ł	2-A-22	}	1	┎┲┖┚╾╸
	Aft	40		40					
General	Fwd	10		10					<b>†</b>
Cargo	Ø	40		40	1	2-A-22	1		┝─┥
-	Aft	20	{	20					
· · · · · · · · · · · · · · · · · · ·	Fwd	40		40					
Tanker	Aft	60		60		2-A-22			
Container-	Fwd			·	<u> </u>	1	1	1	
ship	<b>夏</b>	30		30		2-A-23			r france
<b>L</b>	Aft	20		20					
Miscella-	Fwd		1	†					♠
neous	<b>Q</b> Aft	20		20		2-A-23			┝╌┛
Bulk	Fwd			1		† <del></del>	<u> </u>	1	1
Carrier	Aft	130		130		2 <b>-</b> A-24			
Container-	Fwd	140		140			1		1 1
ship	D D	1037	51	1088	4.7	2-A-24	1,2,4	8,14,15	┝╼╼┫
	Aft	190		190		ļ		1	
	Fwd	30	1	30	1			1	11
Tanker	DQ	ļ	1	1		2-A-24		ł	<b>⊢</b> ⊣
	Aft	30		30				1	ĺ
	Fwd	10	<u>,</u>	10			1		1
Tanker	Aft	50		50		2-A-25			æ
General	Fwd	· · · · · · · · · · · · · · · · · · ·	1	10	t	<u> </u>	<u>+</u>		1.
Cargo	DO	180	1	180	1	2-A-26	1		
	Aft		I	30	[	1	1	1	

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 12, 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
- 11. Neglect 12. Misuse/Abuse
- 7. Combined Tension & Shear 13. Questionable

9. Fabrication/Workmanship

- 8. Design
- 14. Heavy Seas
- 15. Collision
- 10. Welding

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16. Other - See Discussion

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent		Failure		Ī
SHIP TYPE		Details Observed	Details	Details	Failures	Family Number	Mode	Cause	
	Fwd								
Tanker	20								
	Aft Fwd	106	4	110	3.6	2-A-26	1	6,10	4
Narra I	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10 30		10 30		2 1 27			
Naval	Aft	20		20		2-A-27			
	Fwd	20		20					4
Tanker	<b>30</b> Aft	49	l	50	2.0	2-A-27	1	13	<b>]]</b>
Bulk	Fwd								
Carrier	X	24		24		2-A-28			-
	Aft								
General	Fwd	10		10					1 1
Cargo	Q	70		70		2-A-28	j		$\vdash$
	Aft	20		20					1
	Fwd	110		110					-
Naval	QQ	640 240		640		2-A-29			strain a
Bulk	Aft Fwd	240		240					4
Carrier	Aft	180	20	200	10.0	2-A-30	2	15	
Bulk	Fwd		,					· · · · · · · · · · · · · · · · · · ·	
Carrier	X Aft	12		12		2-A-31			2-1-3
Bulk	Fwd								
Carrier	00 Aft	51		51		2 <b>-</b> A-32			ſ <u>₽</u> ₽ <u></u> ₽
Bulk Carrier	Fwd	24	1	25	4.0	2-A-33	2	8,14	
	Aft								j ⊫⊸i
Container- ship	Fwd	378	4	382	1.0	2-A-33	2	14	
Bulk	Aft Fwd					····			
Carrier	<b>30</b> Aft	31	5	36	13.9	2-A-34	1	7,10	
Bulk	Fwd	10		10					
Carrier	QQ	40		40		2-B-1			/
	Aft	10		10					
Combination		30		30					1 🕇
Carrier	۶Ø	420		420		2-B-1			┝╾┈┙
	Aft	30		30				· · · · · · · · · · · · · · · · · · ·	
Tankow	Fwd	20 600		20 600		2-B-2			
Tanker	00 Aft	40		40		2-D-2			<u></u>
Bulk	Fwd	10		10					<u> </u>
Carrier	1 X	260		260		2-в-3			
	Aft	30		30					2.4.

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TABLE A-2 DETAIL FAMILY. TRIPPING BRACKETS

LOCATION ON	SHIP	No. of	No. of	Total	Percent		Failure	
		Sound	Failed	Number	Failures	Family	Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed					
Combination	Fwd	40		40				12.14
Carrier	X	476	4	480	.8	2-в-3	2	13,14
·	Aft	70		70				
	Fwd	20		20				11 15
Tanker	Ø	433	17	450	3.8	2-в-3	2	11,15
	Aft	40		40			 	ļ
Container-	Fwd	20	1	20		0.5.4		1
ship	00	200	ļ	200	]	2~B-4		
	Aft	50		50	ļ		ļ	<b> </b>
Miscella-	Fwd	10	1	· 10	1	2.5.4	1	}
neous	Q	70		70	ł	2-в-4	}	}
	Aft	10	}	10				<b> </b>
	Fwd	20	ļ	20	Į	2-B-4	ļ	
Tanker	Ø		1		[	2-8-4	Ì	{
	Aft Fwd	30	<u> </u>	30				<u> </u>
	1	60	}	60	Į	2 <b>-</b> B-5		
Naval	<b>XO</b> Aft	310		310	.7	2-0-5	2	13
	Fwd	149	1	150	·	<b> </b>	<u> </u>	+
_		1.00	[	1 1 2 0		2-B-6	l	
Naval	<b>XO</b> Aft	120	ł	120	ł	Z-B-0		
	Fwd	<b> </b>	<u> </u>	<u></u>	<u> </u>	<u> </u>	<u>}</u>	
Container-	QQ	40	t.	40	Ì	2-B-7	1	ł
ship	Aft	40		40		2.2.		
Combination	+	30	╆────	30	<del> </del>	<del>{</del>	<del> </del>	<u> </u>
Carrier	30	100	ļ	100	1	2-B-8		
Caller	Aft	90	{	90	ł			1
Miscella-	Fwd		<u> </u>	<u>├───</u> ──	+	<u>+</u>	┼──────	<b> </b>
neous	Ø	20	]	20		2-B-8		
neous	Aft	1	1		[			
Combination		20	ļ	20	t	<u> </u>		†
Carrier	DO	390	1	390	1	2-B-9		}
Catifer	Aft	F	ł	110	Į	Į		
Combination		A second s	<u>                                      </u>	20	†		+	<u>+</u>
Carrier	<u>X</u>	180		180	1	2-B-10	d	1
VIAL L LUL	Aft		1	60				1
	Fwd	<u> </u>	1	40	1	t	<u> </u>	<u>†</u>
Naval	Q	230		230		2-B-10	d	1
	Aft		1	90				

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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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(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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- (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
- 11. Neglect 12. Misuse/Abuse
- 7. Combined Tension & Shear 8. Design
- 15. Collision

13. Questionable

14. Heavy Seas

9. Fabrication/Workmanship 10. Welding

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16. Other - See Discussion

SHIP TYPE         Sound Details () Observed () Observed () Details () Observed () Details () Observed () Details () Observed () Details () Detai	LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure
SHIP TYPE         Details Observed Observed         Details Observed Observed         Details Observed Observed         Number Observed           Tanker         JO         170         170         2-B-11           Bulk Carrier         Fwd         10         170         2-B-11           Bulk Carrier         Fwd         10         170         2-B-12           Maval         Fwd         10         10         2-B-12           Naval         JO         30         30         2-B-12           Tanker         JO         30         30         2-B-12           Tanker         JO         30         2-B-12         8,11           Aft         20         20         2-B-12         8,11           Tanker         JO         821         29         850         3.4         2-B-12         1         8,11           Tanker         JO         20         20         2-B-13         2			Sound	Failed	Number	Failures			
Fwd         10         10         10         2-B-11         -           Bulk         Fwd         -         -         20         -         2-B-11         -           Bulk         Fwd         -         -         20         -         2-B-12         -           Bulk         Fwd         -	SHIP TYPE								
Tanker $30$ $170$ $170$ $2-B-11$ $2-B-11$ Bulk         Fwd $30$ $30$ $30$ $2-B-12$ $2-B-12$ Bulk         Fwd $10$ $10$ $30$ $30$ $2-B-12$ $2-B-12$ Naval $30$ $30$ $30$ $2-B-12$ $2-B-12$ $2-B-12$ Tanker $30$ $30$ $30$ $2-B-12$ $1$ $8,12$ Tanker $50$ $3.4$ $2-B-12$ $1$ $8,12$ Tanker $50$ $50$ $2-B-13$ $2-B-13$ $2-B-13$ Container-         Fwd $50$ $2-B-13$ $2-B-14$ $150$ Tanker $50$ $20$ $20$ $2-B-16$ $1$ $150$ Tanker $50$ $20$ $20$ $2-B-16$ $1$ $150$ Tanker $50$ $20$ $20$ $20$ $2-B-16$ $1$ $150$ Tanker $50$ $100$		<u>.</u>		Observed	Observed			Ì	
Aft         20         20         1         1           Bulk Carrier         Fwd Mt         30 30         30 30         2-B-12         1           Maval         M         10 Mt         10 30         2-B-12 20         1         8,1           Naval         Md         10 Mt         20 30         30 30         2-B-12 20         1         8,1           Tanker         Md         20 Aft         20 50         3.4         2-B-12         1         8,1           Tanker         Md         50 Aft         50 50         50         2-B-13         1         8,1           Tanker         Md         20 Aft         20 50         20 2-B-13         2         1         1,1           Tanker         Md         20 Aft         20 20         20 20         2-B-14         1         15           Tanker         Md         20 20         20 20         20 20         2-B-15         1         15           Maval         Md         140         140         2-B-16         1         15           Naval         Md         144         114         2-B-17         1         13           Container- ship         Md         10					10				
Bulk Carrier         Fwd Mt         30 30         30 30         2-B-12         1           Naval         M         10         11         10 <td< td=""><td>Tanker</td><td></td><td>[</td><td></td><td>170</td><td></td><td>2-B-11</td><td></td><td></td></td<>	Tanker		[		170		2-B-11		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	·		20		20				
Aft         30         30 $2-B-12$ Naval $30$ $30$ $30$ $2-B-12$ Maxal $30$ $30$ $30$ $2-B-12$ Tanker $30$ $821$ $29$ $850$ $3.4$ $2-B-12$ $1$ $8,12$ Tanker $30$ $50$ $50$ $2-B-13$ $2-B-13$ $30$ Tanker $30$ $20$ $20$ $2-B-14$ $30$ $30$ Tanker $50$ $50$ $2-B-13$ $30$ <	1								
Naval $\overline{Wd}$ 10         10         2-B-12           Maval $\overline{M0}$ 30         20         20         2-B-12         1         8,1           Tanker $\overline{M0}$ 821         29         850         3.4         2-B-12         1         8,1           Tanker $\overline{M0}$ 821         29         850         3.4         2-B-12         1         8,1           Tanker $\overline{M0}$ 50         2-B-13         2         3 <th< td=""><td>Carrier</td><td></td><td>4</td><td></td><td>)</td><td></td><td>2-B-12</td><td></td><td></td></th<>	Carrier		4		)		2-B-12		
Naval $\overline{30}$ Aft $30$ 20 $2-B-1220 2-B-12 1 8,11           Tanker         \overline{30}Aft         82150$ $29$ $85050 3.4 2-B-12 1 8,11           Tanker         \overline{30}Aft         50 50 2-B-13 2 2-B-13 2 2-B-13 2 2-B-14 3 3 3 3 3 3 2 2-B-14 3the second s$					the second s				
Aft         20         20         1         1           Tanker $\overline{M}$ 821         29         850         3.4         2-B-12         1         8,13           Tanker $\overline{M}$ 50         50         3.4         2-B-12         1         8,13           Tanker $\overline{M}$ 50         50         2-B-13         2         8,13           Container-         Fwd         50         20         2-B-13         2         2         2         2         2         2         1	N1								
Tanker       Fwd M       821 50       29 50       850 50 $3.4$ $2-B-12$ $1$ $8,12$ Tanker       Fwd Aft       50 Aft $50$ $50$ $2-B-13$ $2-B-13$ Container- ship       Fwd Aft $20$ $20$ $20$ $2-B-14$ $2$ Tanker       Fwd Aft $20$ $20$ $20$ $2-B-14$ $1$ $15$ Tanker       Fwd Aft $20$ $20$ $20$ $2-B-15$ $1$ $15$ Tanker       Fwd Aft $20$ $20$ $20$ $2-B-15$ $1$ $15$ Tanker $M$ $20$ $20$ $20$ $2-B-15$ $1$ $15$ Tanker $M$ $20$ $20$ $20$ $2-B-15$ $1$ $15$ Naval $M$ $20$ $20$ $20$ $2-B-16$ $2$ $2-B-17$ $2$ Container- ship $M$ $114$ $114$ $114$ $2$ $2$ $2$ $2-B-18$ $1$ $8,14$ Container- ship $M$ $10$	Naval		r		1		2-B-12		
Tanker $\overline{M}$ 821       29       850       3.4       2-B-12       1       8,11         Tanker $\overline{M}$ 50       50       2-B-13       1       8,11         Tanker $\overline{M}$ 50       50       2-B-13       1       8,11         Container-       Fwd       90       1       100       1.0       2-B-13       1       15         Tanker $\overline{M}$ 20       20       20       2-B-14       1       15         Tanker $\overline{M}$ 99       1       100       1.0       2-B-15       1       15         Tanker $\overline{M}$ 20       20       20       2-B-15       1       15         Tanker $\overline{M}$ 20       20       20       2-B-16       1       15         Naval $\overline{M}$ 20       20       20       2-B-16       1       15         Ship $\overline{M}$ 14       114       2-B-17       1       16         Container-       Fwd       30       20       30       30       2-B-18       1       8,14         Container-       Fwd       30       30 <td></td> <td></td> <td>20</td> <td></td> <td>20</td> <td></td> <td></td> <td></td> <td></td>			20		20				
Aft         50         50         2-B-13           Tanker $\overline{M}$ 50         20         2-B-13           Container- ship $\overline{M}$ 20         20         2-B-14           Tanker $\overline{M}$ 20         20         2-B-14           Tanker $\overline{M}$ 20         20         2-B-14           Tanker $\overline{M}$ 20         20         2-B-15           Tanker $\overline{M}$ 20         20         2-B-16           Naval $\overline{M}$ 140         140         2-B-16           Naval $\overline{M}$ 114         114         2-B-17           Ship $\overline{M}$ 10         10         2-B-17           Container- ship $\overline{M}$ 10         10         10           Aft         10         10         1.7         2-B-19         1           Ship $\overline{M}$ 20	Tankor		0.01	20	· .			_	
Tanker $\overline{y}$ aft       50 aft       50 aft       2-B-13       2-B-13         Container- ship $\overline{y}$ aft       20 aft       20 20 aft       2-B-14       2-B-14         Tanker $\overline{y}$ 20 aft       20 20 aft       20 2-B-14       1       15         Tanker $\overline{y}$ 20 aft       20 aft       20 2-B-15       1       15         Naval $\overline{y}$ 140 aft       20 aft       20 aft       2-B-16       1       15         Naval $\overline{y}$ 140 aft       140 aft       2-B-16 aft       2-B-16 aft       1       15         Container- ship $\overline{y}$ 114 aft       114 aft       2-B-17 aft       2       2       2       2       2       2       2       2       3       2       2       2       3       2       2       2       3	Tauxer		1	29	•	3.4	2-8-12	1	8,13
Tanker		· · · · · · · · · · · · · · · · · · ·	50		50				
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Tanker		50		50		2 0 1 2		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Tormeo 1		10		50		2-0-13		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Container-								
Aft       Image: constraint of the structure of th			20		20		2-B-14	}	
Fwd         99         1         100         1.0         1         15           Tanker $\widetilde{\mathbf{M}}$ 20         20         20         20         2-B-15         1         15           Naval $\widetilde{\mathbf{M}}$ 20         20         20         2-B-15         1         15           Naval $\widetilde{\mathbf{M}}$ 20         20         20         2-B-16         10         1         15           Container- ship         Fwd         30         140         140         2-B-16         10         10         10         10         10         10         10         10         10         10         10         10         10         10         10         10         10         10         10         13         13           Container- ship $\widetilde{\mathbf{M}}$ 10         10         1.7         2-B-19         1         13           Container- ship $\widetilde{\mathbf{M}}$ 30         30         30         2-C-1         1         13		XAZ Aft			20		2-0-14		
Tanker			99	1	100				
Aft         40         40         10         2	Tanker					110	2-B-15	-	15
Fwd         20         20         20         2-B-16         2-B-16           Naval $M = 140$ 140         140         2-B-16         2-B-16         2-B-16         2-B-17		Aft							
Naval $M = 140$ $140$ $140$ $2-B-16$ $2-B-16$ Container-         Fwd $50$ $50$ $2-B-17$ $2-B-17$ Ship $M = 114$ $114$ $114$ $2-B-17$ $2-B-17$ Aft $10$ $10$ $2-B-17$ $2-B-17$ $2-B-17$ Container-         Fwd $60$ $2$ $62$ $3.2$ $2-B-18$ $1$ $8,14$ Container-         Fwd $0$ $10$ $10$ $10$ $13$ Ship $M = 10$ $100$ $1.7$ $2-B-19$ $1$ $13$ Container-         Fwd $20$ $20$ $2-C-1$ $13$			20						
Aft         50         50         Image: constant of the state of the st	Naval		140	:	140		2-B-16		
ship     Image: Container- ship     Image: Container- Aft     Image: Container- Aft     Image: Container- ship     Image: Container- Aft     Image: Container- ship     Image: Container- Aft     Image: Container- ship     Image: Container- Aft     Image: Container- ship     Image: Container- Ship <thi< td=""><td></td><td>Aft</td><td>50</td><td></td><td>50</td><td></td><td></td><td></td><td></td></thi<>		Aft	50		50				
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	5	Fwd							
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	ship						2-B-17		
ship     0     60     2     62     3.2     2-B-18     1     8,14       Container-     Fwd     10     10     10     1.7     2-B-19     1     13       Ship     0     99     1     100     1.7     2-B-19     1     13       Container-     Fwd     20     20     20     2-C-1     13			10		10				
Aft     10     10       Container-     Fwd     10       ship     30     99     1       Aft     20     20       Container-     Fwd       ship     30     30       Ship     30									
Container- ship         Fwd         10 99         1         10 100         1.7         2-B-19         1         13           Aft         20         20         20         1.7         2-B-19         1         13           Container- ship         Fwd 30         30         30         2-C-1         1         13	ship	ΩΩ	60	2	62	3.2	2-B-18	1	8,14
ship         00         99         1         100         1.7         2-B-19         1         13           Aft         20         20         20         1         13           Container-         Fwd         30         30         2-C-1         1									
Aft         20         20           Container-         Fwd         30         30         2-C-1									
Container-     Fwd       ship     30       30     2-C-1	snip	202		1		1.7	2-B-19	1	13
ship <b>30</b> 30 2-C-1			20		20				
	snip	20	30		30	ĺ	2-C-1		
Aft									· · · · · · · · · · · · · · · · · · ·
Fwd         360         2-C-1	Tankor		260		200				
Tanker         360         360         2-C-1           Aft         360         360         360         360	TRIIVET		500		300		2-C-1		

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

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Aft

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Tanker

ship

Bulk

Carrier

Container-

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause
Combination Carrier	Fwd DD Aft	69	1	70	1.4	2-C-4	1	14
Container- ship	Fwd 00 Aft	1005	72	1077	6.7	2-C-4	1	(7,10,11, 14)
General Cargo	Fwd 00 Aft	448	12	460	2.6	2-C-4	1,4	(10,11, 14,15)
Container- ship	Fwd M Aft	329	3	332	0.9	2-C-5	1	14,15
Bulk Carrier	Fwd XX Aft	164	6	170	3.5	2-C-6	1,4	7,15
Container- ship	Fwd <b>30</b> Aft	148	14	162	8.6	2-C-6	1	8,10
Tanker	Fwd	18	2	20	10.0	2-C-6	2	12
Bulk Carrier	Fwd 00 Aft	1606	83	1689	4.9	2-C-7	1	(7,8,10, 14)
Container- ship	Fwd Ø Aft	1045	146	1191	12.3	2-C-7	1,4	(7,10, 11,14)
Bulk Carrier	Fwd Ø Aft	75	1	76	1.3	2-C <b>-</b> 8	1	7,14
Container- ship	Fwd Ø Aft	956	92	1048	8.8	2-C-8	1,4	(8,10, 14,15)
General Cargo	Fwd Ø Aft	63	1	64	1.6	2-C-8	4	1.5
Bulk Carrier	Fwd D Aft	74		74		2-C <b>-</b> 9		

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{V}$ , 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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(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

11. Neglect 12. Misuse/Abuse

18. Questionable

14. Heavy Seas

7. Combined Tension & Shear

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

TABLE A-2 DETAIL FAMILY: TRIPPING BRACKETS

LOCATION ON SHIP TYPE		Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures			Failure Cause
Container- ship	Fwd 200 Aft	169	1	170	0.6	2-C <b>-</b> 9	1	14
General Cargo	Fwd 20 Aft	4		4		2-C-9		
Bulk Carrier	Fwd 300 Aft	60		60		2-C-10		
General Cargo	Fwd Ø Aft	1116	196	1312	14.9	2 <b>-</b> C-11	1,4	(9,11, 15,16)
Container- ship	Fwd Ø Aft	103	5	108	4.6	2-C-12	1	14
General Cargo	Fwd ØQ Aft	37	3	40	7.5	2-C-12	1	11
General Cargo	Fwd Ø Aft	40	60	100	60.0	2-C-13	1	12
Bulk Carrier	Fwd 202 Aft	16		16		2-C-14		
General Cargo	Fwd 00 Aft	61	9	70	12.9	2 <b>-</b> C-14	1	11
Naval	Fwd Ø Aft	10 30 10		10 30 10		2-C-15		
Naval	Fwd 00 Aft	160 800 310		160 800 310		2-C-16		
Naval	Fwd 00. Aft	10 10 10		10 10 10		2-C-17		
Naval	Fwd <b>30</b> Aft	10 20 10		10 20 10		2-C-18		
Container- ship	Fwd <b>92</b> Aft	175	12	187	6.4	2-C-19	1	(7,10, 11,16)
General Cargo	Fwd D Aft	1249	318	1567	20.3	2 <b>-</b> C-19	1,4	(7,12, 15,16)
Container- ship	Fwd Ø Aft	118	60	178	33.7	2-C-20	1,2,4	10,11,15

DETAIL FAMILY: TRIPPING BRACKETS TABLE A-2

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures			Failure Cause	(
General Cargo	Fwd M Aft	562	38	600	6.3	2-C-20	1,4	(11,12, 15,16)	
Container- ship	Fwd ØØ Aft	78	11	89	12.4	2-C-21	1	11,15	
Bulk Carrier	Fwd XX Aft	75	1	76	1.3	2-C-22	1	7,11	6 6
Container- ship	Fwd MAft	100	5	105	4.8	2-C-22	1	7,11	
General Cargo	Fwd 00 Aft	43	9	52	17.3	2-C-23	1	7,8,16	$\square$
Bulk Carrier	Fwd	228		228		2-C-24			Ū.
Container- ship	Fwd SQ Aft	627	69	696	9.9	2-C-25	2,4	14,15	K
General Cargo	Fwd Ø Aft	50		50		2-C-25			
General Cargo	Fwd Q Aft	99	30	129	23.2	2-C-26	1,4	(10,11, 14,15)	
General Cargo	Fwd Ø Aft	68	50	118	42.4	2-C-27	1	7,8,14	
Container- ship	Fwd XX Aft	222	18	240	7.5	2-C-28	3,4	12,15	1-
General Cargo	Fwd Ø	107	3	110	2.7	2-C-29	4	15	11

### NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{D}$ , 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
- 11. Neglect 12. Misuse/Abuse
- 7. Combined Tension & Shear
- 8. Design
- 13. Questionable 14. Heavy Seas 9. Fabrication/Workmanship 15. Collision
- 10. Welding
- 16. Other See Discussion

