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RECREATIONAL BOAT SAFE LOADING - OPERATOR STUDY.(U)

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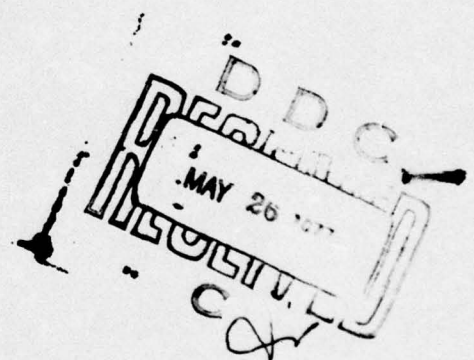
Report No. CG-D-15-77

# RECREATIONAL BOAT SAFE LOADING - OPERATOR STUDY

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DOT USCG

RECREATIONAL BOATING SAFE LOADING - OPERATOR



OCTOBER 1976

FINAL REPORT

Document is available to the U.S. public through the  
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Prepared for

**U. S. DEPARTMENT OF TRANSPORTATION  
UNITED STATES COAST GUARD**

Office of Research and Development  
Washington, D.C. 20590

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16. Abstract This project dealt with the recreational boat operators' role in loading-related accidents. The research was conducted in three interrelated subtasks. The first subtask concerned capacity plates and their use by boat operators. The second subtask identified causes of loading-related accidents and indicated where educational programs may help to prevent such accidents. The third subtask was concerned with identifying operator/owner characteristics that could be related to the excellent boating safety record of one boat manufacturing company.			
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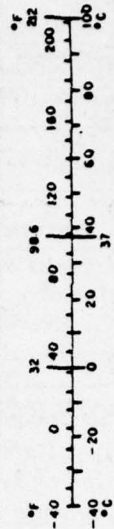
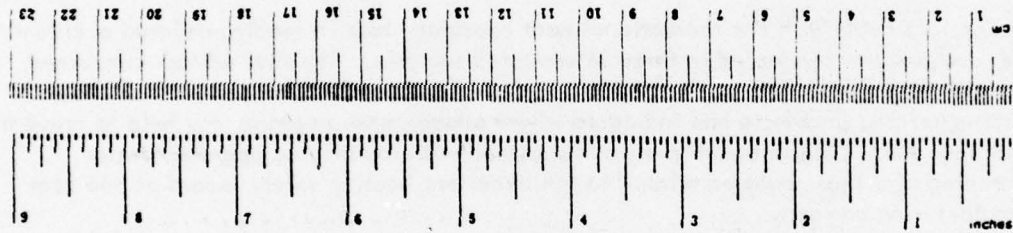
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
<b>AREA</b>				
m <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>
	acres	0.4	hectares	ha
<b>MASS (weight)</b>				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
<b>VOLUME</b>				
teaspoon	teaspoons	5	milliliters	ml
tablespoon	tablespoons	15	milliliters	ml
fluid ounce	fluid ounces	30	milliliters	ml
cup	cup	0.24	liters	l
pint	pint	0.47	liters	l
quart	quart	0.95	liters	l
gallon	gallon	3.8	liters	l
cu ft	cubic feet	0.03	cubic meters	m <sup>3</sup>
cu yd	cubic yards	0.76	cubic meters	m <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

## Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
km	kilometers	1.1	yards	yd
		0.6	miles	mi
<b>AREA</b>				
cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
km <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
ha	hectares (10,000 m <sup>2</sup> )	2.5	acres	
<b>MASS (weight)</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
<b>VOLUME</b>				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m <sup>3</sup>	cubic meters	35	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.3	cubic yards	yd <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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# SAFE LOADING OPERATOR STUDY

## INTRODUCTORY SUMMARY

The subject of this report is the role of the boat operator in safe loading and loading-related accidents. The project was broken down into three interrelated subtasks, all of which were aimed at defining the recreational boat operator's response characteristics towards overloading and loading-related situations.