TABLE A-3 DETAIL FAMILY: NON-TIGHT COLLARS

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details	No. of Failed Details	Total Number Details	Percent Failures		Failure Mode	Failure Cause	
		Observed		Observed		NULLOCI			
Combination	Fwd			130					
Carrier	200	1200		1200		3-A-1			
	Aft	180		180					
Bulk	Fwd	50		50					
Carrier	DQ.	260		260		3-A-2			
	Aft	70		70		•			
Container-	Fwd	10		10			·······		
ship	300	100		100		3-A-2			
-	Aft	50		50		JAZ			
General	Fwd								
Cargo	QQ	68		. 68		3-A-2			
2	Aft					J A-2			
	Fwd	20		20					
Tanker	Q	90		20 90		3 <b>-</b> A-2			
	Aft	40		90 40		J-A-2			
Container-	Fwd			-10					
ship	700 100	212		212		3-A-3			
	Aft	30		30		3-A-3			
General	Fwd	30		30					
Cargo		204		204		2	1		<b>↑</b>
curgo	Ø Aft	204		204		3-A-3	Ì		
	Fwd	25	5	20-	12 3				
Tanker		110	Э	30 110	16.7		2	15	
Tanker	QQ			110		3-A-3			4
Container-	Aft	20		20					
ship	Fwd	20							
Surb	00	200 50		200		3-A-4			
Bulk	Aft			50					
Carrier	Fwd	207				]			
Catifel	Q	207	ļ	207	ſ	3-A-5			
Container-	Aft	90							
	Fwd	90 1700		90					t
ship	QQ			1700	ľ	3-A-5			
D 7.1-	Aft	120		120					
Bulk	Fwd	10	1	10				],	
Carrier	<u>00</u>					3-A-6		1	Į
Contration	Aft	10		10					
Container-	Fwd	10		10					
ship	XX	110		110		3-A-6	1	ļ	
	Aft	30		30					
Container-	Fwd	30		30					
ship	X	488		488		3-A-7		ĺ.	- T
	Aft	50		50					
Bulk	Fwd								
Carrier	DC	41		41		3-A-8		1	T
	Aft				Į				
	Fwd								4
Fanker	Ø	1							
	Aft	40		40		3-A-8			

TABLE A-3	DETAIL	FAMILY	NON-TIGHT	COLLARS

									1
LOCATION ON	SHIP		No. of	Total	Percent			Failure	}
<u> </u>	11	Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE	$\mathbf{I}$	Details	Details	Details		Number			ļ
	1	Observed	Observed	Observed					
Bulk	Fwd								
Carrier	<u>x</u>		1					1	
	Aft	60		60		3-A-9		1	] _
Container-	Fwd								
ship	Ø			i i	ł			j	
	Aft	40	l	40		3-A-10	<u> </u>	l	
General	Fwd	10		10	}				
Cargo	00			ļ		3-A-11			
	Aft	10	<u> </u>	10	<u> </u>		<u> </u>		
	Fwd	160		160					1 1
Naval	双	1200		1200	1	3-A-11	]	ļ	
	Aft	320		320					
	Fwd	10	[	10	]		]	]	
Tanker	DQ.			Ę		3-A-11		Ì	<b></b>
	Aft	30		30					]
Container-	Fwd	40		40					
ship	۵Q	200	1	200	)	3-A-12			
	Aft	50		50	L				1 .
	Fwd	20	[	20	]				1 <b>†</b>
Naval	DQ	100	1	100	1	3-A-12		Í	┝╼┛
	Aft	40		40		l		<u> </u>	
	Fwd	20		20					
Naval	夏	100	)	100		3-A-13		1	
	Aft	40	<u> </u>	40	.[	Ì	l I		
Container-	Fwd		]	]	1		1		1
ship	DQ	70		70	ſ	3-A-14	1	1	
	Aft	l							
General	Fwd				[	[			]₩
Cargo	X	]		l ·	ļ			1	' 🗲
	Aft	58	2	60	3.3	3-A-15	1	9	1
Bulk	Fwd	1		1	T		Γ	T	1
Carrier	<b>D</b>	66	2	68	2.9	3-A-16	1	10	
	Aft	l	1						
Container-	Fwd	1		1	1	1	1	1	1 🔺
ship	00	ļ		ł		ł			┝──┛
-	Aft	30	1	30	ł	3-A-16		}	1
Container-	Fwd		1	1	1	<u>†</u>	†	†	1
ship	X	58	2	60	3.3	3-A-17	1	9	ļ <b>L</b>
~	Aft		1		1		1	}	

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{V}$ , 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

8. Design

7. Combined Tension & Shear

13. Questionable 14. Heavy Seas

12. Misuse/Abuse

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

## TABLE A-3 DETAIL FAMILY: NON-TIGHT COLLARS

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details	Total Number Details	Percent Failures		Failure Mode	Failure Cause	
General	Fwd		Observed	Observed					4
Cargo	20								
Cargo	Aft	68	2					)	
Bulk	Fwd		2	70	2.9	<u>3-A-17</u>	1	9	- ·
Carrier	D Aft	228		228		3-A <b>-</b> 18			F
Container-	Fwd						·····		1 ▲
ship	<b>30</b> Aft	34		34		3 <b>-</b> A-18			┝─┚
Bulk	Fwd								
Carrier	D Aft	103		103		3-A-19			UUT .
Container-	Fwd	<b>+</b> -							
ship	Aft	84		84		3-A-20			T
Bulk	Fwd	1				·····			
Carrier	00 Aft	47		47		3-A-21			J
Bulk	Fwd								
Carrier	00 Aft	120		120		3-A-22			ゥ
Container-	Fwd								
ship	XX Aft	104		104		3-A-23			
Container-	Fwd							······	
ship	00 Aft	104		104		3-A-24			Π.
Container-	Fwd								
ship	Q Aft	261	3	264	1.1	3-A-25	1	9,10	ΨL)
Bulk	Fwd	90	T	90		[			
Carrier	<b>X</b>	1340	}	1340	Í	3-B-1			
Combination	Aft	300		300					
Compination Carrier	Fwd	140	ļ	140			1		1
Cartter	00. Aft	1200 380	ĺ	1200 380		3-B-1		1	<b></b>
General	Fwd		<del></del>	- 000					
Cargo	<b>300</b>			Ì	ľ				
	Aft	40		40		3-в-2			<b>.</b>
man la su	Fwd								
Tanker	<b>D</b> Aft	110	ĺ	110	[	3-в-3			
	Fwd	20		20		<u></u>			
Tanker	<u>I</u>	20		20		3-в-4			13
	Aft	40		40				ļ	
	Fwd	160		160					
Tanker	<u>00</u>	1200		1200		3-в-5		[	
	Aft	400		400	. ]				

LOCATION ON	SHIP		No. of	Total	Percent		Failure		
		Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number	f		
			Observed	Observed					
Bulk	Fwd	30		30					
Carrier	<u>X</u>	260		260		3 <b>-</b> B-6			النظ ا
	Aft	90		90					_
Bulk	Fwd		)					ł	
Carrier	00 Aft	200		200		3-в-7			السلم
Container-	Fwd	}	ļ			1	1		
ship	<b>DO</b> Aft	103		103	ļ	3-B-7			┠┈┈┛
Bulk	Fwd		1	[					
Carrier	00	500	l	500		3-в-8			╎┝┷
	Aft		 		L	ļ	<u> </u>	ļ	
Tanker	Fwd 00 Aft	80		80		3-C-1	1		
Bulk	Fwd					<u> </u>	1		<b> </b>
Carrier	<b>30</b> Aft	96		96		3-C-2			
Combination	Fwd	-			[				<u></u>
Carrier	<b>X</b> Aft	110		110		3-C-2			<u>  </u>
Container-	Fwd	1	1	T					
ship	00 Aft	28		28		3-C-2			
Bulk	Fwd	1	1	180	1	1	<u> </u>	<u>, , , , , , , , , , , , , , , , , , , </u>	
Carrier	DQ.	990	ļ	990		3-C-3			
<u> </u>	Aft	and the second se	8	3.10	2.6	<u> </u>	1	13	j †
Miscella-	Fwd	20		20					
neous	Ø		1	}	1	3-C-4	]		
····	Aft		ļ	20	<b>.</b>	Ļ	ļ		
_	Fwd		1	80	1				- <del></del>
Naval	Aft			300		3-C-5			
	Fwd			160	[	7	1	1	]
Naval	DQ	700		700		3-C-6			
	Aft	. 320	·	320	1				
Container- ship	Fwd Ø Aft	50		50		3-C-7			1

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, D, 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.

Se ...

- (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 & Shear 13. Questionable

9. Fabrication/Workmanship

- 8. Design
- 14. Heavy Seas
- 15. Collision
- 10. Welding
- 16. Other See Discussion

LOCATION ON SHIP TYPE		No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause
General Cargo	Fwd 200 Aft	30		30		3-C-7		
Naval	Fwd 20 Aft	30 150 60		30 150 60		3-C-8		
Naval	Fwd 30 Aft	20 70 20		20 70 20		3-C-9		
Bulk Carrier	Fwd Ø Aft	80		80		3 <b>-</b> C-10		
General Cargo	Fwd Ø Aft	56	4	60	6.7	3 0 10		
Container- ship	Fwd Ø Aft	18	2	20	10.0	3-C-10 3-C-11	1	9 9
Miscella- neous	Fwd Ø2 Aft	57 140 50	3	60 140 50	5.0	3-C-12	2	15
Bulk Carrier	Fwd Ø Aft	21		21		3-C-13		
General Cargo	Fwd 20 Aft	76		76		3-C-14		
bulk Carrier	Fwd Ø Aft	24		24		3 <b>-</b> C-15		
ontainer- hip	Fwd Ø Aft	60		60		3-C-16		

TABLE A-3 DETAIL FAMILY: NON-TIGHT COLLARS

TABLE A-4 DETAIL FAMILY: TIGHT COLLARS

LOCATION ON			No. of	Total	Percent	Detail	Failure		1
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	rallure Cause	
Bulk Carrier	Fwd 20 Aft	30 304 90		30 304 90		4-A-1			

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DETAIL FAMILY. TIGHT COLLARS TABLE A-4

LOCATION ON	SHIP	No. of	No. of	Total	Percent			Failure
. <u> </u>		Sound	Failed	Number	Failures		Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed		· ·		<u> </u>	· · · ·
Combination	Fwd	210		210	¢			
Carrier	Ø	1100		1100		4-A-1		
	Aft	290		290		ļ		
Bulk	Fwd							
Carrier	QQ	19	}	19		4-A-2		e e e e e e e e e e e e e e e e e e e
	Aft		ļ				┨	<u>}</u>
Combination	Fwd	30		30		4-A-2		
Carrier	Ø	220		220				y.
	Aft	the second se	<u> </u>	70	<u>}</u>	<u> </u>		1
Bulk	Fwd			56	Į	4-A-3		
Carrier	Aft	56		00				
	Fwd		+	40	<u>                                      </u>		<u>†</u>	1
Combination	500	300	1	300		4-A-3		1
Carrier	Aft			90	ł			
<u> </u>	Fwd		<u> </u>					
General	00	50	5	55	9.1	4-A-3	1	11
Cargo	Aft							
General	Fwd			1				
Cargo	) XQ	24		24	1	4-A-4		
curgo	Aft	-					<u> </u>	<u> </u>
	Fwd	1		80		4-A-4		
Tanker	Q					l l		
	Aft							
Bulk	Fwd	1				4		
Carrier.	DQ		1	21	1	4-A-5		
	Aft							
Container-	Fwd			10	ļ	4-A-5		·
ship	D D			120	1	A-J		
	Aft			120	-			
General	Fwe			24		4-A-5		
Cargo	00			24			1	
· · · · · · · · · · · · · · · · · · ·	Aft Fwo			20				
_ ,				200		4-A-5	1	1
Tanker	Af			50				
	Fwo			60				
Bulk	X			445		4-A-6		
Carrier	Af	t <u>90</u>		90				

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{D}$ , 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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- (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

8. Design

11. Neglect 12. Misuse/Abuse

14. Heavy Seas

- 7. Combined Tension & Shear 13. Questionable
- 9. Fabrication/Workmanship
- 10. Welding
- 15. Collision
- 16. Other See Discussion

TABLE A-4 DETAIL FAMILY: TIGHT COLLARS

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details	No. of Failed Details	Total Number	Percent Failures	Family	Failure Mođe	Failure Cause	Ţ
	<b>↓</b>	Observed		Details Observed		Number		_	
Combination		50		50					4
Carrier	302	210		210		1			
	Aft	120	İ	120		4-A-6			
Container- ship	Fwd	20		20					1
	Aft	80		80		4-A-6			<b>├</b> ── <b>┤</b>
General	Fwd	20		20		<u>+</u>			
Cargo	302	594	40	634	6.3	4-A-6	3,4	11 15	
	Aft	50		50	0.0	-A-0	3,4	11,15	
Miscella-	Fwd	40		40	· · · · · · · · · · · · · · · · · · ·	┦┈┈┈╴┤			4
neous	<u> </u>	180	!	180		4-A-6			
	Aft	80		80					
Tanker	Fwd	90		90					
	Aft	100	ľ	100		4-A-6			
Bulk	Fwd					└ <u>-</u>			
Carrier	00 Aft	100		100		4-A-7			
Container-	Fwd								
ship	Ø Aft	90		90		4-a-7			
Combination	Fwd	40		40					
Carrier	XX	210	1	210		4 2 0			
	Aft	60		60		4-A-8			Ľ.∣
Bulķ	Fwd								5
Carrier	00 Aft	64		64		4-A-9			
Combination	Fwd			<u> </u>					
Carrier	00 Aft	130		130		4-a-9			
General	Fwd	30	<del></del>	30					
Cargo	00 Aft	34		34		4-A-9			
	Fwd	30		30		4-A-10			
	00. Aft							]-	U
	Fwd								
Carrier	00 Aft	28		28		4-A-11		]-	
	Fwd	90		90					لاعق
	30	841		90 841					+
	Aft	170		170	4	4-A-11		┣━	-1
eneral I	Fwd								
argo	ØC	313		313	4	-A-11		7	
ulk F	wd								
arrier	Ø ft	11		11	4	-A-12			

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TABLE A-4	DETAIL	FAMILY:	TIGHT	COLLARS

OCATION ON	SHIP		No. of	Total	Percent		Failure	
		Sound	Failed	Number	Failures		Mode	Cause
HIP TYPE		Details	Details	Details		Number		
		Observed	Observed	Observed				
ontainer-	Fwd							
híp	X	128		128		4-A-12	1	1
	Aft					ļ	<b> </b>	
eneral	Fwd	30		30			ļ	
argo	QQ	396	{	396	ł	4-A-12		ļ
	Aft	80		80	<b> </b>		<u></u>	
ontainer-	Fwd	30	Į	30				
hip	<u>00</u>	250	ļ	250	1	4-A-13	{	{
	Aft	60	<u> </u>	60	<b>}</b>	<b> </b>	<u> </u>	+
General	Fwd				ļ.	4-A-13	ļ	
Cargo	Aft	34		34		4-A-13	ļ	1
	Fwd		+	20				
lanker	DO	20	1			4-A-13	1	{
anner	Aft	30	1	30		I		-
	Fwd			20				
anker	300		4	[	1	4-A-14		ĺ
anner	Aft	30	]	30			I	l
ombination	Fwd			10	T	T	1	
Carrier	X	1	\ \			4-B-1		
	Aft	40		40				
Container-	Fwd		T		ł			1
ship	D D		Ì					
	Aft			20		4-B-1		
Bulk	Fwd		{				1	1
Carrier	Q	50		50	1	4-B-2		
	Aft		<u></u>		. <b> </b>			
Container-	Fwd			20			[	1
ship	Q	373		373		4-B-2		
	Aft			10	- <u> </u>			
Container-	Fwo			50		4-B-3		
ship	00			200	1	4-8-3		1
	Aft		<u> </u>	80	- <u> </u>			
General	Fwo		1	115		4 8-3		1
Cargo	Aft	115		115		4-B-3		
	Fwo	300		300	1	1	1	1
Naval	Ø	1200	1	1200	1	4-B-3		
	Aft	600	<u> </u>	600				

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
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  - 5. Shear 6. Tension

11. Neglect

8. Design

10. Welding

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9. Fabrication/Workmanship

12. Misuse/Abuse

- 7. Combined Tension & Shear 13. Questionable
  - 14. Heavy Seas
  - 15, Collision
  - 16. Other See Discussio

216 -A-34 TABLE A-4 DETAIL FAMILY: TIGHT COLLARS

LOCATION ON SHIP TYPE		Sound Details Observed	No. of Failed Details Observed		Percent Failures		Failure Mođe	Failure Cause	
Naval	Fwd 20 Aft	20 100 30		20 100 30		4-B-4			
Naval	Fwd 20 Aft	60 300 100		60 300 100	· ·	4-в-5			
Naval	Fwd 300 Aft	30		30		<b>4-</b> B <b>-</b> 6			115
Naval	Fwd SO Aft	60 300 100		60 300 100		<b>4-</b> B-7			11
Naval	Fwd Q Aft	20		20		4-в-8			U
Bulk Carrier	Fwd Ø Aft	18		18		4-C-1			
Container- ship	Fwd Q Aft	112	1	113	0.9	4-C-1	2	13,16	
General Cargo	Fwd Ø Aft	10 40 30		10 40 30		4-c-1			
Container- ship	Fwd 00 Aft	100		100		4-C-2			-U
Container- ship	Fwd Q Aft	120		120		4-c-3			U
Tanker	Fwd 00 Aft	40		40		4-c-4			UZ
Tanker	Fwd 00. Aft	40		40		4-c-5			
Bulk Carrier	Fwd 202 Aft	10 300 50		10 300 50		4-C-6			
Bulk Carrier	Fwd Ø Aft	62		62		4-c-7			
Bulk Carrier	Fwd DO Aft	192		192		4-D-1			1-
Tanker	Fwd Ø Aft	50 1000 180		50 1000 180		4-D-1			

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TABLE A-4	DETAIL	FAMILY:	TIGHT	COLLARS

LOCATION ON	SHIP		No. of	Total	Percent		Failure	
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause
Miscella- neous	Fwd DO Aft	200		200		4-D-2		
Tanker	Fwd 00 Aft	2900		20 2900 240		<b>4-</b> D-2		
Container- ship	Fwd <b>XX</b> Aft	500		500		4-D-3		
Tanker	Fwd 00 Aft	1100		1100 80		4-D-4		

#### DETAIL FAMILY. GUNWALE CONNECTIONS TABLE A-5

LOCATION ON	SHIP		No. of	Total	Percent	Detail	Failure	Failure	
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number		Cause	
∃ulk Carrier	Fwd Ø Aft	6		6		5-A <b>-</b> 1			
Container- ship	Fwd Ø Aft	5	1	6	16.7	5-A-1	2	15,16	
General Cargo	Fwd Ø Aft	14		14		5-A <b>-</b> 1			
Tanker	Fwd Ø Aft	10		10		5-A <b>-</b> 1			
Container- ship	Fwd Ø Aft	2		2		5-A-2			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 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. Shear6. Tension

11. Neglect

12. Misuse/Abuse

7. Combined Tension & Shear 8. Design

- 15. Collision
- 9. Fabrication/Workmanship
- 10. Welding

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- 13. Questionable
- 14. Heavy Seas
- 16. Other See Discussion

# TABLE A-5 DETAIL FAMILY: GUNWALE CONNECTIONS

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures			Failure Cause	
Container- ship	Fwd	4		4		5-A-3			
General Cargo	Fwd 90 Aft	2		2		5-A-3			
Container- ship	Fwd 30 Aft	2		2		5-A-4			<u>₽</u> ₽₽₽
Naval	Fwd Ø Aft	6		6		5-A-5			
General Cargo	Fwd Ø Aft	4		4		5 <b>-</b> A-6			
Bulk Carrier	Fwd Ø Aft	4		4		5-A-7			
Combination Carrier	Fwd Ø Aft	4		4		5-a <b>-</b> 7			
General Cargo	Fwd XX Aft	6		6		5-A <b>-</b> 7			
Miscella- neous	Fwd 20 Aft	2		2		5-A-7			
Tanker	Fwd Ø Aft	6	2	8	25.0	5-A-7	2	12,15	
Bulk Carrier	Fwd 00 Aft	4		4		5-A-8			
Combination Carrier	Fwd <b>90</b> Aft	2		2		5-A-9			⋕
General Cargo	Fwd Ø Aft	4		4		5-A-9			
Tanker	Fwd Ø Aft	2		2		5-A-9			
General Cargo	Fwd X Aft	2		2		5-A-10			॑ <mark>╊ ╋</mark>
Naval	Fwd Ø Aft	2		2		5-A <b>-</b> 11			ŧ

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### DETAIL FAMILY: GUNWALE CONNECTIONS TABLE A-5

OCATION ON S	HIP	No. of	No. of Failed	Total Number	Percent Failures	Detail Family	Failure Mode	Failure Cause	
		Sound	Details	Details		Number			
SHIP TYPE		Details				-	. <u></u>		
		Observed	Observed	ODSELVEG	· · · · · · · · · · · · · · · · · · ·				
Bulk	Fwd		ļ		ļ	5-A-12		1	-∯
Carrier	Ø	2	ļ	2	ļ	J		1	
	Aft			ļ		<u> </u>			1 🛉
	Fwd				ļ	5-A-12		1	┝╾┛
Naval	QQ	2	}	2	ł	1	1	1	
	Aft		<u> </u>	<u></u>		+	<u> </u>		<b>∃</b> ⊪≂
Bulk	Fwd	1				5-A-13	l	1.	
Carrier	Ø	2		2		J-H-T2	Į	3	
	Aft	And the second se	<u> </u>		<u>+</u> -		+		1 _
Bulk	Fwd	ļ			1	5-B-1			
Carrier	D	10		10	ł	10-0-1	ł	Į	
	Aft		<u> </u>		_ <b>_</b>				1 4
Combination	Fwd			1	1		1		
Carrier	DO	4	Į	4	ł	5-B-1	ł	Į	1
CULLICI	Aft	· · · · · · · · · · · · · · · · · · ·				_ <del></del>	+		-1
	Fwd							Į	<u> </u>
Tanker	300		Į	4		5-B-1			
Tauver	Aft	=	ļ						
	Fwo	and the second se			1			1	
Norro I	30			4	1	5-B-2		1	
Naval	Af	E	- {	1					[
General	Fw	and the second s			ļ				
	Ø	1		2	l	5-B-3		ł	
Cargo	Af		4	ļ					<b>_</b>
ateiner	Fw	the second second second second second second second second second second second second second second second se							- IF
Container-	00			4	l	5-B-4		. 1	
ship	Af								
	Fw	and the second se					1	1	1
	<b>X</b>		ļ	2		5-B-4		[* <sup>**</sup>	
Naval	Af	4	1	1	1				
		the second second second second second second second second second second second second second second second se							
Container-	10			10	1	5-B-	5		
ship	Af	<b>K</b> 1 10			l				lu
ļ					-1				们
Container-	Fv			2		5-B-	6		
ship	2	2	Ļ		1				U
		Et			<del>-</del>				
		d b	ł			5-B-	6	ļ	$\vdash$
Naval	2	2 2 Et	1	'					

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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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(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

- 11. Neglect
- 12. Misuse/Abuse 13. Questionable

7. Combined Tension & Shear

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

TABLE A-5	DETAIL	FAMILY:	GUNWALE	CONNECTIONS
the second distance of the second distance of the second distance of the second distance of the second distance				

LOCATION ON	SHIP		No. of	Total	Percent			Failure
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause
Container- ship	Fwd 20 Aft	2		2		5-B-7		
Bulk Carrier	Fwd 30 Aft	4		4		5-B-8		
Container- ship	Fwd 30 Aft	16		16		5-B-8		
Miscella- neous	Fwd 00 Aft	0	2	2	100.0	5-B-8	2	12,15
Tanker	Fwd QQ Aft	• 2		2		5-B-8		