An "overloading-related accident" is defined as a capsizing, swamping, or flooding which involved a boat that was loaded over its capacity limits as listed by the manufacturer on the capacity plate or as determined by an equation (see Subtask I) which can be used to give a rough estimate of a boat's capacity. Following the definition used by the U.S. Coast Guard Research and Development Center, the term "loading-related accident" will refer to:

Accidents which are related to a recreational boat's stability, freeboard, capacity, and 'motions' characteristics. 'Motions' is defined as a boat's performance while drifting, proceeding on a straight course at moderate speed, slow speed maneuvering or undergoing changes in throttle (on/off plane) or direction in such a manner as to cause suspicion of the boat's ability to react properly to the imposed maneuver.

The first subtask concerned capacity plates and their effectiveness in preventing overloading-related accidents. This subtask was divided into two interrelated studies. The first study was concerned with determining what percentage of boats involved in overloading-related accidents were equipped with capacity plates. The second study involved telephone interviews with boat operators from the general boating population. This data was used to determine the operator's awareness of the capacity limits of their boats.

Based upon the available data, capacity plates have no significant affect on the probability that a boat will be involved in an overloading-related accident. Since there were a large number of "unknown" data within our sample, the result is tentative at best. There are many factors which may contribute to the apparent lack of effectiveness of capacity labels. Further research is needed in order to determine how these factors affect capacity plate effectiveness.

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<sup>1</sup> Reference 2 of Subtask II

The second subtask identified the causes of loading-related accidents and indicated problem areas in which educational programs may help. The first part of this report concerns the causes of loading-related accidents and the role of the operator in the accident situation. The data provided some evidence that operators who have taken a boating safety course are less likely to have loading-related accidents than operators who have not taken a course. The data also indicated that loading-related accidents are more likely to be initiated by a load shift (more specifically, by the action of someone standing up) than any other initiator.

A review of existing educational programs was conducted. Their content was compared to that of typical accident scenarios. The results suggested that more emphasis should be given to safety on the water rather than seamanship and courtesy. More emphasis also needs to be placed on small boats (under 16 ft (4.9 m)), since the operators of such craft are often inexperienced.

The third subtask is concerned with determining if there are any characteristics of operators of a certain line of small craft (Boston Whaler was chosen for this study) that could be responsible for the safety record of that line of small craft. Operators of Boston Whalers and operators from the general boating population (obtained from the Nationwide Boating Survey<sup>2</sup> were interviewed by telephone over a six week period. Both groups, consisting of 100 operators each, were asked questions concerning their:

- general boating knowledge,
- boating experience,
- awareness of safe boating practices, and
- knowledge concerning capacity information and what it means.

Boston Whaler operators were more aware of safety and had more knowledge of boats than the sample of the general boating population.

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<sup>2</sup> Reference 1 of Subtask I.

## SUBTASK I — CAPACITY PLATE AWARENESS STUDY

### 1.0 INTRODUCTION AND SUMMARY

The subject of this subtask is capacity plates and their effectiveness in preventing overloading-related accidents. An overloading-related accident is defined as any accident coded as a capsizing, swamping, or flooding which involved a boat that was loaded over its capacity limits as defined by the manufacturer on the capacity plate or as defined by the equation (see Section 2.0 of this report) which can be used to give a rough estimate of a boat's capacity.

This subtask is divided into two interrelated elements. The first element is concerned with determining what percentage of boats involved in overloading-related accidents was equipped with capacity plates. The second element measures the boat operator's awareness of the capacity limits of his boat.

Three main categories of accidents define overloading-related accidents: 1) capsizings, 2) swampings, and 3) floodings. These may be further divided into the following groups:

- Swamping (due to large wave or wake; no prior flooding),
- Capsizing (with no water prior to capsizing incident),
- Capsizing due to flooding/swamping, and
- Sinking due to swamping (flooding).

For the first subtask element, boats involved in overloading-related accidents in 1973 and 1974 were divided into three categories:

- Boats which should have had labels (boats built during and after 1973 which were less than 20 ft (6.1 m) in overall length),
- Boats which probably didn't have labels (boats built before 1973 and boats over 20 ft (6.1 m) long, and
- Unknown (year or length unknown).