## TABLE A-6 DETAIL FAMILY: KNIFE EDGES

LOCATION ON SHIP TYPE	SHI	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Mode	Failure Cause
Bulk Carrier	Fwc 20 Aft	1					
Combination Carrier	Fwc D Aft						
Container- ship	Fwc 30 Aft			IFE EDGE ( VED IN THI	ROSSINGS SURVEY		
General Cargo	Fwc XX Aft						
Miscella- neous	Fwc Ø Aft						
Naval	Fwd Ø Aft						
Tanker	Fwo Ø Aft						

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INDER W-1 DRIVIN INVERSE MISCEPENNEOOS COLOGI	TABLE A-7	DETAIL	FAMILY:	MISCELLANEOUS	CUTOUTS
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OCATION ON	SHIP		No. of	Total	Percent		Failure	
		Sound	Failed	Number	Failures	-	Mode	Cause
HIP TYPE		Details	Details	Details		Number		
	1	Observed	Observed	Observed				
Bulk	Fwd	10		10	[ ]		[	
Carrier	X	95		95	1	7-A-1		
	Aft	10		10				
Container-	Fwd	50		50		ļ		
hip	Ø	60	ļ	60	ļ	7-A-1	)	ļ
	Aft	20		20	ļ	<b> </b>	ļ	
	Fwd	10	ļ	10				
anker	DQ	40	[	40	(	7-A-1		1
	Aft	10	<b> </b>	10	Ļ		<u> </u>	
ulk	Fwd	}		} .	1	Į	1	}
Carrier	00 Aft	18		18		7-A-2	<u></u>	
	Fwd	30	[	30				1
Naval	00	90	ł	90		7-A-2		
	Aft	60	}	60	<u> </u>		<u> </u>	
Bulk	Fwd	20		20			1	l
Carrier	00	143	ļ	143	4	7-A-3		
	Aft	30	1	30	<u> </u>	<b></b>		<u>                                      </u>
Container-	Fwd	90	1	90				
ship	1XX	933	1	933	l	7-A-3	1	1
	Aft		ļ	90	<u> </u>			<u> </u>
leneral	Fwd	i	]	1	1			
Cargo	QQ	45	1	45		7-A-3		Į
	Aft		<u> </u>	<u> </u>	ļ	<u>  </u>		
	Fwd		1	60	1	1	1	1
Naval	X	450		450	1	7-A-3		1
	Aft			100		┦────		<u> </u>
	Fwd		1	10			ļ	
Tanker	<b>X</b>	120		120	}	7-A-3	1	1
	Aft		<u> </u>	20	-↓	+	+	<del> </del>
Combination	Fwd			20				ĺ
Carrier	200		ł	70	ł	7-A-4		1
	Aft		<u> </u>	30		- <u> </u>	+	
Container-	Fwd		}	10	<b>j</b>			ļ
ship	00			65	1	[7-A-4		1
	Aft			10	_ <b>_</b>		<u> </u>	
Bulk	Fwd		1	10				
Carrier	X		1			7-A-5		1
NOTE	Aft	10	<u> </u>	10				

- (A) The above continued table gives information related to individual detail designs in the 86 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

8. Design

- 11. Neglect 12. Misuse/Abuse
- 7. Combined Tension & Shear
- 14. Heavy Seas 15. Collision

13. Questionable

- 9. Fabrication/Workmanship 10. Welding
- 16. Other See Discussion

TABLE A-7 DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON SHIP TYPE		Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number	Failure Mode	Failure Cause
Container-	Fwd			10				
ship	30	197		197		7-A-5		:
	Aft		·	10				
N7 1	Fwd			10				
Naval	D Aft	10		10		7 <b>-</b> A-5		
Bulk	Fwd	10		10				·····
Carrier	300	10		10				
	Aft	34 10		34	· ·	7-A-6		
Container-	Fwd	40		10				
ship	00	97	2	40	2.0			
-	Aft	40	4	99 40	2.0	7-A-6	1	7,14
General	Fwd			40				
Cargo	00 Aft	3		3		7 <b>-</b> A-6		
	Fwd	10		10				
lanker	00 Aft	20		20		7- <b>A-</b> 6		
Bulk	Fwd	10		10				
arrier	Q		ĺ			7-A-7		
	Aft	10		10		•		
ontainer-	Fwd	20		20			· · · ·	
hip	QQ					7-A-7		
	Aft	30		30				
ulk	Fwd	30		30				
arrier	00 Aft	10		10		7-A-8		
ombination	Fwd	30		30				
arrier	Т. Ф	20 20		20				
arrier	Aft	30		20		7-A-8		
ontainer-	Fwd	20		30				
ship	<u>70</u>	64	6	20 70	0.6		_	
-	Aft	40		40	8.6	7 <del>-</del> A-8	1	7,14
General	Fwd	10		10				
Cargo	ØQ.	17		17		7-A-8		
	Aft	20		20				
liscella-	Fwd	10		10			ł	
eous	00	10		10	ŀ	7-A-8		
·	Aft	20		20		-		
	Fwd	30		30				
aval	<b>X</b>	175	5	180	2.8	7-A-8	4	14,16
	Aft	40		40				
	Fwd	30		30				
anker	<u> </u>	150	1	150	ŀ	7-A-8		
	Aft	60		60				<u></u>
eneral argo	Fwd							
ar,yu	00 Aft	32	8	40	20.0	7-A-9	1	7,8,14
	ALC .	10		10				

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t to a set the

LOCATION ON	SHIP		No. of Failed	Total Number	Percent Failures	1	Failure Mode	Failure Cause	
		Sound			LUTICS	Number			
SHIP TYPE		Details	Details	Details		NULLET			
			Observed		······································		<u></u>	·	_
Container-	Fwd	10	ļ	10					
ship	202		Į –		1	7-A-10		1	
	Aft	10		10	<b> </b>				
General	Fwd		1				-	5,11	
Cargo	00	23	1	24	4.2	7-A-10	1	2,11	1
	Aft		<b></b>		<b></b>	<u> </u>		┟┅╍╌╍╍╌╸┥	l
	Fwd	20	{	20	ł			)	
Tanker	<b>X</b>		ļ			7-A-10	1		
	Aft	20	<u> </u>	20	<u> </u>	┥		<u> </u>	
Combination	Fwd	3	}		1		1		IT
Carrier	00	30	ļ	30	1	7-A-11	1	1	Ł
	Aft		<u> </u>	<u> </u>	L	<u> </u>	<u> </u>	<b>↓</b>	ł
	Fwd			ļ					
Naval	DO I	6	4	10	40.0	7-A-11	1	7,8	
	Aft	l			<u></u>		<b></b>	<u></u>	Į
	Fwd	17	3	20	15.0	7-A-11	1	7,8,9	!
Tanker	<u>م</u>			1	1	4			
1411102	Aft	.[	(	1		<u>  </u>	<u> </u>	<u> </u>	
Bulk	Fwd				T	ſ	1		1 (
Carrier	X	4		4		[7-A-12	[	1	11
	Aft	: }		<u> </u>		<u> </u>			1
Combination	Fwd	10		10					
Carŕier	Q	60	4	60	1	7-A-12		1	
	Aft	30		30					
Container-	Fwd	30	1	30				1	1
ship	DO	70	)	70	1	7-A-12	÷.		
· · · · · · · · · ·	Aft			50			<u> </u>		
General	Fwd	the second second second second second second second second second second second second second second second s		1	7				
Cargo	Ø	4	ļ	38		7-A-12	2		
	Aft	:1		1	1				1
	Fwd		+						1
Naval	00	ſ	l l	10	1	7-A-12	2	1	
	Aft	10		10			1		
<u> </u>	Fwo		+	10	-1	1			7
monkor	Ø	1	ł		ļ.	7-A-12	2	1	
Tanker	AE	10	ļ	10			1	{	ĺ
Container	Fwo			-+			1		1
Container-	50		1	14	1	7-A-1	3		H
ship	Af	1 14	1					1	

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
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(C) The numbers 1, 2, 3 & 4 in the column for failure mode refer to cracks, buckles, cracks and buckles, and twisted/distorted, respectively.

No. 1 material 4

- (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 & Shear 8. Design
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

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

TABLE A-7	DETAIL	FAMILY:	MISCELLANEOUS	CUTCUTC
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LOCATION O		Sound Details Observed	No. of Failed Details Observed	Total Number, Details Observed		Detail S Family Number	Failure Mode	Failure Cause
Container-	Fwd	50	1	50	<u> </u>			
ship	20	92	8	100				1
	Aft	100		100	8.0	7-B-1	1	9,14
General	Fwd	40	[					
Cargo	100	100		40				
	Aft			100		7-B-1		
	Fwd			90				
Tanker	302	1 30		30				
	Aft	600		600		7-B-1	-	
Bulk	Fwd		·	120				
Carrier	XX	1 10 1		70				
	Aft	1170		1170		7-B-2		
Combination				200				
Carrier		100 900		100				
	Aft			900		7-B-2		
Container-	Fwd	200		200				
ship		150		150				
~···•F	00	1000		1000		7-B-2		
Cono	Aft	300		300		' <sup>11-2</sup>		
General	Fwd	60		60		1		
Cargo	Ø	920	ĺ	920			Í	
	Aft	100	<u>.</u>	_100		7-B-2	1	
	Fwd	70		70		<u>† −−− </u> +		
Naval	Ø	1200	20	1220	1.6	7-B-2		
	Aft	80		80	4.0	1/-B-2	1,2	11,16
<b>-</b> • •	Fwd	70		70		<u>┼┈───</u> ┼-		
Fanker	00	500		500		7-B-2		
	Aft	50		50		/- <u>B</u> =2		l l
Bulk	Fwd	30		30		╞────╌├─	<u>~</u>	
Carrier	D D	1000		1000		7-B-3		
	Aft	150	Ì	150		/-B-3		1
Container-	Fwd	40		40		┝╼┈╼═──╌┥╌╸	<u> </u>	
hip	<u> </u>	340		340		7		
	Aft	70		70		7-в-з		Ļ
liscella-	Fwd	120		120				
eous	30.	1300	[	1300				
· ·	Aft	300	Í	300		7-в-з		-
Ţ	Fwd	120		120	———{			
aval	<u>70</u>	600		600	1			
'	Aft	220		220		7-в-з		
	Fwd	80						
anker		5400		80				
,	Aft	400		5400	1.	7-в-з	Í	-
ontainer-	Fwd		╺╼─────────────────────────────────────	400				
nip	DE	300	1	200				
- 1	Aft			300	7	7-в-4		-
	Fwd							
irgo	Ø Aft	80		80	7	-в-5		

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TABLE	A-7	DETAIL	FAMILY:	MISCELLANEOUS	CUTOUTS

LOCATION ON S	SHIP		No. of	Total	Percent		Failure		
		Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Observed	Observed	Observed					
Bulk	Fwd	40		40		)	}		.,
Carrier	X	572	ļ	572		7-C-1			
	Aft	70		70		<u> </u>			
Combination	Fwd	80		80			}		1
Carrier	Ø	60	<b>b</b>	60	ļ	7-C-1	1	]	
	Aft	90		0	L		L	l	
Container-	Fwd	90	}	90	}	}	ļ	ļ	
ship	<u>00</u>	781	31	812	3.8	7-C-1	1	(7,9	
	Aft	110	ļ	110	<b></b>	<u> </u>	<b></b>	14,15)	1
General	Fwd	70	}	70	ļ		}	}	
Cargo	M	980	1	980	ļ	7-C-1			
	Aft		16	90	17.8	<u> </u>	1	9	
Miscella-	Fwd	60	}	60	ļ	}	ļ	ļ	1
neous	00	80	1	80	ļ	7-C-1	ł	[	
	Aft	60	·	60	<b></b>	<u> </u>	<u></u>	<b> </b>	1
· · · · · · · · · ·	Fwd		}	80	ļ	ļ			1
Naval	00	200	1	200		7-C-1		ſ	
	Aft	60		60		<u>}</u>		<u> </u>	]
	Fwd	90		<u>∫</u> 90	ļ			}	1
Tanker	00	2586	14	2600	.5	7-C-1	[ 1	8	
	Aft	200	<u>i</u>	200	l	<u> </u>		ļ	1
Container-	Fwd	20	ſ	20	<b>k</b>				1
ship	QQ	100	1	100	{	7-C-2	Ì	l	
	Aft		<u>}</u>	20		1			]
Miscella-	Fwd	20	]	20	1				1 '
neous	Q		1	ł	{	7-C-2	Ì	{	<u> </u>
	Aft			20		1	<u></u>	<u> </u>	1
Bulk	Fwd	1	}	1					.
Carrier	D D	36		36	1	7-C-3		{	
	Aft			<u> </u>		<u> </u>		ļ	1
Combination	Fwd			210					1 1
Carrier	200	900	1	900	1	7-0-3	1	{	
· · · · · · · · · · · · · · · · · · ·	Aft			180	<u> </u>			<u> </u>	1
Container-	Fwd		1	70					[
ship	DQ	502	10	512	2.0	7-C-3	1	11	
	Aft	68	2	70	2.9		1	11	
General	Fwd								1
Cargo	<u>ع</u>	38	1	38	1	7-C-3			
L	Aft	80		80					1

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
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- (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