The manufacturers of the boats involved in these accidents which were built before 1973 and less than 20 ft (6.1 m) long were contacted to determine whether the boats had capacity

plates. The percentage of those boats involved in overloading-related accidents which carried capacity labels was then calculated. Statistics were obtained from the Nationwide Boating Survey (Reference 1) and the boating industry to determine the percentage of total boats under 20 ft (6.1 m) in existence which have capacity labels. The percentage of labeled boats involved in overloading-related accidents was compared to the percentage of labeled boats in existence to determine if fewer boats involved in accidents had plates than in the population. This was done with two different estimates of the population percentage.

The second element involved a telephone survey of 100 boat operators obtained from the Nationwide Boating Survey. They were asked questions pertaining to themselves and their boats. Among the questions were:

- Are you aware that your boat has a capacity limit?
- Does your boat have a capacity plate or label?
- Are you aware of what the plate says?
- What does that information mean to you?
- What would your reaction be to social pressure to exceed the capacity limit?

Section 2.0 describes the methods used to obtain the data for the first subtask element and presents the data concerning overloading-related accidents. Section 3.0 presents the pertinent questions and results of the capacity plate awareness study. This is followed by Section 4.0, "Conclusions and Recommendations", Appendix I-A, the Survey Questionnaire, Appendix I-B, Correlation Computations, and Appendix I-C, Compilation of Remaining Questions.

## 2.0 OVERLOADING DETERMINATION

A review of 1973 and 1974 BARs was made and data collected on all overloading-related accidents. When available, the capacity information was taken from the capacity plate and used to determine whether the boat was overloaded. When this information was not available, overloaded boats were determined using the following equation:

$$\text{Integer} \left[ \frac{\text{Length X Beam}}{15} \right] = \text{The maximum number of people the boat can carry}$$

The equation generates an estimate of the persons capacity of a boat, and was not intended to be as accurate as current measurement methods. A correlation was run to determine whether this equation was a good estimate for determining the maximum persons capacity. The compliance test capacities (determined by tests conducted at Wyle) for 159 boats (boats include bass boats, johnboats, runabouts, and dinghies) were compared to the capacities determined by the equation.

The correlation ( $r = 0.85$ ) was statistically significant and indicates that the equation is good enough to estimate maximum persons capacity for certain types of boats. (See Appendix I-B for the correlations for all types of boats and their meaning.)

A total of 243 BAR questionnaires (136 from 1973 and 107 from 1974) were reviewed and the relevant information concerning the boat involved was extracted. The information taken from these reports was: 1) length of boat, 2) manufacturer, and 3) year.

Since most of the BARs did not contain these three important pieces of information, only eighty-two (82) of the BAR questionnaires could be used, i.e., only 33.7% of the BARs contained data concerning the year, length and manufacture of the boat.

The next step was to determine when the manufacturers of these boats involved in overloading-related accidents began attaching capacity plates. This was done by contacting the manufacturers by telephone. A total of forty-seven boat manufacturers were contacted.

The group of eighty-two boats was divided into two categories: 1) those with capacity plates and 2) those without capacity plates. The percentage of labeled boats within this group was then

determined. Next, the labeled boats were treated as a percentage of the total number of boats involved in loading-related accidents in 1973 and 1974. The breakdown of this data is shown in Table I-1.

The true proportion of labeled boats in overloading-related accidents may lie anywhere from 26% (if all unknowns are assumed not to have plates) to 92% (if all unknowns are assumed to have plates).

TABLE I-1. 1973 AND 1974 OVERLOADING-RELATED ACCIDENTS

<u>Category</u>	<u>Number of Boats</u>	<u>Percentage</u>
With Capacity Plate	63	77%
Without Capacity Plate	19	23%
Total for Known Boats	82	100%
With Capacity Plate	63	26%
Without Capacity Plate + Unknowns	180	74%
Total for Known and Unknown	243	100%
With Capacity Plate + Unknowns	224	92%
Without Capacity Plate	19	8%
Total for Known and Unknown	243	100%

Using the statistics from the Nationwide Boating Survey, the total number of recreational boats in existence was estimated (this total excludes inboards, inboard/outdrives, sailboats, canoes, and boats classified as "other"). Since the Nationwide Boating Survey was taken during 1974, it did not contain the total number of boats for 1974; therefore, an estimate of the boats for that year had to be made. This was found by first calculating the percentage that the number of boats manufactured each year decreased from 1971 to 1972 and from 1972 to 1973. Then the mean percentage was calculated. The 1973 total (second column in Table I-2) was multiplied by this mean percentage and the product subtracted from the 1973 boat totals. Table I-2 shows the breakdown, by age, of all recreational boats (including those greater than 20 ft (6.1 m)) starting with boats manufactured in 1974 (as estimated above).