12. Misuse/Abuse

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

9. Fabrication/Workmanship

15. Collision 16. Other - See Discussion

10. Welding

TABLE A-/	DETAIL	FAMILY:	MISCELLANEOUS	CUTOUTS
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i         Observed         Observed         Observed         Name           Tanker $Md$ 90         90         1600         7-C-3         1600           Bulk         Fwd         90         90         90         7-C-3         111,14           Carrier         Aft         90         1200         .5         7-C-4         1         11,14           Container-         Fwd         200         200         200         7-C-4         1         11,14           Maxal $Mft$ 400         400         7-C-4         1         11,14           Container-         Fwd         200         2000         2000         7-C-4         1         11,14           Cargo $Mft$ 400         400         7-C-6         1         11,14           Cargo $Mft$ 400         400         7-C-7         1         1           General         Fwd         20         20         7-C-7         1         1           Cargo $Mft$ 70         70         7-C-7         1         1         1           Carrier $Mft$ 10         110         110 </th <th>LOCATION ON</th> <th>SHIP</th> <th>Sound</th> <th>No. of Failed</th> <th>Total Number</th> <th>Percent Failures</th> <th>Family</th> <th>Failure Mode</th> <th>Failure Cause</th> <th></th>	LOCATION ON	SHIP	Sound	No. of Failed	Total Number	Percent Failures	Family	Failure Mode	Failure Cause	
Find         90 hft         90 90 90         90 1600 90         7-C-3         1           Bulk Carrier         Fwd Aft         4         4         7-C-4         1         11,14           Container- ship         Fwd Aft         199         1         200         .5         7-C-4         1         11,14           Naval $\overline{30}$ 200         200         7-C-4         1         11,14           Naval $\overline{30}$ 200         2000         7-C-4         1         11,14           Naval $\overline{30}$ 2000         2000         7-C-4         1         11,14           Naval $\overline{30}$ 2000         2000         7-C-4         1         11,14           Naval $\overline{30}$ 150         7-C-5         1         11,04           Ship $\overline{30}$ 150         7-C-6         1         11,04           Cargo $\overline{30}$ 1228         1228         7-C-7         1           Carrier $\overline{30}$ 30         30         7-C-7         1           General         Fwd         20         20         20         7-C-7         1      <	SHIP TYPE		Details Observed	Details Observed	Details Observed		Number			
Aft         90         90         90         700         700           Bulk Carrier $M_{L}$ 4         4         7-C-4         1           Container- ship $M_{L}$ 199         1         200         .5         7-C-4         1         11,14           Naval $M_{L}$ 200         2000         7-C-4         1         11,14           Naval $M_{L}$ 200         2000         7-C-4         1         11,14           Naval $M_{L}$ 400         400         7-C-4         1         11,14           Naval $M_{L}$ 400         400         7-C-5             General         Fwd         20         20         7-C-6             Bulk         Fwd         1228         1228         7-C-7             Combination         Fwd         70         70              General         Fwd         30         30         7-C-7             Gargo $M_{L}$ 30         30         7-C-7							}	·····	<u> </u>	
Bulk Carrier         Fwd Aft         4         4         4         7-C-4           Container- ship         Fwd M         199         1         200         .5         7-C-4         1         11,14           Naval $\overline{M}$ 200         200         200         7-C-4         1         11,14           Naval $\overline{M}$ 200         200         200         7-C-4         1         11,14           Naval $\overline{M}$ 400         400         7-C-4         1         11,14           Naval $\overline{M}$ 400         400         7-C-5         1         11,14           General         Fwd         20         20         7-C-5         1         11,14           General         Fwd         20         20         7-C-6         1         11,14           Bulk         Fwd         20         20         7-C-7         1         1         1           Carrier $\overline{M}$ 70         70         7         1         1           General         Fwd         20         20         7-C-7         1         1           General         Fwd         20	Tanker		1	}	1600	· · ·	7-C-3			
Carrier $\overline{\Omega}$ 4         4         7-C-4         4           Container- ship $\overline{\Omega}$ 199         1         200         .5         7-C-4         1         11,14           Naval $\overline{\Omega}$ 200         200         200         7-C-4         1         11,14           Naval $\overline{\Omega}$ 200         200         200         7-C-4         1         11,14           Naval $\overline{\Omega}$ 200         200         7-C-4         1         11,14           Naval $\overline{\Omega}$ 200         200         7-C-5         1         11,14           Container- ship $\overline{\Omega}$ 150         150         7-C-5         1         1           General         Fwd         20         20         20         1         1         1         1         1           Combination         Fwd         70         70         7-C-7         1			90		90	ļ	<b></b>			
Aft         Image: container ship         Fwd         Image: container ship         Fwd         Image: container ship         Image: container ship <thimage: container="" ship<="" th="">         Image: con</thimage:>							ļ			{
Container- ship         Fwd Aft         199         1         200         .5 $7-C-4$ 1         11,14           Naval $\overline{00}$ 200         200         2000         7-C-4         1         11,14           Naval $\overline{00}$ 2000         2000         7-C-4         1         11,14           Naval $\overline{00}$ 200         2000         7-C-4         1         11,14           Container- ship         Fwd Aft         400         400         7-C-5         1         1         11,14           Container- ship         Fwd Aft         20         200         7-C-5         1         1         1         1,14           Container- song $\overline{00}$ 40         400         7-C-6         1<	Carrier		4		4		7-C-4			[
Aft         Constrained         Fund         200         <	Container-		† <b></b> -				<u> </u>			ł
Aft         0         1         1         1           Naval $\widetilde{M}$ 200         2000         2000         7-C-4         1         11/14           Naval $\widetilde{M}$ 2000         2000         2000         7-C-4         1         11/14           Ship $\widetilde{M}$ 400         400         7-C-5         1	ship		199	1	200	-5	7-6-4	7	17 14	┝
Naval $\overline{\mathfrak{Q}}$ 2000         2000         7-C-4           Container- ship $\overline{\mathfrak{Pwd}}$ 150         7-C-5         7-C-6           General $\overline{\mathfrak{Fwd}}$ 150         7-C-6         7-C-6           General $\overline{\mathfrak{Fwd}}$ 20         20         7-C-7           Sulk $\overline{\mathfrak{Fwd}}$ 20         20         7-C-7           Sulk $\overline{\mathfrak{Fwd}}$ 1228         1228         7-C-7           Combination $\overline{\mathfrak{Fwd}}$ 70         70         7-C-7           Combination $\overline{\mathfrak{Fwd}}$ 70         70         7-C-7           Combination $\overline{\mathfrak{Fwd}}$ 30         30         7-C-7           Combination $\overline{\mathfrak{Fwd}}$ 20         20         7-C-7           Cargo $\overline{\mathfrak{M}t}$ 60         60         7-C-7           Container- $\overline{\mathfrak{M}t}$ 20         20         7-C-7           Container- $\overline{\mathfrak{M}t}$ 150         150         7-C-8           Sargo $\overline{\mathfrak{M}t}$ 120         20         20         7-C-8           Sarger $\overline{\mathfrak{M}t}$ 20									17978	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	_	!			200					ĺ
Container- ship         Fwd Aft         150         100         7-C-5           General Cargo         Fwd Aft         150         150         7-C-5           General Cargo         Fwd Aft         20         7-C-6         100           Bulk Carrier         Fwd Aft         1228         7-C-7         100           Combination Carrier         Fwd Aft         1228         7-C-7         100           Combination Carrier         Fwd 010         110         70         70         7-C-7           Combination Carrier         Fwd 010         30         30         7-C-7         100           General Cargo         Fwd 00         30         30         7-C-7         100           General Cargo         Fwd 00         30         30         7-C-7         100           Miscella- neous         Fwd 20         20         7-C-7         100         100           Stip         Aft         150         150         7-C-7         100         100           Stip         Aft         120         120         7-C-8         100         100           General         Fwd         20         20         7-C-8         100         100         100         <	Naval		1 1				7-C-4			
ship $\widetilde{M}$ 150         150         7-C-5           General         Fwd         20         7-C-6         7-C-6           Bulk         Fwd         20         20         7-C-7           Bulk         Fwd         1228         1228         7-C-7           Carrier $\widetilde{M}$ 100         110         7-C-7           Combination         Fwd         70         70         7-C-7           Carrier $\widetilde{M}$ 110         110         7-C-7           General         Fwd         70         70         7-C-7           General         Fwd         30         30         7-C-7           General         Fwd         20         20         7-C-7           Miscella-         Fwd         20         20         7-C-7           Miscella-         Fwd         20         20         7-C-7           Seneral         Fwd         30         30         30         7-C-7           Seneral         Fwd         20         20         7-C-8         7-C-8           General         Fwd         20         20         7-C-8         7-C-9           Salk	an hai	_	400		400	·				
Aft         Image: constraint of the second se		5	150							
General Cargo         Fwd Aft         40 20         7-C-6           Bulk Carrier         Fwd QU Aft         1228         1228         7-C-7           Combination Carrier         Fwd QU Aft         1228         1228         7-C-7           Combination Carrier         Fwd QU Aft         70         70         70           Carrier         QU Aft         110         110         7-C-7           General Cargo         Fwd QU Aft         30         30         7-C-7           General Cargo         Fwd QU Aft         20         20         7-C-7           Miscella- neous         Fwd QU Aft         30         30         7-C-7           Container- ship         Fwd QU Aft         20         20         7-C-8           Cargo         QU Aft         20         20         7-C-8           General Salk         Fwd 70         70         7-C-8         7-C-9           Sulk         Fwd 20         20         7-C-9         1         11           Cargo         Mit         120         120         7-C-9         1         11           Sulk         Fwd 3526         3526         7-C-9         1         11         11           Sulk <td>2.11-F</td> <td></td> <td>120</td> <td></td> <td>150</td> <td></td> <td>7-C-5</td> <td></td> <td></td> <td> </td>	2.11-F		120		150		7-C-5			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	General									ł
Aft         20         20 $7-C-6$ Bulk         Fwd         1228 $7-C-7$ Bulk $\overline{M}$ $\overline{M}$ 1228 $7-C-7$ Combination         Fwd $70$ $70$ $7-C-7$ Combination         Fwd $70$ $110$ $110$ $110$ Carrier $\overline{M}$ $60$ $60$ $7-C-7$ $7-C-7$ General         Fwd $20$ $20$ $7-C-7$ $7-C-7$ Miscella-         Fwd $20$ $20$ $7-C-7$ $7-C-7$ Container-         Fwd $30$ $30$ $7-C-7$ $7-C-8$ General $\overline{D}$ $50$ $50$ $7-C-8$ $7-C-8$ Container-         Fwd $20$ $20$ $7-C-8$ $7-C-8$ General $\overline{D}$ $526$ $3526$ $7-C-9$ $7-C-8$ Gargo $\overline{D}$ $\overline{D}$ $\overline{D}$ $\overline{D}$ $\overline{D}$ Cargo $\overline{D}$ $\overline{D}$ $\overline{D}$ </td <td></td> <td></td> <td>40</td> <td></td> <td>40</td> <td></td> <td>7.0.6</td> <td></td> <td></td> <td>1</td>			40		40		7.0.6			1
Bulk Carrier       Fwd Aft       1228       1228       7-C-7         Combination Carrier       Fwd Mit       70       70       70       70         Carrier       MI       110       110       7-C-7       70         Carrier       MI       10       7-C-7       70       70         General       Fwd       30       30       7-C-7       70         General       Fwd       20       20       7-C-7       70         Miscella-       Fwd       20       20       7-C-7       70         Miscella-       Fwd       30       30       7-C-7       70         Container-       Fwd       30       30       7-C-7       70         Seneral       Fwd       20       20       7-C-8       70         General       Fwd       20       20       7-C-8       70         General       Fwd       20       20       7-C-8       7-C-8         General       Fwd       80       80       7-C-9       7-C-9         General       Fwd       96       4       100       4.0       11         Cargo       Mit       120       120	-	Aft	1				/-0-6			
Aft         70         70           Combination         Fwd         70         70           General         Fwd         60         60         7-C-7           General         Fwd         70         30         30         7-C-7           General         Fwd         70         110         7-C-7         7           General         Fwd         70         30         30         7-C-7           Miscella-         Fwd         20         20         7-C-7           meous $\overline{00}$ 50         50         7-C-7           Ship $\overline{00}$ 30         30         7-C-8           Container-         Fwd         20         20         7-C-8           General         Fwd         80         7-C-9         1           General         Fwd         80         7-C-9         1           General         Fwd         80         7-C-9         1 <td>Bulk</td> <td></td> <td></td> <td></td> <td>** ¥</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Bulk				** ¥					
Aft         70         7	Carrier	Ø	1228		1228		7-C-7	Ì		
Carrier $\overline{\mathbf{X}}$ 110 $\mathbf{Aft}$ 100 <b>60</b> 100 <b>60</b> 7-C-7           General Cargo         Fwd $\overline{\mathbf{X}}$ 30         30         7-C-7           Miscella- neous         Fwd $\overline{\mathbf{X}}$ 20         20         7-C-7           Miscella- neous         Fwd $\overline{\mathbf{X}}$ 30         30         7-C-7           Container- ship         Fwd $\overline{\mathbf{X}}$ 30         30         7-C-7           Container- ship         Fwd $\overline{\mathbf{X}}$ 20         20         7-C-8           General         Fwd 20         20         20         7-C-8           Gargo $\overline{\mathbf{X}}$ 30         30         7-C-9           Sulk         Fwd 70         70         7-C-9         7-C-9           Sulk         Fwd 70         70         7-C-9         1         11           Carrier $\overline{\mathbf{M}}$ 80         80         7-C-9         1         11           Ship $\overline{\mathbf{M}}$ 80 $\overline{\mathbf{M}}$ 100         4.0         7-C-9         1         11           Gargo $\overline{\mathbf{M}}$ 80 $\overline{\mathbf{M}}$ $\overline{\mathbf{M}}$ $\overline{\mathbf{M}}$ $\overline{\mathbf{M}}$										
Aft         60         60         7-C-7           General Cargo $\overline{MC}$ 30         30         7-C-7           Miscella- meous $\overline{MC}$ 20         20         7-C-7           Miscella- meous $\overline{MC}$ 50         20         7-C-7           Ship $\overline{MC}$ 30         30         7-C-7           Ship $\overline{MC}$ 30         30         7-C-7           Ship $\overline{MC}$ 30         30         7-C-8           General         Fwd         20         20         7-C-8           General         Fwd         20         20         7-C-8           General         Fwd         20         20         7-C-8           General         Fwd         70         70         7-C-8           Sulk         Fwd         70         70         7-C-9           Carrier $\overline{MS}$ 80         80         7-C-9           Container- ship $\overline{MC}$ 80         80         7-C-9           Aft         120         120         11         11           Aft         96         4         100         4.					70					
General Cargo       Fwd Miscella- neous       Fwd Aft       30       30       7-C-7         Miscella- neous       Fwd QZ       20       20       7-C-7       1         Miscella- neous       Fwd QZ       30       30       7-C-7       1         Container- ship       Fwd Aft       30       30       7-C-8       1         Container- ship       Fwd Aft       20       20       7-C-8       1         General Cargo       Fwd QZ       20       20       7-C-8       1         General Cargo       Fwd QZ       70       70       7-C-8       1         Bulk       Fwd 70       70       70       7-C-9       1       1         Carrier       M       3526       3526       7-C-9       1       1         Solutainer- ship       Fwd Aft       80       80       7-C-9       1       11         Aft       120       120       1       1       1       1       1       1         Container- ship       Fwd Aft       96       4       100       4.0       1       1       1       1         Aft       196       4       200       2.0       1       1 </td <td>Carrier</td> <td></td> <td></td> <td>[</td> <td></td> <td></td> <td>7-C-7</td> <td></td> <td>i</td> <td></td>	Carrier			[			7-C-7		i	
Cargo $\overline{00}$ $30$ $30$ $7-C-7$ Miscella- meous       Fwd $20$ $20$ $7-C-7$ Miscella- meous       Fwd $20$ $20$ $7-C-7$ Miscella- meous       Fwd $30$ $30$ $7-C-7$ Container- ship       Fwd $30$ $30$ $7-C-7$ General       Fwd $20$ $20$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ Gargo $\overline{00}$ $Aft$ $20$ $20$ $7-C-8$ Bulk       Fwd $70$ $70$ $7-C-8$ $7-C-9$ Bulk       Fwd $70$ $70$ $7-C-9$ $7-C-9$ Container- ship $\overline{00}$ $80$ $80$ $7-C-9$ $1$ $11$ Raval $\overline{00}$ $80$ $80$ $7-C-9$ $1$ $11$ Raval $\overline{00}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Raval $\overline{00}$ $1491$ $9$ $1500$ $.7$ $7$	General		60		60					
Aft $000$ $1000$ $1000$ $1000$ Miscella- neous         Fwd         20         20 $7-C-7$ $7-C-7$ Container- ship         Fwd         30         30 $7-C-7$ $7-C-7$ Container- ship         Fwd         30         30 $7-C-7$ $7-C-7$ General         Fwd         20         20 $7-C-8$ $7-C-8$ General         Fwd         20         20 $7-C-8$ $7-C-8$ Bulk         Fwd         70         70 $7-C-9$ $7-C-9$ Bulk         Fwd         70         70 $7-C-9$ $7-C-9$ Container- ship         SS         80         80 $7-C-9$ $1$ Aft         120         120 $100$ $100$ $111$ Aft         120 $100$ $4.0$ $7-C-9$ $1$ $11$ Maval $\overline{SS}$ 80 $7-C-9$ $1$ $11$ Aft         196         4         100 $4.0$ $10$ $11$ <td></td> <td></td> <td>30</td> <td></td> <td>20</td> <td></td> <td></td> <td></td> <td></td> <td></td>			30		20					
neous $\overline{00}$ $50$ $20$ $7-C-7$ Aft $30$ $30$ $7-C-7$ Container- ship       Fwd $30$ $30$ $7-C-8$ Seneral       Fwd $20$ $20$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ Sulk       Fwd $70$ $7-C-8$ $7-C-8$ Bulk       Fwd $70$ $7-C-8$ $7-C-9$ Bulk       Fwd $70$ $7-C-9$ $7-C-9$ Container- ship $\overline{00}$ $80$ $80$ $7-C-9$ Aft $120$ $120$ $7-C-9$ $1$ $11$ Aart $\overline{00}$ $80$ $80$ $7-C-9$ $1$ $11$ Aart $196$ $4$ $100$ $4.0$ $1$ $11$ $11$ Maval $\overline{00}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Haval $\overline{00}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$	5-				30		7-C-7		1	
neous $\widetilde{00}$ $50$ $50$ $7-C-7$ Aft $30$ $30$ $7-C-7$ Container- ship $\widetilde{00}$ $Aft$ $150$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ Gargo $\widetilde{00}$ $3526$ $20$ $7-C-8$ Bulk       Fwd $70$ $7-C-8$ $7-C-8$ Carrier $\widetilde{00}$ $3526$ $3526$ $7-C-9$ Aft $120$ $120$ $7-C-9$ $1$ Container- ship $\widetilde{00}$ $80$ $80$ $7-C-9$ $1$ $11$ Wava1 $\widetilde{00}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Wava1 $\widetilde{00}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Fwd $400$ $400$ $400$ $200$ $2.0$ $1$ $11$	4iscella-	Fwd	20		20			<u> </u>		
Aft $100$ $7 \cdot C - 9$ Container- ship       Fwd $30$ $30$ $7 \cdot C - 8$ General       Fwd $20$ $20$ $7 \cdot C - 8$ General       Fwd $20$ $20$ $7 \cdot C - 8$ General       Fwd $20$ $20$ $7 \cdot C - 8$ General       Fwd $20$ $20$ $7 \cdot C - 8$ Bulk       Fwd $70$ $7 \cdot C - 8$ $7 \cdot C - 8$ Bulk       Fwd $70$ $7 \cdot C - 9$ $7 \cdot C - 9$ Container- ship       Fwd $80$ $80$ $7 - C - 9$ Naval       Fwd $96$ $4$ $100$ $4 \cdot 0$ $1$ $11$ Naval       Fwd $96$ $4$ $100$ $4 \cdot 0$ $1$ $11$ Aft $196$ $4$ $200$ $2 \cdot 0$ $1$ $11$ Naval $M$ $400$ $400$ $400$ $100$ $1$ $11$	ieous	Ø I					7-0-7	[		
ship $\overline{00}$ $30$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ General       Fwd $20$ $20$ $7-C-8$ Cargo $\overline{00}$ $\overline{3526}$ $20$ $7-C-8$ Bulk       Fwd $70$ $7-C-8$ $7-C-8$ Bulk       Fwd $70$ $7-C-9$ $7-C-9$ Container-       Fwd $80$ $7-C-9$ $7-C-9$ Container-       Fwd $80$ $80$ $7-C-9$ $1$ $11$ Vaval $\overline{96}$ $4$ $100$ $4.0$ $7-C-9$ $1$ $11$ Aft $196$ $4$ $200$ $2.0$ $1$ $11$ Aft $196$ $4$ $200$ $2.0$ $1$ $11$ $11$ Fwd $400$ $400$ $400$ $400$ $100$ $1$ $11$		Aft			55		,-U-,			
Aft       150       150         General       Fwd       20       20       7-C-8         Cargo $\overline{\mathbf{M}}$ 20       20       7-C-8         Bulk       Fwd       70       70       7-C-9         Bulk       Fwd       70       70       7-C-9         Carrier $\overline{\mathbf{M}}$ 3526       3526       7-C-9         Aft       120       120       7-C-9       1         Container-       Fwd       80       7-C-9       1       11         Naval $\overline{\mathbf{M}}$ 96       4       100       4.0       1       11         Naval $\overline{\mathbf{M}}$ 196       4       200       2.0       1       11         Fwd       400       400       400       400       100       100       100	1	1	30		30					
General Cargo       Fwd       20       20       20       7-C-8         Bulk       Fwd       70       70       70       7-C-9         Bulk       Fwd       70       70       7-C-9       7-C-9         Carrier       M       70       7-C-9       7-C-9       11         Container-       Fwd       80       80       7-C-9       11       11         Container-       Fwd       80       7-C-9       1       11         Naval       M       96       4       100       4.0       1       11         Naval       M       96       4       100       4.0       1       11         Naval       M       96       4       200       2.0       1       11         Naval       M       96       4       100       4.0       1       11         Naval       M       96       4       200       2.0       1       11         Naval       M       96       4       200       2.0       1       15         Naval       M       96       4       200       2.0       1       15	ship						7-C-8			_
Cargo $\overline{\mathbf{XC}}$ $10^{\circ}$ $20^{\circ}$ $7-C-8$ Bulk       Fwd $70$ $70$ $7-C-9$ Bulk       Fwd $70$ $70$ $7-C-9$ Carrier $\overline{\mathbf{MC}}$ $3526$ $3526$ $7-C-9$ Aft $120$ $120$ $7-C-9$ $7-C-9$ Container-       Fwd $80$ $80$ $7-C-9$ Ship $\overline{\mathbf{MC}}$ $80$ $80$ $7-C-9$ Naval $\overline{\mathbf{MC}}$ $100$ $4.0$ $11$ $11$ Naval $\overline{\mathbf{MC}}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Haval $\overline{\mathbf{MC}}$ $1491$ $9$ $1500$ $.7$ $7-C-9$ $1$ $11$ Haval $\overline{\mathbf{MC}}$ $400$ $400$ $200$ $2.0$ $1$ $11$	'enoral									
Aft         20         20         7 C - 0           Bulk         Fwd         70         70         70           Carrier $\overline{M}$ 3526         3526         7 - C - 9           Aft         120         120         7 - C - 9         1           Container- ship         Fwd Aft         80         7 - C - 9         1         11           Maval         Fwd 96         4         100         4.0         1         11         11           Maval $\overline{M}$ 1491         9         1500         .7         7 - C - 9         1         11           Fwd         400         400         400         200         2.0         1         15			20		20				ļ	
Bulk       Fwd       70       70         Carrier $\overline{00}$ 3526       3526       7-C-9         Aft       120       120       7-C-9       11         Container-       Fwd       80       7-C-9       1       11         Ship $\overline{3526}$ 80       80       7-C-9       1       11         Laval       Fwd       96       4       100       4.0       7-C-9       1       11         Laval       Fwd       96       4       200       2.0       1       11         Fwd       96       4       200       2.0       1       11         Fwd       96       4       200       2.0       1       11         Fwd       400       400       400       2.0       1       15			20				7-C-8			
Carrier $\overrightarrow{00}$ 3526       3526       3526       7-C-9         Aft       120       120       7-C-9       120         Container- ship $\overrightarrow{500}$ 80       80       7-C-9         Aft       96       4       100       4.0       1       11         Maval $\overrightarrow{500}$ 1491       9       1500       .7       7-C-9       1       11         Maval $\overrightarrow{500}$ 1491       9       1500       .7       7-C-9       1       11         Fwd       96       4       200       2.0       1       15         Fwd       400       400       400       100       1       15	Bulk									
Aft       120       3526       7-C-9         Container- ship       Fwd       80       7-C-9         Maval       Fwd       96       4       100       4.0       1       11         Maval       Mat       96       4       100       4.0       1       11         Fwd       96       4       200       2.0       1       11         Maval       Mat       196       4       200       2.0       1       15         Fwd       400       400       400       400       100       100       100       100	1	1		ļ			7 ~ ~	{		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$							/-C-9	ļ		_
Aft $ref         Iaval       Fwd       96       4       100       4.0       1       11         Mathematical       Mathemathematical       Mathematical$	Container-	Fwd			<u> </u>					
Aft $record           Iaval         Fwd         96         4         100         4.0         1         11           Aft         196         4         200         .7 7-C-9         1         11           Aft         196         4         200         2.0         1         15           Fwd         400         400         400         100         11         15  $		XX	80		80		7-0-0		ļ	
Iava1 $\overline{\text{JOC}}$ 1491     9     1500     .7     7-C-9     1     11       Aft     196     4     200     2.0     1     15       Fwd     400     400     400     15     15		Aft							1	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	arra 1				100	4.0			11	
Aft         196         4         200         2.0         1         15           Fwd         400         400         400         1         15	aval	20				.7	7-C-9			
				4						
	anker			{		}	Ì			
Vanker         Ø         16000         16000         7-C-9           Aft         1000         1000         7-C-9	anver	JUL Aft				ŀ	7-C-9		ŀ	



### DETAIL FAMILY: MISCELLANEOUS CUTOUTS TABLE A-7

LOCATION ON S	HIP	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number		Failure Cause	
Container- ship	Fwd XX Aft	8	2	10	20.0	7-C-10		8,9	<u>.</u>
Combination Carrier	Fwd Aft	10		10		7-C-11			
Container- ship	Fwd XX Aft			20	ļ	7-c-11	 		┝╼┥ ┥╿╷
General Cargo	Fw0	10		10		7-C-11		8	┝╾┛ ┥
Combination Carrier	Fw0	8	2	10	20.0	7-C-12			
Bulk Carrier	Fwo MO Af	356		356		7-C-1	3		_ -∲ -
Container- ship	Fw MAf	a 70		70		7-C-1	3		$\left  \right $
Naval	Fw Ø	d 800 2000		800 2000 1100		7-C-1	.3		┝╾┛ ╌┥╶╻
Naval	Fw Q	rd 40 2		40 30		7-C-1	4		
Bulk Carrier	Fv			126 40		7-C-:	15		
Combination Carrier	ΪÌΤ	wd D ft 60		60		7-C-	15		
Container- ship	F	wd 20 80 759 ft 180	19	20 778 180	2.4	7-C-	15 1	7,11	
General Cargo	F ]	wd 10 <b>X</b> 477 ft 40	1	10 478 40	0.2	7-C-	15 1	9,11	

NOTES.

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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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(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

6.

11. Neglect

12. Misuse/Abuse

16. Other - See Discussion

7. Combined Tension & Shear 13. Questionable

- 14. Heavy Seas 15. Collision
- 9. Fabrication/Workmanship
- 10. Welding

8. Design

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure	]
	11	Sound	Failed	Number	Failures	Family	Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
			Observed	1	}				
Container-	Fwd	40		40					
ship	00			}	}	7-D-3			
	Aft	60		60	<b>!</b>				
Bulk	Fwd	10		10					-Fin
Carrier	QQ	20		20		7-D-4		{	1404
	Aft			10		<u> </u>			بصا
Container-	Fwd	20		20	1			•	1 1
ship	00	30		30	ł	7-D-4			
	Aft			30		<b> </b>			
General	Fwd	50	[	50	[	1		1	
Cargo	<b>D</b> Aft	80		80		7-D-4			
Container-	Fwd				[	<u> </u>		{	13
ship	00	24		24	}	7-D-5			1 N
SHTD	Aft	24		24		1-0-5			HF+
······································	Fwd	40		40					1 🛉
Tanker	DQ.	1200		1200	1	7-D-5		1	┝╍╍┩
	Aft	80		80					
Bulk	Fwd	50		50					
Carrier	X	812	l	812		7-E-1			1 <u>-</u> =(+)-
	Aft	180		180	L				<u>'</u>
Combination	Fwd	40		40				1	
Carrier	QQ	1200	]	1200		7-E-1	ł	1	
	Aft	120		120					
Container-	Fwd	80		80					
ship	Q	804	4	808	0.5	7-E-1	1	7,14	<b>⊢</b> -1
~ .	Aft	300		300		ļ			
General	Fwd								
Cargo	Q	446		446	1	7-E-1			
Má 2.2	Aft Fwd			70		<b> </b>		<u> </u>	
Miscella-	1	70	1	70	1				
neous	DO	200	1	200	1	7-E-1	}		
	Fwd		<b> </b>	170	<b>}</b>	<b> </b>		<b> </b>	4
Naval			1	800	-			1	
NAVAL	Aft	5000	\$	5000	1	7-E-1	}		
	Fwd	1200		1200	ł	<b> </b>	ļ		11
Tanker		140		140					
Tanker	Aft	5410	90	5500	1.6	7-E-1	1	8,16	
NOMBO	ALC	700	L	700	L	ł	ł	1	ł

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 2 , 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

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

TABLE A-7 DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON	SHIP	No. of Sound	No. of	Total	Percent		Failure		T
SHIP TYPE		Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mođe	Cause	
Miscella-	Fwd			10	·		<u> </u>		1
neous	20	30		30		7-C-15	Ì		
	Aft			1		/-C-12			
	Fwd								-
Na				10		_			·
Naval	<b>0</b> 0	20		20	ļ	7-C-15		}	
	Aft			10					1
	Fwd			300			ĺ		
Tanker	30	8000		8000		7-C-15			<b></b>
	Aft	800		800			į .		ł
Bulk	Fwd								1
Carrier	QQ	673		673	1	7-C-16			
	Aft				1	1 0-10			]
Container-	Fwd	and the second se		40			ļ		1
ship		2172	3	40 2175		7 9 10			
Surb	100 Aft	1 1	<u>с</u>		0.1	7-C-16	1	11	<b>—</b>
Conorral	_			80					1
General	Fwd								
Cargo	00	1417	17	1434	1.2	7-C-16	1	11	┣
	Aft								1
Container-	Fwd							· · · · · · · · · · · · · · · · · · ·	1
ship	ΩQ.	300		300	}	7 <del>.</del>	!		
- -	Aft			80		a v servise e			
	Fwd								1
Nayal	<u>X</u>	70		70		7_0 17			
mayal	Aft				{	7- <sub>℃</sub> -17			<b></b>
<u></u>	_	and the second se							4
Container-	Fwd				}		[		
ship	00	84		84		7-C-18			
	Aft								]
	Fwd				,				1 '
Naval	Q	78	2	80	2.5	7 <del>.</del> C.18	1	10	<b> </b>
	Aft	ļļ				-			i
	Fwd							·	1
Naval	30	60.		60	ļ	7 <sub>7</sub> C-19			
sur A CIT	Aft			10		140413			ΙG
Containen	Fwd	<del>╶┟╴╶╾<sup>┎</sup>╘╧╶┈</del> ┨		<u> </u>	<u>├</u> ────			<u> </u>	ł
Container-									1 /
ship	<u> </u>	269		269		7-C-20			1
	Aft							·	ļ
Bulk	Fwd					1			1 -14
Carrier	QQ	116	l	116		7-D-1			141
	Aft								
Container-	Fwd	20		20					۱,
ship	Q	279	1	280	0.4	7-D-1	1	14	
	Aft	50	-	50	<b>~</b> • <b>-</b>		<b>→</b>	74	
	Fwd	10		10				·	ł
Tankow	Œ						(	<b>.</b>	
Tanker		118	2	120	1.7	7-D-1	1	14	
<del></del>	Aft	40		40					1 .
Bulk (	Fwd	20		20		}		,,	
Carrier	Q	80		80.		7-D-2			111
	Aft	104	16	120	13.3	{	1	9,10,13	11_`

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# TABLE A-7 DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure
	r I	Sound	Failed	Number	Failures			Cause
SHIP TYPE		Details	Details	Details		Number		
	₿.	Observed	Observed	Observed				
Bulk	Fwd	20		20				
Carrier	30	173		173		7-E-2		
	Aft	40		40				
Combination	Fwd	20		20				
Carrier	ΣΩ.	435	65	500	13.0	7-E-2	2,3	8,14
	Aft	30		30			_,_	-,
Container-	Fwd	20		20				
ship	302	496		496		7-E-2		
	Aft	30		30				
General	Fwd							
Cargo	<u>X</u>	46		46		7-E-2	1	
·	Aft							
	Fwd	20		20				
Tanker	Q	300		300		7-E-2		
	Aft	40		40				
Bulk	Fwd	20		20				
Carrier	<u>00</u>	196	7	203	3.4	7-F-1	1	9,10,11
	Aft	50		50				
Combination	Fwd	20		20				
Carrier	QQ	60		60		7-F-1		
	Aft	40		40				
Container-	Fwd	30		30				
ship	Ø	1294	11	1305	0,8	7-F-1	1 1	(8,9
	Aft	120		120			<u> </u>	11,14)
General	Fwd	20	,	20				
Cargo	00	593	2	595	0.3	7-F-1	1	6,11
	Aft	60		60				
Miscella-	Fwd	10		10				
neous	Ŭ,	60		60	l   	7-F-1		
	Aft	40		40	<b> </b>		ļ	
-	Fwd	10		10				
Naval	DQ .	80		80		7-F-1		
·····	Aft	60		60	[		L	
<b>—</b>	Fwd	10		10				
Tanker	<u>00</u>	220	_	220		7-F-1		
D11-	Aft	159	1	160	0.6		1	8,9
Bulk	Fwd	10		10		_		
Carrier	<b>100</b>	150		150		7-F-2	E L	
-	Aft	50		50		Ļ	ļ <u>_</u>	ļ
Combination	Fwd	20		20				
Carrier	100	150		150		7-F-2		
	Aft	60		60				
Container-	Fwd	20		20	]			
ship	X	145		145		7-F-2		
	Aft	115	5	120	4.2		<u> </u>	10
General	Fwd	10		10				
Cargo	<u>00</u>	121	ς	121		7 <b>-</b> F-2	[	
	Aft	80		80				