The boats were then divided into three groups: 1) boats built before 1965, 2) boats built between 1965 and 1972, and 3) boats built after 1973. This division was chosen because the

TABLE I-2. TOTAL NUMBER OF RECREATIONAL BOATS IN UNITED STATES <sup>1</sup>

<u>Age of Boats (Years)</u>	<u>Total</u>
1 (1974 boats)	385,678
2	450,575
3	539,758
4	583,466
5	490,097
6 - 8	1,291,136
9 - 11	960,906
12 - 16	684,129
17 - 21	302,057
Over 21	339,317
Total	6,028,119

<sup>1</sup> Nationwide Boating Survey

law requiring a capacity plate on boats did not apply to those boats built before November, 1972. Also, in 1965, the Boating Industry Association began a certification program for its members. Therefore, a certain percentage of the boats built between 1965 and 1972 may have had capacity plates. Table I-3 presents the data for the three groups mentioned above.

TABLE I-3. TOTAL NUMBER OF RECREATIONAL BOATS

<u>Year</u>	<u>Total</u>
Before 1965	1,646,805
Between 1965 and 1972	3,545,061
1973 and 1974	836,253

Of course, the boats less than 20 ft (6.1 m) built after November, 1972, should all have plates. How many of the boats built between 1965 and 1972 have plates?

Out of the 100 boats used in the Nationwide Boating Survey telephone survey, 63 of the boats were built between 1965 and 1972. Of these 63, 43 or 68.3% of the boats had capacity plates. This percentage (called "Survey Pct." below) could be multiplied by the number of boats between 1965 and 1972 in Table I-3 and used in the formula in Figure I-1 to compute the total number of boats built after 1965 which had plates.

$$\begin{aligned}
 \left. \begin{array}{l} \text{Total No. in} \\ \text{Population Built} \\ \text{After 1965} \\ \text{With Plates} \end{array} \right\} &= \text{Boats Built in 1973 and 1974} + \text{Boats Built Between 1965 and 1972} \times \text{Survey Pct.} \\
 &= 836,253 + 3,545,061 (.683) \\
 &= 836,253 + 2,421,276 \\
 &= 3,257,529 \\
 &= 74.4\% \text{ of total population from 1965 to 1974}
 \end{aligned}$$

FIGURE I-1. POPULATION CAPACITY PLATES COMPUTATION

Thus, the data indicate that approximately 75% of the boats built between 1965 and 1974, inclusive, have capacity plates.

In the 82 boats in the accident sample, 14 boats were built in 1973-74, and 13 of those had plates. The other one was a sailboat. Of the remaining 68 boats, the survey percentage indicates that we can expect 68.3% to have plates. Thus, the expected frequency of boats with plates in our sample is  $13 + 68(0.683) = 59$ . If the plates were preventing overloading-related accidents, then the percentage of boats with plates in accidents should be lower than the expected percentage from the population, and the resulting corrected  $X^2$  should be significant. The  $X^2$  statistic ( $X^2 = 0.74$ ,  $df = 1$ ,  $p > 0.25$ ) indicates that there was no statistically reliable difference between the number of boats with plates in overloading-related accidents and the number with plates in the boat population built after 1965. A  $X^2$  analysis also indicates that the population of boats in the accidents was not statistically different from the overall population in terms of the number of boats built prior to or after 1973 ( $X^2 = 0.17$ ,  $df = 1$ ,  $p > 0.50$ ).