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### DETAIL FAMILY: MISCELLANEOUS CUTOUTS TABLE A-7

LOCATION ON	SHIP		No. of	Total	Percent		Failure	Failure
	]   ]	Sound	Failed	Number	Failures	_	Mode	Cause
SHIP TYPE		Details	Details	Details		Number	1	
		Observed	Observed	Observed				
Miscella-	Fwd	10		10			1	
neous	00	90		90		7-F-2		
	Aft	40		40				
	Fwd	20		20				
Naval	DQ	600		600		7-F-2		1
	Aft	90		90			ļ	]
	Fwd	20		20				
Tanker	W	120		120	l	7-F-2		
	Aft	140		140		2		
Bulk	Fwd	10		10				
Carrier	D	51	1	52	1.9	7-F-3	1	7,8,14
	Aft	20	i -	20		, 1-3	-	/,0,14
Combination	Fwd	10	+	10		<u> </u>	1	<u>†</u>
Carrier	QQ	30		30		7-F-3		1
UULA IUL	Aft	40		40		/5	ļ	
Container-	Fwd	20		20			1	1
ship	00	102	1 1	103	1.0	7-F-3	1	10
211+5	Aft	50		50	1.0	1-1-2	ļ <b>-</b>	10
General	Fwd		+ · · · · · · · · · · · · · · · · · · ·					
Cargo	X	30		30	j	7-F-3		ł
cargo	Aft	20		20		/-1-2		
Miscella-	Fwd		1		+		1	
neous	Ø	10		10		7		
neous	Aft			10		7-F-3		1
	Fwd	1	+	20	+			
Naval	20	200	1	200	ł			
MAVAL	Aft			200 50	1	7-F-3		1
	Fwd		+	10		+	+	+
Tanker	1 DO	50	1	50		7-F-3		
Tailket	Aft		2	40	5.0	'- <u>-</u> 3	1	10
Container-	Fwd	+	<u> </u>	+	+	+	<u> </u>	+ +
	1	1	ł	1 101	ł	7-F-4		
ship	00	101		101	1	/-1-4	1	
<u></u>	Aft		+	<b> </b>	<b></b>	. <u> </u>		<u> </u>
General	Fwd							
Cargo	Aft							1
			<b>_</b>	10	<b>_</b>	7-F-4	Ļ	
<b>.</b>	Fwd	1						
Tanker	Q							
NOTES	Aft	8	2	10	20.0	7-F-5	1	8,9

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

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

The numbers 1, 2, 3 & 4 in the column for (C) 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship 10. Welding
- 13. Questionable 14. Heavy Seas
- 15. Collision

12. Misuse/Abuse

16. Other - See Discussion

TABLE A-7	DETAIL	FAMILY:	MISCELLANEOUS	CUTOUTS

LOCATION ON SHIP TYPE	SHII	No. of Sound Details	No. of Failed Details	Total Number Details	Percent Failures		Failure Mode	Failure Cause
			Observed			number		
Container-	Fwo							
ship	30	. [			ļ			
<b>-</b>	Aft			30		7-F-6		
General	Fwc							
Cargo	00							
···· <b>)</b> ·	Aft	10		10		7 <b>-</b> F-6		
Miscella-	Fwd							
neous	X	}						
	Aft			10		7-F-6		
	Fwd							
Naval	Ø	50		50		7-г-б		
	Aft			50		-		
	Fwc							
Tanker	Q							
	Aft	30		30		7 <b>-</b> F-6		
Bulk	Fwc	1						······································
Carrier	Ø	95	1	96	1.0	7-F-7	1	10
	Aft	: ]						
Container-	Fwc	L	······					
ship	Ø	124		124		7-F-8		
	Aft	:						
General	Fwd	i j						
Cargo	00	40	ĺ	40		7-F-8		
	Aft							
Bulk	Fwd	1						
Carrier	00	97		97		7-G <del>-</del> 1		
	Aft			40				
Combination								
Carrier	Û	10		10		7-G-1		
	Aft			40			. <u>-</u> .	
Container-	Fwd		_					
ship	00	28	2	30	6.7	7-G-1	1	10
Conomel	Aft			60				
General	Fwd			3.0		7 6 1		
Cargo	<u>00</u>	10		10 20		7-G <b>-</b> 1		
Miscella-	Aft			20				
	Fwd			10		7 ~ 1		
neous	<u>50</u>	10		10 20		7-G-1		
	Aft			20				
	Fwd			100				
Naval	X			200		7-G-1		
	Aft			200				
<b>m</b>	Fwd			150				
Tanker	Q			150		7-G-1		
	Aft			200				
Bulk	Fwd	1 1						
Carrier	<u></u>	10		10		7-G-2		
	Aft	50		50				

TABLĘ	A-7	DETAIL	FAMILY:	MISCELLANEOUS	CUTOUTS
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LOCATION ON S	SHIP		No. of	Total	Percent Failures		Failure	Failure Cause	
		Sound	Failed	Number	rallures	Number	MOUE	Cause	Í
SHIP TYPE	ŀ	Details	Details	Details		Number			
	1	Observed	Observed	Observed					
Combination	Fwd		i i					) .	
Carrier	X	150		150	ļ	7-G-2			-
	Aft	250	L	250					
Container-	Fwd		]			ļ	ļ	1	l t
ship	QQ	50		50		7-G-2	[	{	$\square$
	Aft	90	<u> </u>	90		<u> </u>			
General	Fwd			1					1 1
Cargo	QQ	10	{	10	}	7-G-2	ł	1	$\vdash$
	Aft				L	<u> </u>		·	4 1
Miscella-	Fwd				l I	ļ			
neous	Q	40		40	J	7-G-2			$\square$
	Aft	40	1	40	[		L		11
	Fwd	60		60				1	
Naval	00	200		200	1	7-G-2			$\vdash$
	Aft	220		220	}		L	1	1 1
	Fwd								
Tanker	<u>00</u>	10		10		7-G-2	1		$\vdash$
Iumer	Aft		1	60	}	)			
Bulk	Fwd			20	1	1			٦.,
Carrier	X	300	5	305	1.6	7-G-3	1	9,10	
Currier	Aft			300					
Combination	Fwd	<u></u>		30	1		1	1	7 1
Carrier	Ø	200	1	200	1	7-G-3			
Carrier	Aft			600	1	1, 2, 2			
Container-	Fwd		1	40	<u> </u>	+	+	1	1 ]
ship	Ø	332	1	333	0.3	7-G-3	1	7,14	$\vdash$
SUTD	Aft		-	500	0.0	1, 0, 0	-	///	
General	Fwd	<u> </u>	╂=	20	1	†	- <u> -</u>	+	1
	Ø	95	1	95	1	7-G-3		1	
Cargo	Aft			80		1,-0-5			
Miscella-	Fwd			10	+				1
neous	DO	30	1	30	1	7-G-3			
	Aft			70	1	,		1	
	Fwd		·· <del>†</del>	500	+		+		4
Norro 7	X		}	1800		7-G-3			
Naval	Aft		<b>_</b>	2200	1 ,	(	1	7,8	
	Fwd		3		.1			<u> </u>	-
Tanker	X	1	1	50 200	ł	7-G-3		1	
		1 200	1	1 200		1/	1	F	1

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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

8. Design

10. Welding

7. Combined Tension & Shear

13. Questionable 14. Heavy Seas

15. Collision

12. Misuse/Abuse

9. Fabrication/Workmanship 16. Other - See Discussion

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Failures			Failure Cause	Ī
SHIP TYPE		Details	Details	Details Observed	Failures	Number	Mode	Cause	
Container-	Fwd								ļ
ship	20 Aft	20 ·		20		7-G <b>-</b> 4			0
Bulk	Fwd	10		10					] (
Carrier	Q	20		20		7-G-5			-ø-
	Aft	30		30					
Combination				ļ					1 1
Carrier	<u>00</u>								
	Aft	_20		20		7-G-5			
Container-	Fwd								
ship	<u>00</u>	0.5							
	Aft	80		80		7-G-5			
General	Fwd								
Cargo	Q Aft	100 20		100 20		7-G-5			
Miscella-	Fwd								
neous	Ø	ł		1					
	Aft	20		20		7-G-5			}
	Fwd								1
Tanker	Q								┝╾┛
	Aft	60		60		7-G-5			1
Bulk	Fwd	300		300					
Carrier	Q	3915	4	3919	0.1	7-H-1	1 1	9,14	1 I'
	Aft	600		600					
Combination		366	34	400	8.5		1	8,10,15	
Carrier	00	1878	22	1900		7-H-1		10,13,15	
<u> </u>	Aft	894	6	900	0.7		1	10,11	
Container-	Fwd	271	29	300	9.7		1	14,15	
ship	Q	9032	54	9086		7-н-1	1	9,12,14	
General	Aft Fwd	884	16	900	1.8		1	9,10,14	11
Cargo		900 8721	59	900 8780	~ -		_	(9,10,11,	
Curyo	00 Aft			-	0.7	7-н-1	1	12,14	
Miscella-	Fwd	300		<u>1300</u> 300	- <u></u>			15)	⊦ I
neous	<u>00</u>	1500		1500		7-H-1			
	Aft	<u>400</u>		400		,- <i>u</i> -T			
	Fwd	60		60					
Nayal	300	797	3	800	0,4	7-H-1	1	15	
	Aft	200		200	0.1	, _11 <b>T</b>	1	тЭ .	
<u>`</u>	Fwd	597	3	600	0.5		1	5,15	
Tanker	Œ	6468	32	6500		7-H-1	1	5,15 5,7,8,9	
	Aft	1700	_	1700		· •• ±	-	5,,0,5	
Bulk	Fwd				······································				
Carrier	00 Aft	845		845		7-н <del>-</del> 2			-0
Combination	Fwd	120		120	<u> </u>				4
Carrier	Q	700		700		7-н-2			
	Aft	200		200		·2			

TABLE A-7 DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON	SHIP		No. of	Total	Percent		Failure	
		Sound	Failed	Number	Failures	-	Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
	<b>F</b>	Observed	Observed	Observed				
Container-	Fwd							
ship	<b>XX</b> Aft	86		86		7-H-2		
General	Fwd							
Cargo	00 Aft	885	1	856	0.1	7-н-2	1	10
	Fwd	100		100				
Naval	QQ	900	1	900	ł	7 <b>-</b> H-2		1
	Aft	300	l	300	ļ			
Container-	Fwd	100		100				
ship	Q	889	8	897	0.9	7-н-3	1	14
	Aft	200		200				
General Cargo	Fwd	19	1	20	5.0	7-н-3	1	9,10
	Aft		1 -		1			",10
· · · · · · · · · · · · · · · · · · ·	Fwd	200		200				
Naval	00	1200		1200	ļ	7-н-3		
	Aft	198	2	200	1.0		1,2	15
······	Fwd	20	1	20		1	-/-	
Tanker	Q	30		30		7-н-3		
	Aft	20		20				
Bulk	Fwd		<u> </u>				1	
Carrier	00 Aft	18		18		7 <b>-</b> H-4		
	Fwd	[	Ī	T	1	1	1	1
Tanker	<b>X</b> Aft	1200		1200		7-H-4		
Bulk	Fwd	- + -	40	300	13.3	[	1	5,14,1
Carrier	Ø	4800		4800		7-н-5		
	Aft		16	800	2.0	<u> </u>	1	14
Container-	Fwd	600		600				1
ship	00	2600		2600		7-н-5		
<u> </u>	Aft	1200		1200				
Miscella-	Fwd			600		T	T	
neous		2600	1	2600		7-н-5	1	
		1200	1	1200			1	
	Fwd		1	60	Ī		Î.	
Tanker		1400	1	1400	1	7-н-5		
	Aft	140		140	1	L.		

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 22, 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

8. Design

- 11. Neglect 12. Misuse/Abuse
- 6. Tension

7. Combined Tension & Shear 13. Questionable

- 14. Heavy Seas
- 15. Collision
- 9. Fabrication/Workmanship 10. Welding

16. Other - See Discussion

# TABLE A-7 DETAIL FAMILY: MISCELLANEOUS CUTOUTS

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Fạilures		Failure Mode	Failure Cause	l
SHIP TYPE		Details	Details	Details Observed		Number			
	Fwd	500	Observed	500				·	
Tanker	30	10000		10000		7-н-6			5
Taliker	Aft	800		800		/-H-6		1	
Bulk	Fwd			000					1
Carrier	30	170		170		7 77 7			
Callier	Aft	1 1/0		170		7-н-7	}	]	ין
Container-	Fwd			i					
ship	300	20		20		7 17 7			
aurb	Aft	20		20		7-H <b>-</b> 7		1	
General	Fwd				· · · · · · · · · · · · · · · · · · ·				
Cargo	Σ Σ	1323		1323		7_17 7	ļ		
Cargo	Aft	1323	1 1		1	7-H-7		8.12	I I
	Fwd	13	1	80	1.2	<u> </u>	<u> </u>	<u> </u>	1
Tanker	ſ	600		600		7-H-7			
2 MIING1	Q Aft	50		50		/ -n-/			(
Bulk	Fwd	40	<b></b>	40	}	7-н-8	<u> </u>	+	t
Carrier	2		1	40	]	/-n-8			
~att t tigt	00 Aft		1		-	ŀ			
General	Fwd	<b>├</b> ───			<u> </u>			<u> </u>	4
Cargo		104		104		7-н-8			
cargo	Aft	104		104		/8			$\square$
	Fwd	30				·	· · · · · · · · · · · · · · · · · · ·	<b> </b>	
Tanker	<u>7</u>	400		30	}			F	
Tanker	Aft	60		400 60		7-н-8			
Bulk	Fwd	200			<u> </u>	<u> </u>	<b></b>		4
Carrier	00	1466	{	200 1466	1		[		1
Carrier	Aft	400		400	1	7-н-9			"
Combination	Fwd	200		200		ł			1 🔺
Carrier	D	700		700	l	7н <b>-</b> 9	ļ	ļ	
	Aft	300				/~n=9	j		
Container-	Fwd	1800		<u> </u>	<u> </u>	<u> </u>		<u>+</u>	1
ship	302	12804	35	1			,	1 17 0	
	Aft	3000		12839 3000	0.3	7-H-9	1	(7,9	
General	Fwd	500	h	500	<u>†</u>	<u> </u>	<u> </u>	10,11	†
Cargo	<u>00</u>	6802	21	6823	0.3	7-н-9	1	5,8,10	
· · · = y =	Aft	1000		1000				0,0,10	
Miscella-	Fwd	300	├─── <b>─</b> ─	300	<del> </del>	<u> </u>	<b>_</b>	<u> </u>	1
neous	302	1500		1500	1	7 <b>-</b> H-9	1		
	Aft	700	Į	700	[		l		
	Fwd	1000	<u> </u>	1000	╊	<u> </u>	<u> </u>	<u> </u>	1
Naval	702	7000		7000	1	7-н-9			
	Aft	2000	]	2000	İ	1-11-9			
	Fwd	2000	<u> </u>	2000	<u>}</u>	<u>├</u> ───	<u> </u>	<u>                                      </u>	11
Tanker	Q	25000	1	25000	]	7-н-9	1		
	Aft	4000		4000		, <u>"</u>	1		
Bulk	Fwd	200	<u> </u>	200	<u> </u>	<u> </u>	<u>†</u>	<u> </u>	1
Carrier	DQ.	2345		2345	1	7-н-10	]	}	1-4
	Aft	500	[	500				1	1 '

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#### DETAIL FAMILY: MISCELLANEOUS CUTOUTS TABLE A-7

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Failures		Failure Mode	Failure Cause
				Details	Failures	Number	Mode	Cause
SHIP TYPE		Details Observed	Details Observed			Number		
	<b>1</b>		Observed					
Combination	Fwd	400		400 3000		  7-н-10		
Carrier	<u>00</u>	3000		800	1	/-H+10		
	Aft	800		400	ļ. <u>.</u>			ļ
Container-	Fwd	400				7-H-10	1	9,10
ship	DO	3268	4	3272 900	0.1	/10	-	3,10
	Aft	900		200			l <u> </u>	
General	Fwd	200	26	1484	1.8	7-H-10	1	10,12
Cargo	X	1458	26	400	<sup>1.0</sup>	,-H-TO	<b>-</b>	10,12
112	Aft	400		100	<u> </u>	· · · ·		
Miscella-	Fwd	100 300		300		7-H-10		1
neous	DO Aft	300 100	1	100		),- <u>11</u> -10	1	1
	Fwd	400		400		<u> </u>	<u> </u>	<u> </u>
Na 1		2800		2800		  7-н-10		
Naval	Aft	800		800		) - II - IO	í .	
<u>.                                    </u>	Fwd	200	<b> </b>	200				
		2500		2500		7-H-10	ļ	
Tanker	Aft	500		500		/ 11 10		
Cantainan-	Fwd	500		500	· · · · · · · · · · · · · · · · · · ·	<u> </u>	<u> </u>	ļ
Container-		11	3	14	21.4	7-H-11	1	10
ship	Aft			11		· · ·	-	
······································	Fwd	9	1	10	10.0	7-H-11	$\frac{1}{1}$	8,14
Tanker	Ø	5	, <b>*</b>	10	10.0	/	-	
Tanker	Aft						1	
Combination	Fwd		<u> </u>	·		+	<u> </u>	
Carrier	Q							
Ourrade	Aft	47	3	50	6.0	7-H-12	1 1	13
Container-	Fwd				1	1	+	[
ship	Q	10		10		7-H-12		
<b>F</b>	Aft			100				
	Fwd					+	<u> </u>	<u> </u>
Tanker	200							
TUINGI	Aft	50		50		7-H-12		
Bulk	Fwd				<u> </u>	1		
Carrier	00	12	12	24	50.0	7-н-13	1 1	7
	Aft		1	27		'= <u>n=</u> ±3		'
Bulk	Fwd		+	1	· • · · · · · · · · · · · · · · · · · ·	+	+	<u> </u>
Carrier	DQ	32		32		7-H-14		
	Aft					1,		1

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 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

10. Welding

7. Combined Tension & Shear 8. Design

9. Fabrication/Workmanship

- 11. Neglect 12. Misuse/Abuse
- 13. Questionable
- - 14. Heavy Seas
  - 15. Collision
    - 16. Other See Discussion

TABLE A-8 DETAIL FAMILY: (	CLEARANCE	CUTOUTS
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LOCATION ON SHIP TYPE	SHIP	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause
General Cargo	Fwd 20 Aft	234	36	270	13.3	8-A-1	1	8
Container- ship	Fwd 20 Aft	150		150		8-A-2		
Bulk Carrier	Fwd 30 Aft	75		75		8-A-3		
Container- ship	Fwd Ø Aft	177		177		8-A-3		<u></u>
Bulk Carrier	Fwd Ø Aft	150 345		150 345		8-B-1		
Container- ship	Fwd 00 Aft	100		100		8-B-1		
General Cargo	Fwd Ø Aft	6		6		8-B-1		
Combination Carrier	Fwd XX Aft	19	1	20	5.0	8-B-2	1	8,9
Container- ship	Fwd 20 Aft	166 39	1 1	167 40	0.6 2.5	8-B-2	1	9 9
General Cargo	Fwd Ø Aft	73 100		73 100		8-B-2		<u></u>
Tanker	Fwd Ø Aft	150 1958 496	22 4	150 1980 500	1.0 0.8	8-B-2	1,2 1	8,11,12 8
Container- ship	Fwd 90 Aft	12		12		8-B-3		· · · · · · · · · · · ·
General Cargo	Fwd <b>30</b> Aft	224 50		224 50		8-в-3		
Tanker	Fwd Ø Aft	2400 100		2400 100		8-B-3		
Bulk Carrier	Fwd JOL Aft	40		40		8-в-4		
Naval	Fwd Ø Aft	70		70		8-B-5		

### TABLE A-8 DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON	SHIP		No. of	Total	Percent		Failure	
	]	Sound	Failed	Number	Failures	-	Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed	Observed				
Container-	Fwd							
ship	00							
	Aft	188	2	190	1.1	8-B-6	1	5,10
Bulk	Fwd							
Carrier	Ø	40		40		8-B-7		
,	Aft							
Container-	Fwd							
ship	Ø	15		15		8-C-1		
-	Aft			ł				
	Fwd	80		80		8-C-1		
Tanker	00			_		_		
	Aft	[	1	(				
Container-	Fwd							
ship	00	15		15		8-C-2		
<u>r</u>	Aft						ļ	
General	Fwd					·····		
Cargo	300	56		56		8-C-2		;
	Aft			i .				
	Fwd	300	<u></u>	300				
Tanker	X	628	72	700	10.3	8-C-2	1	14
	Aft	70		70			_	
Bulk	Fwd							
Carrier	QQ	12	2	14	14.3	8-C-3	1	7
Cartici	Aft		-			•	_	
Container-	Fwd	300		300		<u>·</u>		·····
ship	Ø	1100		1100		8-C-3	İ	
outh	Aft	59	1	60	1.7		1	9
General	Fwd					<u> </u>		
Cargo	Ø	39		39		8-C-3		
Car yo	Aft							
Container-	Fwd	100	<u> </u>	100	h	8-C-4	<u> </u>	<u>-</u>
ship	302					0-0-4		
auth	Aft							
General	Fwd	·····	<u> </u>					
	SQ.	73		73		8-C-4		
Cargo	Aft	/3		/3		0-0-4		
	Fwd		<u> </u>					
Container-	X	68	2	70	2.9			14
ship	Aft	414	3	417	0.7	8-C-5	1	9,10
NOTES.	INTE	650	L	650				

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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
  - Shear Tension б.
  - 6.
- 12. Misuse/Abuse 13. Questionable
- 7. Combined Tension & Shear
- 8. Design
- 9. Fabrication/Workmanship 10. Welding
- 14. Heavy Seas
- 15. Collision
- 16. Other See Discussion

TABLE A-8 DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Failures		Failure	
SHIP TYPE		Details	Details		Faitures		Mode	Cause
SHIP TIPE				Details Observed		Number		
Bulk	Fwd	40	Opserved	40				
Carrier	<u>300</u>	400		400		0 0 0		
Callfer	Aft	· ·				8-C-6		
Miscella-	Fwd	<u>40</u> 80		40		0.0.0		
		80	[	80	t i	8-C-6		
neous	D Aft							
	Fwd							
Tanker	300	1					]	
Taurer	Aft	200		200		0 0 6		
Bulk	Fwd	400		400		8-C-6	_ <b>_</b>	
Carrier		3332		400 3332		8-C-7		
VALLEVI	Aft	1100		1100		J-U-/		
Container-	Fwd							<u> </u>
ship	Q	162		162		8-C-7		1
E	Aft			~~2				l
Container-	Fwd				<b></b>		<b></b>	
ship	00	278	4	282	1.4	8-D-1	1	9
<b>1</b>	Aft	50	-	50			-	
General	Fwd						<u> </u>	
Cargo	Q	125		125		8-D-1		ļ
90	Aft			120				3 1
·····	Fwd				·			
Tanker	QQ	]					1	]
	Aft	150		_150		8-D-1		
Container-	Fwd							
ship	00	210		210		8-D-2		1
	Aft					_		
General	Fwd							
Cargo	DQ.	42		42		8-D-2		
	Aft							
	Fwd	100		100				
Tanker	QQ	755	45	800	5.6	8-D-2	1	8,9
·	Aft	150		150	ļ	L	ļ	
Bulk	Fwd							
Carrier	00	[		ł			1	1
	Aft	80		80		8-D-3	L	L
Container-	Fwd					l	{	Į
ship	00							
	Aft	60		60		8-D-3		
General	Fwd	ļ	1					
Cargo	QQ							
	Aft	60		60		8-D-4	ļ	
Miscella-	Fwd	50		50				
neous	QQ	240		240		8-D-4		
	Aft	100		100	1		[	ł
Container- ship	Fwd	215	4	219	1.8	8-D-5	1	5,8

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TABLE A-8 DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON	SHIP		No. of	Total	Percent		Failure		
		Sound	Failed	Number	Failures	-	Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Qbserved	Observed	Observed					
General	Fwd								
Cargo	<b>X</b> Aft	28		28		8-D-5			Ţ
	Fwd	170		170					1
Tanker	Ø	1880	120	2000	6.0	8-D-5	1	5,8 -	
,	Aft	400		400	1				
Bulk	Fwd							-	- 4
Carrier	20 Aft	350	ļ	350		8-D-6			Ţ
Combination	Fwd	500		500		· · · · · · · · · · · · · · · · · · ·	<u> </u>		_ <b>↓</b>
Carrier	00	3850	350	4200	8.3	8-D-6	1	5,8,11,	
CALLECT	Aft	900		900				14)	
Miscella-	Fwd	60		60		1	•		
neous	Ø	2100		2100	1	8-D-6			
	Aft	300	1 · · ·	300	ł	1	1		
	Fwd	60		60			<u> </u>		
Tanker	00	530	70	600	11.7	8-D-6	1	8,14 -	
	Aft	100		100					
General	Fwd				<b>-</b>	<b></b>	<u>+</u>	<u> </u>	
Cargo	X	70	]	70	}	8-D-7	}		1
-	Aft	1			ĺ		ł		
·····	Fwd	30	1	30	1		1	<b></b>	ŧ
Tanker	Q	90		90	ţ	8-D-7		1 k=	_
	Aft	60		60					
Miscella-	Fwd		1	<u>+</u>	<u>†</u>	<u>+</u>	<u>†</u>	┼───┥.	
neous	Ø	ł	}	}	ł				
	Aft	70		70	1	8-D-8		1	
	Fwd			<u> </u>	<b> </b>	<u>+</u>	<u> </u>	t	ŧ
Tanker	Ø	300		300		8-D-8		1 L	
	Aft			Ì	l.				
Container-	Fwd		<u> </u>	<u> </u>		+	<u> </u>	╆╼╍╍╼┥.	
ship	00	643	1	644	0.2	8-E-1	1	10 -	
-	Aft	1							d
General	Fwd		<u> </u>	90			<u>†</u>	<u> </u>	ł
Cargo	DO	422	1	422	1	8-E-1			
-	Aft			30			1		
Bulk	Fwd		14	140	10.0	+		8,14	T
Carrier	Q	2271	12	2283	0.5	8-E-2	1,2	9,11,	$\rightarrow$
	Aft	200	-	200				14,16)	Ĩ

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 20, 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

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TABLE A-8 DETAIL FAMILY: CLEARANCE CUTOUTS

LOCATION ON			No. of	Total Number (	Percent Failures			Failure Cause
		Sound	Failed		rattures	- 1	moue	cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed	Observed				· · · · · · · · · · · · · · · · · · ·
Container-	Fwd	210	_	210	• • •	0 - 0	•	E 10
ship	30	2415	1	2416	0.0	8-E-2	1	5,10
	Aft	400		400			1	14
General	Fwd	148	2	150	1.3	0	L L	
Cargo	Q	918	ļ	918	ļ	8-E-2		
	Aft	300		300				
	Fwd	110		110	_			
Tanker	302	409	11	420	2.6	8-E-2	1	8,14
	Aft	90		90				ļ
Bulk	Fwd				1	1		
Carrier	<u>X</u>	32		32		8-E-3		
	Aft		l	[				ļ
Container-	Fwd	100		100	1			
ship	Q	132		132		8-E-3	1	
~··-F	Aft					1		
<del>,</del>	Fwd	60	<u> </u>	60	<u>†                                    </u>	8-E-3		
Tanker	1 X X		1				1	
TAUNCL	Aft					Ĩ		
D11-		<u></u>			+			+
Bulk	Fwd	1 1 2 2		122		8-E-4		
Carrier	Ø	132	i i	132	1	0- <u>L</u> -4		
	Aft		<u> </u>		<u> </u>	<u> </u>		15
	Fwd	146	4	150	2.7		1,2	1
Tanker	00	2376	24	2400	1.0	8-E-5	1,2	5,14
	Aft	100		100	<u>.</u>			
Bulk	Fwd				1		1	1
Carrier	00	1	_			0		1 35
	Aft	98	2	100	2.0	8-E-6	2	15
	Fwd	229	1	230	0.4		1	15
Tanker	D D	2484	16	2500	0.6	8-E-6	2	14,15
	Aft	160		160				ļ
Combination	Fwd	108	12	120	10.0		1,2	8,14
Carrier	00	110	l	110	1	8-E-7		
	Aft		l	1				
Container-	Fwd	120	1	120				
ship	DQ.	1500		1500		8-E-8	1	
-	Aft	200		200		1		
Bulk	Fwd		1	1		1		
Carrier	700	43		43		8-E-9		
~~~~~~ <del>~</del>	Aft	•						
Container	Fwd		·+ · · · · · · · · · · · · · · · · · ·	140	<u>†</u>	+		
Container-			3	3927	0.1	8-E-9	1	10,14
ship	100	3924	5	1	0.1	0-5-3		1 TO, TA
	Aft	the second second second second second second second second second second second second second second second s		260	+	+	+	4
Bulk	Fwd					0 - 10		
	DC.	80		80		8-E-10		
Carrier	1 7 4 1	1	1	1	L			
	Aft							
Container-	Fwd							
		296		296		8-E-10		

LOCATION ON	SHIP		No. of	Total	Percent			Failure
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause
Tanker	Fwd DO Aft	920		920		8-E-10		
Tanker	Fwd <b>X</b> Aft	800		800		8-E-11		
Tanker	Fwd XX Aft	1200		1200		8-E-12		
Bulk Carrier	Fwd 00 Aft	84		84		8-E-13		
Bulk Carrier	Fwd D Aft	240		240		8-E-14		

TABLE A-8 DETAIL FAMILY: CLEARANCE CUTOUTS

TABLE A-9 DETAIL FAMILY. STRUCTURAL DECK CUTS

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure	]
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause	
Bulk Carrier	Fwd Ø Aft	4.5		45		9-A-1			
Combination Carrier	Fwd XX Aft	10		10		9 <b>-</b> A-1			
Container- ship	Fwd Ø Aft	10 10		10 10		9-A-1	· · · · · · · · · · · · · · · · · · ·		
General Cargo	Fwd Ø Aft	10		10		9-A-1			μ

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 22, 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
   11. Neglect
  - 5. Shear 6. Tension
- 7. Combined Tension & Shear 13. Questionable
- 8. Design
- 9. Fabrication/Workmanship
- 10. Welding
- 14. Heavy Seas 15. Collision

12. Misuse/Abuse

16. Other - See Discussion

LOCATION ON	SHIP		No. of	Total	Percent	Detail	•	Failure
	T	Sound	Failed	Number	Failures		Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed	Observed				
	Fwd							
Tanker	20	900		900		9-A-1		
	Aft	30		30				
Bulk	Fwd							
Carrier	D	14		14		9-A-2		
	Aft					:		
Combination	Fwd	20		20				
Carrier	300	10		10		9-A-2		
	Aft	10		10				
Container-	Fwd	10		10				
ship	X	12		12		9-A-2		
-	Aft							
General	Fwd			·			· · · · · · · · · · · · -	,
Cargo	X	50		50		9-A-2		-
	Aft			20		5 m - 2		
Miscella-	Fwd	10		10				
neous	100	20		20		9-A-2		
110040	Aft	10		10		9-A-2		
	Fwd	20		20				• · · · • • • • • • • • • • • • • • • •
Tanker		20		20		9-A-2		
Tunker	00 Aft	40		40		9-A-2		
Bulk	Fwd	20				·		·····
Carrier		33		20 33				
carrier	00 Aft	20		20		9-A-3		
Combination	Fwd	20		20				
Carrier		40		20 40				
carrier	00 Aft	20				9-A-3		
				20				
Container- ship	Fwd	20 34		20 34		9-A-3		
SHIP	Q	30		34		9-A-3		
<u> </u>	Aft				<u> </u>			
General	Fwd	45		<u>.</u>				
Cargo	Ø	45		45		9-A-3		
	Aft							
<b>m</b> = = 1= = =	Fwd	20		20				
Tanker	82	50				9-A-3	_	-
	Aft	59	1	60	1.7		1	8
Combination	Fwd							
Carrier	302	10		10		9-A-4		
	Aft	I						
	Fwd	l Î	1					
Naval	<u>20</u>						-	
	Aft	10		10		9-A-4		
	Fwd							
Tanker	Q		ļ					
	Aft	10		10		9-A-4		
Bulk	Fwd	1						
Carrier	Ø	12		12	ì	9-A-5		
	Aft						1	

TABLE A-9 DETAIL FAMILY: STRUCTURAL DECK CUTS

TABLE A-9 DETAIL FAMILY: STRUCTURAL DECK CUTS

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detail	Failure	Failure	<b>1</b>
	11	Sound	Failed	Number	Failures			Cause	
SHIP TYPE		Details	Details	Details	i urrures	Number	Houe	Cause	
			Observed			Number			
Combination	Fwd		observed	20			· · · · ·		
Carrier	20	20 90		90		9-A-5		-	-
Carrier	Aft	30		30		9-A-5			
Container-	Fwd	30		30					
ship	00	197		197		9-A-5			
~ <u>r</u>	Aft	30		30					
General	Fwd	20		20	<u> </u>				
Cargo	00	49		49	1	9-A-5			
2	Aft	30		30					
Miscella-	Fwd	80		80	1				
neous	Q	60		60		9-A-5			$\square$
	Aft	150		150					
Combination	Fwd								
Carrier	00	10		10		9-A-6			
	Aft								
Miscella-	Fwd			1					▲
neous	Ø	10		10		9-A-6		1	
	Aft								
	Fwd								
Tanker	Ø	10		10		9-A-6			
	Aft								
Bulk	Fwd	30		30					_
Carrier	Q	30		30		9-A-7			$ \Gamma\rangle$
	Aft								
Container-	Fwd								
ship	Ø								
	Aft	10		10		9-A-7			
	Fwd								
Tanker	Ø								
	Aft	10		10		9-A-7			
	Fwd								
Tanker	X	250		250		9-A-8			
<u> </u>	Aft								<u> </u>
General	Fwd	20		20	······				
Cargo	DQ	40		40		9-A-9			
	Aft	40		40					$ $ $\sim$
	Fwd								
Tanker	X	60		60		9-A-9			
	Aft			-					

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{V}$ , 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 & Shear 13. Questionable
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 14. Heavy Seas 15. Collision

12. Misuse/Abuse

16. Other - See Discussion

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TABLE	A-9	DETAIL	FAMILY:	STRUCTURAL	DECK	CUTS

LOCATION ON SHIP TYPE	SHII	P No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Bulk	Fwd			10					
Carrier	30	61		61		9-B-1			C
	Aft	= 10		10					
Container-	Fwd	1							<u>،</u> ا
ship	D Aft		4	38	10.5	9-B-1	1	10	
General	Fwd	1							1
Cargo	)) Aft			18		9 <b>-</b> B-1			
Miscella-	Fwd						l	1	1
neous	Ø2 Aft			10		9-B-1			⊢
	Fwd			30	1				1
Naval	Q	1		120		9-B-1			Ļ
a yun V lakala	Aft			40				1	
	Fwc			10	1				t
Tanker	00 Aft			10		9-B-1			$\vdash$
Bulk	Fwd								
Carrier	QQ Aft	17	8	25	32.0	9-в-2	1	9,11,14	
Combination	Fwc			10		9-B-2		<u> </u>	14
Carrier	00 Aft					, , , ,			
Container-	Fwd	Statement of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local division of the local		40				1	1
ship	Ø			22		9-B-2			$\vdash$
	Aft			10					
General	Fwc			<u> </u>	t		<u> </u>	<u> </u>	1
Cargo	00 Aft	38		38		9-в-2			
	Fwd			20					1
Naval	QQ			120		9-B-2			
	Aft	10		10					
···· ··· ·	Fwd			10	1		1	1	1
Tanker	00			10		9 <b>-</b> B-2			$\square$
	Aft			10					
Combination	Fwd			10	1		<u> </u>	<u>†</u>	1
Carrier	Q		1	70	1.4	9-B-3	1	8	
	Aft		-	10					
Container-	Fwd			40	t		· · · · · ·	<u> </u>	1
ship	Q			145		9-B-3	1		<u> </u>
·•	Aft			20					
Miscella-	Fwd						<u> </u>	1	1
neous	Ø			20		9-B-3	· .		<b> </b>
	Aft			10					1
	Fwd			40	T				1
Naval	<u>0</u> 0			260		9-B-3	1		┣
	Aft	80		80				1	ſ

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TABLE A-9 DETAIL FAMILY: STRUCTURAL DECK CUTS

LOCATION ON S	SHIP		No. of	Total	Percent			Failure	
		Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Observed	Observed	Observed					
	Fwd	• 20		20	1				
Tanker	<b>XX</b> Aft	40		40		9 <b>-</b> B-3			
Bulk	Fwd							·	
Carrier	<b>XX</b> Aft	20	-	20		9-в-4			
Miscella-	Fwd	10	[	10					
neous	<b>Ø</b> Aft	10		10		9 <b>-</b> B-4			
	Fwd	10		10					
Naval	00 Aft	20		20		9-в <del>-</del> 4			
	Fwd								
Tanker	<b>Ø</b> Aft	10		10		9 <b>-</b> B-4			
Bulk	Fwd								
Carrier	00 Aft	46 10		46 10		9- <b>B-</b> 5			$\bigcirc$
Combination	Fwd	10	· · · · ·	10			1		1 ▲
Carrier	X	20		20		9-B-5			
	Aft	20		20	1		[		
Container-	Fwd	80		80	1		[		1 1
ship	Q	173		173	1	9-B-5	ļ		
	Aft	90		90					
General	Fwd	10		10	T · · · · · · · · · · · · · · · · · · ·	1	1	[	1
Cargo	DQ.	242	4	246	1.6	9-B-5	4	12,15	
	Aft	10		10		1			
Miscella-	Fwd	10		10					11
neous	Q	10		10		9-B-5			
	Aft	10		10					
	Fwd	60		60					1
Naval	<u>X</u>	300		300		9-B-5			
	Aft	110		110					
	Fwd	50		50					1
Tanker	Q	50		50		9-B-5			Ш
	Aft	60		60				1	1
Combination Carrier	Fwd	10		10		9-в-6		1	

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 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.
- The numbers 1, 2, 3 & 4 in the column for (C) 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
- 12. Misuse/Abuse
- 7. Combined Tension & Shear
- 8. Design
- 9. Fabrication/Workmanship 10. Welding
- 18. Questionable 14. Heavy Seas
- 15. Collision
- 16. Other See Discussion

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LOCATION ON	SHIP	No. of Sound	No. of	Total	Percent		Failure		Ī
SHIP TYPE		Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause	
Container- ship	Fwd 30 Aft	10		10		9 <b>-</b> B-6			
Tanker	Fwd 20 Aft	20		20		9-в-б			
Naval	Fwd 30 Aft	10		10		9~B-7			
Tanker	Fwd Ø Aft	10		10		9-в-7			<u> </u>
Bulk Carrier	Fwd Ø Aft	30		30		9-C-1			Ð
Combination Carrier	Fwd Ø Aft	30		30		9-C-1			
Combination Carrier	Fwd Ø Aft	4	6	10	60.0	9 <b>-</b> C-2	1	8	Ð
Container- ship	Fwd XX Aft	14		14		9-C-2			
Combination Carrier	Fwd 20 Aft	20		20		9-C-3			Ð
Container- ship	Fwd Q Aft	59		59		9 <b>-</b> C-3			
General Cargo	Fwd 00 Aft	16		16		9-C-3			
Bulk Carrier	Fwd Ø Aft	112		112		9-c-4			Ð
Combination Carrier	Fwd 00 Aft	100		100		9-C <b>-4</b>			
Container- ship	Fwd Ø Aft	533	1	534	0.2	9-C <b>-</b> 4	1.	10	
General Cargo	Fwd 00 Aft	472	4	476	0.8	9-c-4	1,3	10,11,15	
Container- shìp	Fwd Ø Aft	10		10		9-c-5			ŧ

LOCATION ON	SHIP	No. of	No. of	Total	Percent		l	Failure	
SHIP TYPE		Sound Details Opserved	Failed Details Observed	Number Details Observed	Failures	Family Number	1	Cause	-
Bulk Carrier	Fwd X Aft	50		50		9-C <b>-</b> 6			T
Container- ship	Fwd <b>D</b> Aft	30		30		9-C <b>-</b> 6			
General Cargo	Fwd 00 Aft	90		90		9-C-6			
Naval	Fwd 00 Aft	40		40		9-C-7			

LOCATION ON	SHIP	No. of	No. of	Total	Percent	Detai1	Failure	Failure	1
SHIP TYPE		Sound Details	Failed Details	Number Details	Failures	Family Number		Cause	
	<b>I</b>		Observed	Observed					
Combination	Fwd								I Ľ
Carrier	Aft	10		10		10-A-1	}		[
Container-	Fwd			[					4
ship	DQ .	8	2	10	20.0	10-A-1	1	8,10	<u> </u>
<u>F</u>	Aft		6	20	30.0		1	8,10	
Container-	Fwd		1	100	1.0		1	6,10	
ship	DO	20		20		10-A-2			ľ
*	Aft	20		20	ŧ .				15
General	Fwd			20	[		[		1,
Cargo	Q	}	}	ł	}	10-A-2	1	ļ	
	Aft	20		20				ł	
Miscella-	Fwd	50		50				[	1
neous	Ø	130		130	1	10-A-2			
	Aft	60	ł	60	}	}	Į		]

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 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

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

TABLE A	1-10	DETAIL	FAMILY:	STANCHION	ENDS

LOCATION ON SHIP TYPE		1	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Tanker	F Af	νđ Σ	20 10 20		20 10 20		10-A-2			<b>E</b>
Miscella- neous	Fw D Af	rd Σ	10		10		10.0.0			E A
Naval	Fw <b>X</b> Af	rā Σ	50 150 30		50 150 30		10-A-3 10-A-3			
Naval	Fw 00 Af	đ	20 70 20		20 70 20		10-A-4			ŦŢ
Container- ship	Fw Ø	a	20		20		10-A-5		L	T
Tanker	Fw Ø Af	đ	20 20		20 20		10-A-5			
Bulk Carrier	Fw Q Af		20		20		10-A-6		<del>,</del>	Ţ
Bulk Carrier	Fw <b>X</b> Af	t	10		10		10-A-7			1
Combination Carrier	00 Af	t	20 20		20 20		10-A-7			
Tanker	Fwa Q Afi	t	20		20		10-A-8		-	T
Bulk Carrier	Fwo XX Aft		10		10		10-A-9			T
Naval	Fwc 00 Aft		20 20		20 20		10-A-9			
Combination Carrier	Fwc 200 Aft		10		10		10-A-10			IJ
General Cargo	Fwc QQ Aft		10		10		10-A-10			_1
Naval	Fwd Ø Aft		10 20		10 20		10-A-10			
Combination Carrier	Fwd Ø Aft		20 10		20 10		10-A-11			$\mathbb{T}$

LOCATION ON S	SHTP	No of	No. of	Total	Percent	Dotail	Esiluro	Failure	
		Sound	Failed	Number	Failures			Cause	
SHIP TYPE		Details	Details	Details	rurrures	Number	Mode	cause	
			Observed			Number			
Combination	Fwd	40	0.0001.000	40		· · · · · · · · · · · · · · · · · · ·			
Carrier	<u>00</u>					10-A-12			
	Aft	40		40					<b>U</b>
Container-	Fwd	10		10		10-A-12			4
ship	Ø								
	Aft								
General	Fwd	10		10					
Cargo	<b>X</b>	26	36	62	58.1	10-A-12	1,4	12	
Miscella-	Aft	10 30		10		ļ			
	Fwd	30		30					
neous	<b>D</b> Aft	10		10		10 <b>-</b> A-12			
	Fwd	130		130					
Tanker	00					10-A-12			
	Aft	20		20	:				
Container-	Fwd		<b> </b>						
ship	00								
	Aft	10		10		10-A-13			L L
Miscella-	Fwd	10		10		10-A-14			£
neous	<b>X</b> Aft	-				•			Ţ
	Fwd			i — — — — — — — — — — — — — — — — — — —		<b></b>			•
Tanker	QQ	10		10		10-A-14			
	Aft								
Container-	Fwd								
ship	Q	10		10		10 <b>-</b> A-15			
	Aft								<b>u</b>
General	Fwd								♠
Cargo	<b>Ø</b> Aft	. 83		83		10-A-15			
	Fwd	30		30					
Tanker	202					10-A-15			
	Aft								
Combination	Fwd	20		20		10-A-16			
Carrier	QQ								
	Aft								l U
	Fwd		<u> </u>						<b>A</b>
Naval	Ø								
NOTES	Aft	10		10		10-A-16			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 20, 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 & Shear 13. Questionable
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

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TABLE	A-10	DETAIL	FAMILY:	STANCHION	ENDS
				O TIMOUTON	

LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Failures		Failure Mode	Failure Cause
SHIP TYPE		Details Observed	Details Observed	Details Observed		Number		
Combination	Fwd	1						
Carrier	<b>XO</b> Aft	10		10		10-A-17		
	Fwd							
Tanker	20 Aft	20		20		10-A-17	·	
Miscella-	Fwd							
neous	90 Aft	10		10		10-A-18		
General	Fwd							
Cargo	<b>X</b> Aft	10		10		10 <b>-</b> A-19		
	Fwd							
Tanker	Q Aft	20		20		10-A-19		
Combination								
Carrier	X Aft	10		10		10-A-20		
<u>.</u>	Fwd	10	· · · · · · · · · · · · · · · · · · ·	10				
Naval	QQ	20		20		10-A-21		
	Aft	10		10				
Bulk Carrier	Fwd	40		40		10-A-22		
Carrier	Aft	40		40		10 <b>-</b> A-22		
Miscella-	Fwd	20		20		10-A-22		
neous	00 Aft							
	Fwd	10		10			ļ	
Tanker	<u>م</u>					10-A-22		
	Aft	40		40				
Bulk	Fwd	20		20				
Carrier	00 Aft					10-A-23		
Container-	Fwd	20 40	······································	<u>20</u> 40		10-A-23		
ship	Ø. Aft			40		LU-R-23		
Bulk	Fwd	20		20		10-A-24		
Carrier	<b>XX</b> Aft							
General	Fwd	40		40		10-A-24		
Cargo	<b>X</b> Aft							
	Fwd	20		20				<u>-</u>
Tanker	X	Į				10-A-24		
	Aft	10		10				
Container- ship	Fwd Ø Aft	10		10		10-A-25		

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LOCATION ON S	SHIP		No. of	Total	Percent	<b>}</b>	Failure	
		Sound	Failed	Number	Failures		Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed	Observed				
General	Fwd	-						
Cargo	<b>DD</b> Aft	4	2	6	33.3	10-A-25	1	8
General	Fwd							
Cargo	00 Aft	34		34		10-A-26		
General	Fwd							[
Cargo	<b>XX</b> Aft	58		58		10-A-27		
General	Fwd							[
Cargo	<b>DO</b> Aft	1	3	4	75.0	10-A-28	1	8,11
General	Fwd						<u> </u>	
Cargo	<b>DO</b> Aft	0	2	2	100.0	10-A-29	3	8
Combination	Fwd	20		20		1	1	
Carrier	<u>X</u>					10-в-1		
	Aft	20		20				
Container-	Fwd							
ship	<b>X</b> Aft	20		20		10-B-1		
General	Fwd	20		20	_			
Cargo	QQ	10		10		10-в-1		
	Aft	10		10				
	Fwd	10	1	10				
Naval	00	20		20		10-B-1		
	Aft	20		20	<b></b>	<u> </u>	1	<b> </b>
Tanker	Fwd Ø Aft	20		20		10-B-1		
Bulk	Fwd	70	<u> </u>	70	<u> </u>	+	<u> </u>	<u> </u>
Carrier	DO	,0				10-B-2		
QUITICE	Aft	70		70				ł
Combination	Fwd		<u> </u>	60		+	<u>† ·· · · · ·</u>	<u> </u>
Carrier	Ø Aft	60		60		10-в-2		
Container-	Fwd	120		120	<u>}</u>	+		
ship	Ø	131		131		10-в-2		
	Aft	50		50	[			

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

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LOCATION ON	SHIP	Sound	No. of Failed	Total Number	Percent Failures	Family	Failure Mode	Failure Cause
SHIP TYPE		Details Observed	Details Observed	Details Observed		Number		
General	Fwd		0.000,100	20				
Cargo	20	90		90		10-в-2		
с	Aft	30		30	0			
Miscella-	Fwd	40		40				
neous	00	10		10		10-в-2		
	Aft							
	Fwd	60	· · · · · · · · · · · · · · · · · · ·	60				
Naval	302	210		210		10-в-2		
	Aft	90		90				
	Fwd	208	2	210	1.0	<u> </u>	1	6,9,13
Tanker	302	10		10		10-в-2		
	Aft	130		130				
Miscella-	Fwd							
neous	100	1				1		
	Aft	10		10	1	10-в-з		
Combination				<u>~~</u>	<u> </u>			<u> </u>
Carrier	100						1	
CULTICE	Aft	10		10	Ĩ	10-B-4		
Container-	Fwd	10		10		10-0-4	ļ	
		6		6		10-в-4	l	
ship	<b>Q</b> Aft			0		10-8-4	1	
Bulk	Fwd							
Carrier								
Callier	00 Aft	10		10		10-в <b>-</b> 5		
General	Fwd			10	<u> </u>			
	202						-	
Cargo	Aft	4		4		10-B-5		
	Fwd					<u> </u>	<u> </u>	
Naval	D.	20		20				
Navai	Aft	20		20		10- <b>В-</b> 6		
	Fwd				·	,		
Naval	200	20		20		10 <b>-</b> B-7		
Naval	Aft	20		20				
Container-	Fwd	20		20		<u>├</u>		<b>_</b>
ship	300	10		10		10-B-8		
Surb (	Aft	10		10		10-0-0		
	Fwd	50		50				
Naval	300	190		190		<b>10-в-8</b>		
Mavar	Aft	40		40	[	T0-B-9		
······	Fwd			40			ļ	
Nankor				10				
Tanker	Ø Aft	10		10		10- <b>B-</b> 8		
Combination		10		10	·			
Combination				20	100.0	10		_
Carrier	Ø	0	20	20	100.0	10-в-9	1	8
	Aft							— <u>-</u> —-
Container-	Fwd							_
ship	00	0	10	10	100.0	10-в-9	1	8
	Aft							

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LOCATION ON	SHIP		No. of	Total	Percent		Failure	(	
		Sound	Failed	Number	Failures		Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
	Ŧ	Observed	Observed	Observed					
Container-	Fwd								
ship	DQ	32	l	32		10-в-10			
-	Aft		1	ł	}		1	1	
General	Fwd	40		40		10-B-10			l 🛉 .
Cargo	QQ				ļ				
· · · · · · ·	Aft	1		Į.		l			
	Fwd		1	<u>†</u>		h			1
Naval	30	20	1	20		10-в-10		1	
	Aft	10	1	10	1				ł
	Fwd		<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u>├</u>		1
Naval	<b>D</b>	20	1	20	ļ	і 10-в-11	ļ	Į	
Navar	Aft			20	1	Γ΄		1	
O	Fwd		<u> </u>	20	<b> </b>		<u> </u>	<b>}</b> <i>#</i>	-
Combination	1			20		10-в <b>-</b> 12		ļ	🛱
Carrier	DQ.	20	1	20	{		}		<b>1</b>
	Aft	And the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se		l			<b> </b>		
	Fwd			ļ					1 1
Naval	DQ.				1				
	Aft			10		10-B-12			
	Fwd	20		20		<u>10-в-12</u>			1
Tanker	DQ		ĺ	1		ł	1	ł	┟┈╾┛
	Aft							<u> </u>	ł
Container-	Fwd	40		40		10-B-13	i.		] <b>m</b>
ship	夏	Î				1			
<b>__</b>	Aft			1				e e e e e e e e e e e e e e e e e e e	J€_↓Ľ
	Fwd	1	1	<u>†                                    </u>	1	<b>*</b>	<u>†</u>	1	1 ∔
Naval	X	10	[	10	1	10-B-13		l	ĽЦ
	Aft			10					
Bulk	Fwd			20	+	10-B-14		+	1 🖛
Carrier	Ø		1			[			
Calller	Aft		1					1	IF T
Bulk	Fwd			<u> </u>		+	+	+	┥┈╍╍
Carrier			[	[	ł		1	1	<b>m</b>
carrier	00	20	1	30		10-B-19		1	1.4
	Aft					μυ- <u>β</u> -11	1	<b> </b>	┨┺み└┚
Combination		1			ļ		1	1	
Carrier	00	10		10	1	10-B-15	2	1	
·	Aft		<u></u>	10	L				
Container-	Fwd		[	[	[	[	1		
ship	DQ	10		10	1	10-B-1	5	1	┝━┛
	Aft	30		30	1			1	

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

- (B) The rows labeled aft,  $\mathfrak{D}$ , 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
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  - 7. Combined Tension & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 12. Misuse/Abuse
- 13. Questionable
- 14. Heavy Seas
- 15. Collision
- 16. Other See Discussion

SHIP TYPE		No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number	Failure Mode	Failure Cause
General	Fwd		00002 780	ODSEL VEU		ļ		
Cargo	202	48	2	50				_
3 .	Aft	10	2	10	4.0	10-B-15	1,4	12,15
	Fwd	40		40				·····
Naval	Q	60						
	Aft	50		60 50		10-в-15		
· · · · · · · · · · · · · · · · · · ·	Fwd	30		50				·
Tanker	300	50		30		10 <b>-</b> в-15		
	Aft	20		20		10 2 13		
Bulk	Fwd	10		10				·····
Carrier	20					10 <b>-</b> В-16		
	Aft	10		_ 10			1	
Combination		30		30		<b>├───</b>		······
Carrier	<b>X</b>	30		30		10-в-16	ł	
	Aft	10		10		10		
Container-	Fwd	30		30				
ship	0	28		28		10-в-16		
	Aft	20		20				
General	Fwd							
Cargo	DQ	62	ł	62	ŀ	10-в-16		
	Aft	10		10		J		
Miscella-	Fwd							
neous	X			1				
	Aft	10		10		10-B-16	[	
• •	Fwd	30		30				
laval	00	80		80		LO-B-16		
	Aft	50		50				
	Fwd							
lanker	02	10		10	נ	LO-B-16		
	Aft	70		70				
General	Fwd						╺──────────────────────────────────────	
Cargo	00						1	
lomb i i i	Aft	40		40	1	.0- <b>В-1</b> 7		
ombination				T				
arrier	00		ĺ	ļ			1	
ontainer-	Aft	20		20	1	.0-в-18		
	Fwd	, 1	[					······
hip	00 Aft	4		4	1	0-в-18		
						1	ļ	ſ
eneral	Fwd	_						
argo	X	6	[	6	ļı	0-B-18		L.
	Aft	30	<u>i .</u>	30				
I	Fwd						<u></u>	
aval	DC	20		20	1	0-в-19		I
	Aft				{			[`
ombination		1						
arrier	00	1.0			}			
	Aft	10		10	11	0-в-20		4

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DETAIL FAMILY: STANCHION ENDS TABLE A-10

LOCATION ON	SHIP	No, of Sound	No. of Failed	Total Number	Percent Failures	1 1		Failure Cause	
SHIP TYPE		Details Observed	Details	Details	- all all of	Number			
Container- ship	Fwd XX Aft	28	2	30	6.7	10 <b>-</b> В-21	1	8,10	<u>_</u>
Tanker	Fwd 00 Aft	10		10		10-в-21			
Container- ship	Fwd Ø Aft	8	2	10	20.0	10-в <b>-</b> 22	ı	8	
Tanker	Fwd <b>DO</b> Aft	20		20		10-в <b>-</b> 23			
Bulk Carrier	Fwd DD Aft	4	6	10	60.0	10-в-24	3	8	
Tanker	Fwd <b>20</b> Aft		1	10	10.0	10-B-25	2	12	
Container- ship	Fwd XQ Aft	8	6	14	42.9	10-в-26	1	6,8	V
General Cargo	Fwd Ø Aft	4		4		10-в-27	7		
General Cargo	Fwd Ø Aft	8	2	10	20.0	10 <b>-</b> B-28	3 1	7	
Container- ship	Fwd Ø Aft	8	2	10	20.0	10-C-1	1	8	
Container- ship	Fwd XX Aft	20		20		10-C-2			
Tanker	Fwd 00 Aft	30		30		10-C-2			
Naval	Fwd Ø Aft	20		20		10-C-3	T		╠

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Tanker	Fwd 30 Aft	10		10		10-C-3			₽
Container- ship	Fwd Ø Aft	10		10		10-C-4			Ţ
Bulk Carrier	Fwd 90 Aft	4	6	10	60.0	10-C <b>-</b> 5	1	8	T
Combination Carrier	00 Aft	10		10		10 <b>-</b> C-6			-J
General Cargo	Fwd Ø Aft	8	2	10	20.0	10 <b>-</b> C-6	1,2	12	<u>t</u>
Container- ship	Fwd Ø Aft	10		10		10-C-7			Ŧ
General Cargo	Fwd Ø Aft	52	2	54	3.7	10 <del>~</del> C-7	2	8	
Tanker	Fwd Ø Aft	20		20		10-C-7	· · · · · · · · · · · · · · · · · · ·		
Tanker	Fwd 00 Aft	20		20		10-C-8			
Combination Carrier	00 Aft	10		10		10 <b>-</b> C-9			ŧţ
General Cargo	Fwd Ø Aft	26 20		26 20		10 <b>-</b> C-9			
Bulk Carrier	Fwd DD Aft	20		20		10 <u>-c</u> -10			Ŧ
Combination Carrier	Fwd Ø Aft	10		10		10-C-10			
Tanker	Fwd SOL Aft			20		10 <b>-</b> C-11		ł	₽ <b>₽</b> ₽
General Cargo	Fwd Ø Aft	20		20		10 <b>-</b> C-12			€ <b>Ŧ</b> Ţ
Naval	Fwd Ø Aft	20 20		20 20		10-C-12			

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LOCATION ON	SHIP	No. of Sound	No. of Failed	Total Number	Percent Failures		Failure Mode	Failure Cause
SHIP TYPE		Details	Details	Details	raitutes	Number	MOGE	cause
		Observed	L	Observed		in callaber		
General	Fwd							
Cargo	Ø	•	1					
curgo	Aft	40		40	j	10-C-13		
	Fwd	30		30			·····	(
Naval	Ø	70		70	ļ	10-C-13		
	Aft	20	(	20	1	f •		ſ
	Fwd	50		50		<b> </b>		
Naval	<u> </u>	30		30	}	10-C-14	1	l i
	Aft	20		20				
General	Fwd			[	1	[		]
Cargo	M						ĥ	
	Aft	40	1	40	i	10-C-15		1.
Container-	Fwd		[	[	[	· · ·		1
ship	DO		1	ļ				
+	Aft	10	{	10		10-C-16		
General	Fwd							
Cargo	00	32		32	ł	10-c-16		· ·
	Aft							
Bulk	Fwd	10		10	[	10-C-17	· · ·	[
Carrier	30		ļ				[	Í
	Aft			<u> </u>				
Combination	Fwd	20		20		10-C-18		
Carrier	妏			1	]			
	Aft			<u> </u>	L			
	Fwd							
Naval	Ø	1	-	ł	]			
	Aft	20	·	20	ļ	10-C-18		
Combination	Fwd	1 .	1	Į _	ļ			
Carrier	Q	10		10		10-C <b>-</b> 19	1	
·	Aft			<u> </u>	<b>_</b>	<u> </u>		
	Fwd	20	[	20			ł	1
Naval	00	40	1	40	1	10-C-20	1	
	Aft	20	<b>_</b>	20	k	<u></u>		<u>                                     </u>
Bulk	Fwd				ļ		]	
Carrier	<u>X</u>		Į .		}	10	}	]
	Aft	20	<b> </b>	20	<b> </b>	10-C-21	<b> </b>	ļ
- · ·		1 10	1	10	1	1	1	1
Container- ship	Fwd	10 10	}	10		10-C-21		

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft,  $\mathfrak{D}$ , and fwd refer to locations along the ship length. The midship symbol row covers the mid-length throughout the entire cargo section.
- The numbers 1, 2, 3 & 4 in the column for (C) 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

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  - 7. Combined Tension & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 15. Collision 16. Other - See Discussion

12. Misuse/Abuse

13. Questionable

14. Heavy Seas

LOCATION OF		Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number	Failure Mode	Failure Cause
General	Fwd			ODSEL VEU				
Cargo	20	20		20		10-C-21		
	Aft	10		10		10-0-21		
	Fwd		· · · · · · · · · · · · · · · · · · ·					
Tanker	D							
	Aft	30		30		10-C-21		
Container-	Fwd					10-0-21		
ship	302							
-	Aft	10		10		10 0 00		
	Fwd					10-C-22		
Tanker	302							
	Aft	10	1	10				
General	Fwd		·			10-C-22		
Cargo	Q	10		10		10 0 00		
-	Aft			10	-	10-C-23		
	Fwd						<u>`</u>	
Naval	00	20	ĺ				ľ	
	Aft	20		20		10-C-24	1	
Container-	Fwd							
ship				ļ				
Surb	00 Aft	10						
Aiscella-	Fwd	10		10		10-C-25		
neous			1		ĺ		ľ	
ieous	Ø Aft							
		10		10		10-C-25		
Naval	Fwd	10		10				
aval	00	10	1	10	þ	LO-C-25		
1	Aft	10		10			[	
Container-	Fwd		1	T				
ship	DQ			-				
	Aft	20		20	þ	0-C-26		
	Fwd							
Tanker	00 Aft	_						
		10		10	ի	0-C-26		
Container-	Fwd							
ship	<u> </u>			Ì				
ombineti	Aft	20		20	þ	0-C-27		
Combination Carrier			T	1				
arrier	00	.			-			
116	Aft	10		10	l	0-C-28		
ulk	Fwd				+			
arrier	TXC.	[	1			ł		
	Aft	20	[	20	þ	0-C-29		
eneral	Fwd					<del></del>		
argo	DC	6	l I	6	h	0-C-30		5
	Aft			-	ľ			
eneral	Fwd							
argo	00 Aft	108		108		0-C-31		ĺ
	Aft				۲ <b>۲</b>		1	

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Detail Failure Failure LOCATION ON SHIP No. of No. of Total Percent Failures Family Mode Cause Sound Failed Number Details Details Number SHIP TYPE Details 0 Observed Observed Observed Fwd General 10-C-32 <u>D</u> 70 70 Cargo Aft Fwd General 1 .6,8 100.0 10-C-33 4 4 Cargo 00 0 Aft Fwd General 10-C-34 44 00 44 Carqo Aft General Fwd 4 12,15 \_ 7 8 12.5 10-C-35 1 Cargo Aft Fwd General 10-C-36 12 00 12 Cargo . Aft General Fwd 10-C-37 6 00 6 Cargo Aft

## TABLE A-10 DETAIL FAMILY: STANCHION ENDS

TABLE A-11 DETAIL FAMILY. STIFFENER ENDS

LOCATION ON	SHIP		No. of	Total	Percent			Failure	
		Sound	Failed	Number	Failures			Cause	
SHÌP TYPE		Details	Details	Details	<b>(</b>	Number	[	(	
		Observed	Observed	Observed					
Bulk	Fwd	200		200					
Carrier	页	1				11-A-1		1	
	Aft	190	10	200	5.0	]	1	5	
Combination	Fwd	280		280					
Carrier	Q	300	Į	300		11-A <b>-</b> 1			
	Aft	300	· ·	300			ŀ		
Container-	Fwd	90		90					
ship	Ø	316	1	317	0.3	11-A-1	1	5	┝╾╌┛
_	Aft	340	· ·	340	Í		ł		

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 2 , 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.

5. Shear 6. Tension

•

- 12. Misuse/Abuse 13. Questionable 14. Heavy Seas
- 7. Combined Tension & Shear 13. Questionable

8. Design

9. Fabrication/Workmanship

10. Welding

15. Collision 16. Other - See Discussion

 <sup>(</sup>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 Sheer

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures			Failure Cause
General	Fwd	70		70		t		{
Cargo	30	395	8	403	2.0	11-A-1	1	5
	Aft	118	2	120	1.7			5
Miscella-	Fwd	50		50	<u></u> _	1		
neous	D	60		60		11-A-1		1
	Aft	80		80				i
	Fwd	700	····	700	<u> </u>	<u> </u>		<u> </u>
Tanker	302	1523	77	1600	4.8	11-A-1	1	5
	Aft	650		650	1.0			
Container-	Fwd	80		80		<u>}</u>		
ship	00	118	2	120	1.7	11-A-2	1	5
-	Aft	80		80	±•/	n-2		
General	Fwd	<u> </u>			<u> </u>			
Cargo	192	85		85		11-A-2		
-	Aft	10		10				
	Fwd	20		20		11 <b>-</b> A-2		
Tanker	DQ Aft			20		11 <b>-</b> A-2		
Bulk	Fwd	20		20		11-A-3		
Carrier	00 Aft						:	
Container-	Fwd	290		290	·			
ship	<u>30</u>	262	5	267	1.9	11-A-3	1	5,10
	Aft	110	{	110			~	0,10
General	Fwd							
Cargo	00	674		674		11-A-3		
	Aft	50	}	50				
	Fwd	19	1	20	5.0		1	6,8,14
Naval	Q		-			11-A-3	÷	-,-,-
	Aft	20		20		•		
······································	Fwd	30		30				·
Fanker	Q		ļ			11-A-3		
	Aft	60		60				
	Fwd	50		50				·····
Naval	DQ.	120		120		11-A-4		
	Aft	70	ļ.	70				
Container-	Fwd	19	1	20	5.0	11 <b>-</b> A-5	1	5
ship	00						-	-
	Aft		Í					
	Fwd	20		20		11-A-5		
fanker	QL Aft			- <del>-</del> -				
Container-	Fwd							
ship	DC	252	5	257	1.9	11-A-6	1,4	5,7,15
<b>-</b>	Aft	18	2	20	10.0		2	
	Fwd		~~~~~~	······································		· i		8
laval	00 Aft	63	7	70	10.0	11-A-6	ı	7

LOCATION ON S	SHIP		No. of	Total	Percent		Failure		
		Sound	Failed	Number	Failures	-	Mođe	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Observed	Observed	Observed	L				
Bulk	Fwd	170		170					
Carrier	X	1003		1003	ł	11-A-7			
	Aft	210		210					
Combination	Fwd	375	5	380	1.3		1	14	1 🛉
Carrier	Q	360		360		11-A-7			H
	Aft	250		250					
Container-	Fwd	547	3	550	0.5		1	14,15	}
ship	QQ	2868	6	2874	0.2	11-A-7	1	8	┝╼╍┫
_	Aft	660		660					1
General	Fwd	210		210					]
Cargo	<u> </u>	3032	6	3038	0.2	11-A-7	1	11	
_	Aft	500		500					
Miscella-	Fwd	110		110					1
neous	<u>م</u>	30		30	ł	11-A-7	1		
	Aft	100		100					
	Fwd	604	6	610	1.0		1	7,11,14	]
Tanker	<u>30</u>	820		820		11-A-7			
	Aft	540		540					
Combination	Fwd				1		ţ	1	ੀ⊤ਙੁ⊼
Carrier	<u>ک</u> ور	200		200		11-A-8			
	Aft						•		비내
<u>, , , , , , , , , , , , , , , , , , , </u>	Fwd	80	1	80	<u> </u>			1	1 🛉
Naval	Q	420	Ì	420		11-A-8			
	Aft	166	4	170	2.4		1 1	8,14	
Bulk	Fwd	80	· · · · · · · · · · · · · · · · · · ·	80			<u> </u>		
Carrier	DQ.	293		293	-	11-A-9			I MA EL
	Aft	170		170			-		
Combination	Fwd	40		40		<u> </u> "	†		4
Carrier	Ø					1-A-9			
	Aft	90		90	1				
Container-	Fwd	50		50	1	t	1		1
ship	00	504		504	1	11-A-9			
*	Aft	150		150	1				
General	Fwd			60	<u> </u>		1	†	11
Cargo	Ø	429	45	474	9.5	11-A-9	1	5,8,11	
2 -	Aft	110		110		[		-,-,**	
	Fwd			240	1	t	<u> </u>	<u>├</u>	11
Naval	X	1600		1600	ł	11-A-9			μJ
NOTES	Aft			300		Γ	[	1	

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

(B) The rows labeled aft, 2 , 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
- 11. Neglect
- 12. Misuse/Abuse & Shear 13. Questionable
- 7. Combined Tension & Shear 8. Design

8. Design 14 9. Fabrication/Workmanship 15

- 14. Heavy Seas
- 15. Collision 16. Other - See Discussion

10. Welding

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SHIP TYPE		No. of Sound Details Observed			Percent Failures	Detail Family Number	Failure Mode	Failure Cause	
	Fwd	87	3	90	3.3		ī	11	╘
Tanker	20				]	11-A-9			
	Aft	130		130		l			ſĽ
	Fwd	230		230					Т
Naval	D D	1500		1500		11-A-10			
	Aft	400		400					ין
Container-	Fwd								]т
ship	302					{			(†
	Aft	20		20		11-A-11			l
N	Fwd	60		60		11-A-11			1
Naval	<u>D</u>	1							$\vdash$
·	Aft	<u> </u>							J
	Fwd	50		50					1
Tanker	Q					11-A-11			⊢
D 11-	Aft	60		60					1
Bulk	Fwd								ᠯ᠇
Carrier	00			(	ł				
	Aft	20		20		11-A-12			4
M	Fwd	30		30					1
Naval	Ø	110		110		11-A-12			┝━
	Aft	50		50					
<b>—</b> ——)-——	Fwd		}						1
Tanker	Ø								⊢
	Aft	40		40		11-A-12			1
Combination		30	ļ	30					
Carrier	00		ļ		ļ	11-B-1	{		
Contoiner	Aft	30		30					4
Container-	Fwd								
ship	D	491	2	493	0.4	11-в-1	1	5	L
Conomel	Aft	80		80				ĺ	
General Cargo	Fwd	704	.						
Cargo	00	786	4	790	0.5	11-в-1	1	10,11	
	Aft								
ma piras	Fwd	20	_ /	20					•
Tanker	00	195	5	200	2.5	11-в-1	1	7	
Container	Aft	16	4	20			_ 1	5	
Container-	Fwd		]						
ship	00	60		60	Í	11-B-2		1	Ų
	Aft					_ [	1		Ψ
Container-	Fwd	50		50			+		
ship	302	832	8	840		11-B-3	1	7	13
	Aft	247	3	250	1.2		2	14	Ч
General	Fwd	[	Í	-1					
Cargo	<u>.</u>	60	1	60	1	11-B-3	ļ		
	Aft								
Bulk	Fwd								_
Carrier	00	111		111		11-в-4		Ĩ	E?
[	Aft			1	l		ļ	(	U

LOCATION ON S	SHIP		No. of	Total	Percent		Failure	Failure	ļ
		Sound	Failed	Number	Failures		Mode	Cause	1
SHIP TYPE		Details	Details	Details		Number		1	
		Observed	Observed	Observed	<u> </u>				1
Container-	Fwd				[		Į		ĺ
ship	<u>00</u>	201	{	201		11-B-4		1	
1	Aft		ļ		}	ļ			ľ
General	Fwd	20		20	<u> </u>				1
Cargo	QQ	159	2	161	1.2	11-в-4	2	12,15	┝
	Aft	50		50				ļ	
	Fwd		<u> </u>	<u> </u>	1	1			1
Tanker	300	1908	12	1920	0.6	11-в-4	1	7	F
	Aft				{		{		1
Container-	Fwd	ţ	<u>†</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>		1,
ship	DO	140		140	ļ	11-B-5	1		
auth	Aft	59	1	60	1.7	Γ	L	7	ļľ
	Fwd		<u> </u>	+	<u>+</u>	<u>+</u> -	<u>├</u>	<u> </u>	┥
Container-				38	2.6	11-в-6	1	8	L
ship	00	37	1	30	2.0				
	Aft	ļ	<u> </u>	<u> </u>	<u> </u>		<u>↓</u>	<u> </u>	4
General	Fwd				]		1 1	11	1
Cargo	<u>00</u>	74	4	78	5,1	11-в-6	1 -	ļ <u>**</u>	T
	Aft		<u> </u>	<u> </u>	ļ	<b>_</b>	<u> </u>	<b>↓</b>	-
Bulk	Fwd		1		1		1		1
Carrier	<b>X</b>	412		412		11-в-7			[[
	Aft		<u> </u>	<u> </u>		<u> </u>	<u> </u>	<u> </u>	
Bulk	Fwd	{	ļ	]			1	}	1
Carrier	QQ	26		26	ĺ	11-в-8	1	ł	1
	Aft		1		}	]			
Container-	Fwd	1	1	1		1		1	1
ship	<u>ک</u>	30	(	30	{	11-в-8		1	$\left  \right $
_	Aft	)		]					
General	Fwd		T			1	1	1	1
Cargo	Ø	160	2	162	1.2	р1-в-9	1	11	ļ
~	Aft	1		ļ	4				
Container-	Fwd		1	t	1	<u> </u>	1		4.
ship	202	41	Į	41	J	11-c-1			Į
0.14P	Aft	1	1	1	1		1	(	1
General	Fwd		+	+	<u> </u>	+	┼────	+	+
Cargo	302	158		158			ļ		
var yv	Aft		[	30	ļ	11-C-1		1	ſ
	Fwd		+	50	- <del> </del>	11-C-1			-
Tanker	Aft		1					{	L

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

(B) The rows labeled aft,  $\mathfrak{D}$ , 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 & Shear
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 12. Misuse/Abuse 13. Questionable 14. Heavy Seas
- 15. Collision
- 16. Other See Discussion

TABLE A-11	DETAIL	FAMILY:	STIFFENER	ENDS
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SHIP TYPE	SHIP	No. of Sound Details	No. of Failed Details	Total Number Details	Percent Failures		Failure Mode	Failure Cause
		7	Observed			Number		
General	Fwd		00002104	obset ved	<u>                                     </u>	<u>  </u>	<u> </u>	
Cargo	202	16		16				
50	Aft			10		11-C-2	ļ	
	Fwd					<del> </del>		<u> </u>
Tanker	00			Į		ļ		
	Aft	40		40				
	Fwd		· · · · · · · · · · · · · · · · · · ·	40		<u>11-C-2</u>		
Naval	302	170		40 170	ĺ			
	Aft	60				11-C-3		
	Fwd	40		60 40		<u> </u>		
Naval	<b>X</b>	60		_	ļ			
	Aft	1		60 40		11-C-4		
Container-	Fwd	+		<u>40</u>			····	
ship	Q							
	Aft	60		60				
	Fwd	+	·	60		11-C-5		·
Naval	100	13	7	20	<b>15 0</b>			~
	Aft		,	20	35.0	11-C-6	1	8
Bulk	Fwd	╉━───┥						
Carrier		72		70				
0411101	00 Aft	12		72		11-D-1		
Combination	Fwd	20		20		·		·
Carrier	<u>300</u>	20		20				
0411101	<u>yw</u> Aft	20		20	İ	11-D-1		
Container-	Fwd	20		20				·
ship	00			Í				
Surb	Aft	60		60	ł			
General	Fwd	00	·	60		<u>ll-D-1  </u>		
Cargo	Q	}		}				
Sur yo	Aft	30		20	1			
	Fwd	<u>├</u>		30	·	<u>11-D-1</u>	<u> </u>	
Tanker	00	[						
	Aft	110		110	l	Ì	]	
Container-	Fwd	╞──╧┶╵──┤		<u> </u>	_ <del></del>	L1-D-1		
ship	<u>00</u>	193	}	102	1			
	ىمور Aft	9.5		193	P	L1-D-2	[	
Aiscella-	Fwd	50	<u>}</u>	<u></u>		·		
neous	700		[	50	l		l	
	Aft	40	. l	40	ľ	ll-D-2		
	Fwd							
Fanker	TONE							
	Aft	30		30	ų.	.1-D-2	ļ	
+	Fwd	60		60				
1-17-1		200	1	200	l	[		ļ
Naval	00 Aft	1060	ĺ	1060	Į.	.1-D-3		
	Fwd	360		360				
$\alpha\alpha\tau a_1\alpha\alpha\tau = 1$	E WUL		]	1			[	
ship	DQ	58	2	60	1.7	1-D-4	1	7

LOCATION ON	SHIP		No. of	Total	Percent		Failure	Failure Cause	
SHIP TYPE		Sound Details	Failed Details	Number Details	Failures	Number	mode	Cause	
SHIF IIID		Observed							
<u> </u>	Fwd						_	-	60
Tanker	00 Aft	2108	42	2150	2.0	11-D-5	1	7	
		160		160					
General Cargo	Fwd 00 Aft	60		60		11-E-1			
General Cargo	Fwd	108		108		11-E-2			Ш
	Fwd	10		10				1	11
Tanker	Aft	120	1	120		11-E-2			
Tanker	Fwd	20		20		11-E-3			<b>n</b>
TOUVET	Aft	20		20			<u> </u>		JH

## TABLE A-12 DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON	SHIP	No. of	No. of	Total	Percent		1	Failure	
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	•	Cause	
Naval	Fwd Ø Aft	6	24	30	80.0	12-A-1	1	5,8	<del> </del>
Tanker	Fwd 00 Aft	150 60 330		150 60 330		12-A-1			
Gen <b>era</b> l Cargo	Fwd 00 Aft			<sup></sup> 20		12-A-2			
Tanker	Fwd X Aft			40		12-A-2			

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 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 & Shear 8. Design
  - 9. Fabrication/Workmanship 10. Welding
- 13. Questionable 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

TABLE A-12 DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON SHIP TYPE	SHIP	Sound Details	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Bulk	Fwd	30		30					1
Carrier	X	600	8	608	1.3	12-A-3	1,2	15	K-F
	Aft	60		60		}			
Combination	Fwd	120		120				····-	1 🛉
Carrier	Q	400		400		12-A-3			$\vdash$
	Aft	210		210					
Container-	Fwd	150		150					1 1
ship	TO .	1295	2	1297	0.2	12-A-3	2	15	
-	Aft	320		320		[			
General	Fwd			100		i		(8,11,	1
Cargo	30	1731	103	1834	5.6	12-A-3	1,2,4	12,16)	
	Aft		5	220	2.3	Г <b> с</b>	1	11	
Miscella-	Fwd	and the second second second second second second second second second second second second second second second		40				<u> </u>	
neous	Q	60		60	ł	12-A-3			
	Aft			70					
	Fwd			200				<u> </u>	+
Naval	100	2100		200		12-A-3			
	Aft	1		400		12-A-3			
	Fwd		·	210				<u> </u>	
Tanker	۲wu کو	670		670		12-A-3			
Taliker	Aft			490		12-H-2			
	Fwd			4.50					-
Naval									
Naval	Ø Aft	150		150					L
	Fwd	150		150		12-A-4			ł .
Tanker									1
Tallker	00			00		10.2.4			
Combination	Aft	90 60		90		12-A-4			-
Combination				60		12-A-5			1 ÷-
Carrier	Q								
	Aft	╁───┤							ľ.
Container-	Fwd		_				_	<b>.</b> .	
ship	00	219	3	222	1.4	12-A-5	1	14	$\vdash$
	Aft								
General	Fwd								
Cargo	DQ.	10		10		12-A-5			
	Aft	┤─┉──┤							
Miscella-	Fwd								l
neous	<u> </u>		)						
	Aft	40		40		12-A-5			
	Fwd				'				
Tanker	X		ſ						┝╾╾┛
	Aft	40	l	40		12-A-5			1
Bulk	Fwd	291	9	300	3.0		1	14	l.
Carrier	Q	1621	21	1642	1.3	12-A-6	1	7,15	
· · · · · · · · · · · · · · · · · · ·	Aft	460		460		[			r
Combination		40		40					♠
Carrier	Q	160		160		12-A-6			┝──┙
	Aft	90		90					

international and an and a second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se

### DETAIL FAMILY: PANEL STIFFENERS TABLE A-12

LOCATION ON	SHIP		No. of	Total	Percent			Failure	÷ .
SHIP TYPE		Sound Details Observed	Failed Details Observed	Number Details Observed	Failures	Family Number	Mode	Cause	
Container-	Fwd	40		40		·_··			. 1 .
ship	202	623	2	625	0.3	12-A-6	1,2	15	
-	Aft	60		60	}				11
General	Fwd			ļ					1 1 <b>1</b> 1 1 1
Cargo	00	2283	60	2343	2.6	12-A-6	1,2,4	(8,11,	
	Aft	70	L	70	<u> </u>			12,15)	
Miscella-	Fwd	20		20		Į	]		
neous	<u> </u>	20	]	20	1	12-A-6	1	1	
	Aft	30		30	ļ	L	<u> </u>	<b> </b>	
	Fwd	50	ł	50	4	Į	]	1	
Naval	DO	400	}	400	ļ	12-A-6		1	
	Aft	80		80	ļ	L	<u> </u>	ļ	
	Fwd	80	1	80	1	<b> </b>	1	· ·	
Tanker	DO I	260		260		12-A-6	]		
	Aft	230		230	<b></b>	ļ	<u> </u>	<b>[</b>	4
	Fwd	ł				1			
Naval	Aft	0	10	10	100.0	12 <b>-</b> A-7		5,8	
Bulk	Fwd		[		1				ł
Carrier	Aft	17	3	20	15.0	12-A-8	1	8	
<u></u>	Fwd	50		50	1	12-1-0	<u>↓</u>	+	
373	00	330	ļ	330		12-A-8		1	
Naval	Aft	110		110	l	#2-A-0	(	1	l '
Bulk	Fwd		<b> </b>	+	<u> </u>	╆	<u> </u>	┼╌╌╾	4
Carrier	300	30	ł	30		12-A-9	ļ	}	
Caller	Aft		ļ	50	1	Γ	ł		1 End
Combination		÷	<del> </del>	<u> </u>	{	<del> </del>	<del> </del>	╉━━━━━	¦'.
Carrier	Ø	702	8	710	1.1	12-A-10	1	5,10	
ANT T T GT	Aft		Į			]		ļ .	TOT DE
General	Fwd	<b>†</b>	+	+	<u> </u>	+	<u>+</u>	ţ	1 🔺
Cargo	00	131	27	158	17.1	12-A-10	1,2	10,12,15	
	Aft	1	1		}	1			ļ
Container-	Fwd	4	+	50	<u>+</u>	<b>†</b>	<u> </u>	<u> </u>	
ship	30	470	25	495	5.1	12-B-1	1,2	11	
<b>r</b>	Aft	1	{	220	1	ł		1.	μ <u></u>
General	Fwd		1	1	<u> </u>	<u>†</u>	<u>+</u>	┨╼╼╼╼╼	1 🔺
Cargo	DQ	93	20	113	17.7	12-B-1	2,4	8,12,15	<b>└──</b> ┙
	Aft		1	(	1	1	1	1 -	1

NOTES:

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- (B) The rows labeled aft, 10, 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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- (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 & Shear 13, Questionable
  - 8. Design
  - 9. Fabrication/Workmanship
  - 10. Welding
- 14. Heavy Seas 15. Collision

12. Misuse/Abuse

16. Other - See Discussion

# TABLE A-12 DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON SHIP TYPE		Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number		Failure Cause	
Bulk	Fw								<u></u>
Carrier	X			93	I	12-в-2	}	]	[ <b> </b> ]
Container-	Af								
ship	Fw		<i>(</i>	20					Ì '
SUTD	DQ Af					12-в-2			
General	Fw		·	40					Į
Cargo			1.65	50					
Cargo	<b>30</b> Af		165	336	49.1	12-в-2	1	5,11,16	
	FW		┟─────┤	60			<u> </u>		4
Naval			· · . · ·			l			
Hava1	DO Af			60		12-B-2			
	Fw		├ <b></b>			<u> </u>			
Tanker				30					
TAUVET	Q Af	t 50		50		12 <b>-</b> B-2			<u> </u>
Bulk	Fw			50		ļ			ļ
Carrier	۰ T		ţ	30					
Cartter	Af:	1 1		325		12-в-з			
Combination			<u>├</u>	<u>20</u> 90					
Carrier			ļ	90 270		12. 2. 2			
Cariter	Q Af	190 E	-	270 190		12-B-3			<b></b>
Container-	Fwe		·				·		Ì
ship	00		r l	60				0 14	
aurb	Aft		1 4	898		12-B-3	2,4	8,14,15	
General	Fwd			<u>120</u> 50	3.3	i	1	11,12	
Cargo	00		26	1534	1.7	10_10 0	24	10 15	
Curring C	Aft		20		1./	12 <b>-</b> В-З	2,4	12,15	
Miscella-	Fwd			80 20					
neous	D			30		12-B-3			
	-Aft			30		±2-₽-3			
	Fwc			20					
Naval	Q		ł	20 70		12-B-3			
	Aft			_20	1	±∠-⊅-3		1	
	Fwd			110					
Tanker	00	1 1		210		12 <b>-</b> B-3			
	Aft		ł	210		±2-D-3			
Bulk	Fwd			10		<u> </u>			,
Carrier	Q		ļ	581		12-B-4	-		
	Aft		ĺ	20		±2-D-4			
Combination	Fwd			30					<u> </u>
Carrier	Œ		ļ	70	ļ.	12-B-4			1
Cartter	Aft			60		±2-D-4		1	
Container-	Fwd	the second second second second second second second second second second second second second second second s		20			~~		ļ
ship	Œ	-		30		12-B <b>-4</b>			
F	Aft			30		14- <b>D-4</b>	Ì		
				*****		<del></del>			
General	Fwd	י נון ו							
General Cargo	Fwd		38	10 655	5.8	12-в-4	1,4	(11,12,	

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PANEL STIFFENERS TABLE A-12 DETAIL FAMILY:

LOCATION ON	SHIP	No. of	No. of	Total	Percent			Failure
	1	Sound	Failed	Number	Failures		Mode	Cause
SHIP TYPE		Details	Details	Details		Number		
		Observed	Observed				·	
	Fwd	17	3	20	15.0	12-в-4	1	14
fanker	Aft							
	Fwd	20		20				
Naval	Ø	210		210		12-B-5		
	Aft	40		40				
	Fwd	10		10				
Naval	X	20		20	1	12-в-6	1	1
	Aft	20		20	L		[	<u> </u>
	Fwd	10		10		ļ	]	
Naval	<b>D</b> Aft	1694	6	1700	0.4	12-в-7	2	15
	Fwd	330	[	330	]			
Naval	Ø	3400	1	3400		12-в-8		
	Aft	700		700				
Container-	Fwd							
ship	<b>X</b> Aft	120		120	}	12-C-1	ł	
General	Fwd							
Cargo	Aft	60	10	70	14.3	12-C-1	1	8
	Fwd	10		10		1.		
Tanker	<u>م</u>			[	1	12-C-1	[	<b>·</b>
	Aft	30		30	1			
	Fwd			20				
Naval	DQ.	50		50	1	12-C-2	1	
	Aft	180	1	180	1			
Bulk	Fwd	90		90			,	
Carrier	<b>X</b>	304	3	307	1.0	12-C-3	1	6,8,11
-	Aft			190	1			
Container-	Fwd		1			1		1 .
ship	Aft	596	1	596		12-C-3		
Miscella-	Fwd		+	50			+	
	00	310		310		12-C-3		
neous	Aft			60				
	Fwd	1	+	350	-	1	†	†
Tanker	<b>Q</b> Aft	4882	18	4900 370	0.4	12-C-3	1	7,10

NOTES:

(A) The above continued table gives information related to individual detail designs in the 86 ship survey.

- (B) The rows labeled aft,  $\mathfrak{D}$ , 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

10. Welding

- 7. Combined Tension & Shear
- 8. Design 9. Fabrication/Workmanship
- 13, Questionable
- 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 16. Other See Discussion

TABLE A-12 DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON SHIP TYPE		Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures		Failure Mode	Failure Cause	
Combination	Fwc	1 50		50					-
Carrier	DQ	120		120		12-C-4			
÷	Aft	50		50					le-t
Container-	Fwd	l 50		50	······			·····	
ship	<b>D</b>	300		300		12-C-4			
	Aft	90		90					
Miscella-	Fwd		······································	30			<u> </u>		4
neous	X	230		230		12-C-4			
	Aft			50		-2-U-4			
,	Fwd			240		<u> </u>			┥┃
Tanker	DO	2200		2200		12-C-4			
	Aft			120		12-0-4			·
Bulk	Fwd								4
Carrier	Q Aft	• 96		96		12 <b>-</b> C-5			
General	Fwd								<del>ت مر</del>
Cargo	00		-						
	Aft	68	12	80	15 0	10 6 5		•	
	Fwd		14		15.0	12 <b>-</b> C-5	1,2	14	
Naval				50					
Maval	00 Aft	1000	1	1000		12-C-5	Υ.		$\vdash \vdash$
	Fwd	110		110					1
Tanker		90		90			T		
ranver	00 Aft	740	1	740		12-C-5			┝╼╼┛
Bulk		180		180					
Bulk Carrier	Fwd	30		30					
Carrier	00	358	1	358		12-C-6	ļ		
	Aft	70		70					2
	Fwd	20		20		T			<b></b>
Naval	Q	80		80		12-C-6			
	Aft	30		30					
	Fwd		-						
Tanker	00								<b></b>
	Aft	110		110		12-C-6			
	Fwd	ļ		Т		1			
<b>Fanker</b>	QQ.	400		400		ĺ			П
	Aft	60		60	1:	12-C-7	ĺ		<u></u>
Bulk	Fwd	200		200		<del>_</del>			_
Carrier	<u>30</u>	l i				12-C-8			Π
	Aft	60		60					
	Fwd	30		30		<u>+</u>			
Carrier	Q			-	11	L2-C-8		Į	
	Aft	80		80	. [		ľ	Ī	
Container-	Fwd					····-+			
ship	Ø		ľ	ľ	1				
-	Aft	50		50	,	L2-C-8		ſ	
	Fwd	50		50					
						1			H
Tanker	Q	410	1	410	1 -	L2-C-8	1	1	

TABLE A-12 DETAIL FAMILY: PANEL STIFFENERS

LOCATION ON S	SHIP		No. of	Total	Percent		Failure	Failure Cause	
		Sound	Failed	Number	Failures	- 1	Mode	Cause	
SHIP TYPE		Details	Details	Details		Number			
		Observed	Observed		· · · · · · · · · · · · · · · · · · ·				
	Fwd	60	[	60				(	
Tanker	00	390	1	390		12-C-9		1	
	Aft	80		80		ĺ			E P
	Fwd				]		Į	ļ	
Naval	Ø		r		}				
1.4.7.4.2	Aft	240		240		12-D-1	l		<b>b</b>
Container-	Fwd		[	-					I T
ship	QQ	376	54	430	12.6	12-D-2	1	(8,10,	
21175	Aft		1					14,15)	
	Fwd	20		20	T		[		1 1
Mankar	00	290	1	290	}	12-D-2		ļ	$\vdash \downarrow$
Tanker	Aft	40		40			1	1	
	Fwd	<u> </u>	<del> </del>	<u>↓ · · · · · · · · · · · · · · · · · · ·</u>	<u>+</u>	1	<u>+</u>	1	1
General	1	00	1	80	ł	12-D-3		1	П
Cargo	Aft	80	ł		ł				╽──┺┵
	Fwd	the second second second second second second second second second second second second second second second s	<u> </u>	ł	+	+	+	<u>+</u>	1
Bulk		1		1 10		12-D-4	1		-
Carrier	00	12	}	12	1	12-0-4	1	1	
· · · · · · · · · · · · · · · · · · ·	Aft			<u> </u>		<u> </u>	<u> </u>		
Container-	Fwd						1,2	8,10,15	
ship	Q	1277	92	1369	6.7	12-D-4	1,2	0,10,15	
	Ăft			<u> </u>	<u></u>				4
Combination		70	1	70		12 <b>-</b> D-5			
Carrier	Q			ł					
	Aft	.]	· · · ·		<u> </u>				<b>.</b>
General	Fwd	1		Τ	{	1			1
Cargo	Ø	20		20		12-D-5			
	Aft				1				
Container-	Fwd		1	1	1				] п
ship	Ø	658	8	666	1.2	12-D-6	1,2	8,14	
211Th	Aft		_	1				1	שיבן
Combination				40					1 _
	00				1	12-E-1	{	1	ΙΓ
Carrier	Aft	110	ļ	110	ł			1	
Container-	Fwd		+	· + · · · · · · · · · · · · · · · · · ·				· <u> </u>	1 ▲
		1	1	- 40	1	12-E-1	}	]	
ship	Aft				ł				
	Fwd		-+	•+	+			· <del>[</del> · ···	4
Container-	TWC DD		10	181	5.5	12-E-2	1	12	Π
ship									

NOTES:

- (A) The above continued table gives information related to individual detail designs in the 86 ship survey.
- (B) The rows labeled aft, 10, 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
  - Shear 5.

6. Tension

7. Combined Tension & Shear 8. Design

9. Fabrication/Workmanship

- 13. Questionable
  - 14. Heavy Seas

12. Misuse/Abuse

- 15. Collision
- 10. Welding
- 16. Other See Discussion

TABLE A-	12	DETAIL	FAMILY	PANEL	STIFFENERS
the second second second second second second second second second second second second second second second se	_				

LOCATION ON SHIP TYPE	SHIP	No. of Sound Details Observed	No. of Failed Details Observed	Total Number Details Observed	Percent Failures	Detail Family Number	Failure Mode	Failure Cause	
Container- ship	Fwd	60 80		60 80		12-E-3			
Container-	Aft Fwd	<u> </u>							╎╌╌┸┺╌╴
ship	D Aft	59	l	60	1.7	12-F-1	1	5,10	F
Container- ship	Fwd 00 Aft	69	1	70	1.4	12-F-2	1	15	
Container- ship	Fwd Ø Aft	76	4	80	5.0	12-F-3	1	7,8	
Tanker	Fwd Ø Aft	20 60		20 60		12 <b>-</b> F-4			H
Container- ship	Fwd Ø Aft	143 88	2	143 90	2.2	12-F-5	1	7	

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