	BAR's	
	Observed Frequency	Expected Frequency
With Plates	63	59
Without Plates	19	23
	82	82

A second means of estimating the percentage of the population of boats that have plates is to use the percentage in the telephone sample as the estimate. A comparison was made between the total number of labeled boats involved in overloading-related accidents to the total number of labeled boats from the awareness questionnaire. The first example used only those boats from the awareness questionnaire built after 1965. This comparison includes all boats built prior to and after 1965. A  $\chi^2$  test was used to determine if there was any association between capacity plates and overloading-related accidents. The computations for  $\chi^2$  are as follow:

	Telephone Survey	BAR's	
With Plates	67 (69.77)	63 (60.23)	130
Without Plates	28 (25.23)	19 (21.77)	47
	95	82	177

As before, the  $\chi^2$  analysis ( $\chi^2 = 0.60$ ,  $df = 1$ ,  $p > 0.25$ ) indicated that there was no association between overloading-related accidents and capacity plates. Because of the number of unknowns (180), the result should be regarded as tentative.

A third means of estimating the population of boats that have capacity plates is to use BIA figures. Since 1965, the BIA has had a certification program. The members, who were certified under this program were required to display a capacity plate on their boats. The BIA estimates of how many boats are made by members in their certification program are very close to the 68% of the boats in our survey that have capacity plates. Thus, a new  $\chi^2$  test is not needed, since it would replicate the one on page I-6.

### 3.0 CAPACITY PLATE QUESTIONNAIRE AND DATA

To determine if boat owners were aware of their boats' capacity limits, a telephone interview was conducted over a three week period. From this survey, data were obtained from 100 boat owners. The telephone numbers were taken from the Nationwide Boating Survey. The telephone numbers were selected randomly from those people that owned a boat in 1973. The requirements of the survey were: (1) the person must still own a boat, and (2) the boat must have been used in the last two years. The second requirements was used because the questionnaire had to do with usage of the boat, and it was felt that if the operator had not used his boat for two years, then he would not remember details needed for the survey.

The survey contained questions which provided information about the boat operator and his awareness of his boat's capacity limits. See Appendix I-A for the complete survey.

The first questions concerned the boat operator and his background. The data are shown in Table I-4.

TABLE I-4. BOAT OPERATORS BY AGE, INSTRUCTION, AND EXPERIENCE

Age	Instruction	Experience *
Mean Age — 45 years	Yes — 18%	Under 20 hours — 5%
Median — 44 years	No — 82%	20 to 100 hours — 19%
		101 to 500 hours — 41%
		501 hours or over — 35%

\* Experience is defined as the total number of boat operating hours.

The results of six questions concerning capacity information and the operator's understanding of capacity limits are summarized below:

(1) Are you aware that your boat has a capacity limit?

Yes — 93%  
No — 7%

(2) Does your boat have capacity information such as a label or plate on it?

Yes - 67%

No - 28%

Don't Know - 5%

(3) Do you know what information is given on the capacity plate? \*

Yes - 78%

No - 22%

\* This percentage is based on the number of "yes" answers to No. 2 above.

What is the capacity limit given for:

- 1) Persons \_\_\_\_\_ (this may be given in no. of people or pound
- 2) Horsepower \_\_\_\_\_
- 3) Persons, motor and gear maximum capacity \_\_\_\_\_

If an operator was not able to give at least one detailed answer on the capacity limit for persons, horsepower, or maximum capacity, his answer for question (3) was tabulated as a "no." Of those people who were asked question (3), 48% mentioned a persons capacity, 51% gave a horsepower limit, and 48% gave a capacity for persons, motor, and gear.

(4) What does capacity information mean to you?

- a) The maximum weight or number of people the boat can carry: 53%
- b) Comment about capacity being a safety feature: 31%
- c) Don't know: 16%

(5) Have you ever loaded your boat beyond its capacity limit?

- a) Yes - 10%
- b) No - 90%

- (6) Social pressure question: This was a two-part question - when asked, "How would you react if you discovered that you had more potential passengers for an outing than the capacity limit of your boat?", boat owners replied:
- a) Wouldn't overload, make more than one trip, leave someone behind, or not go: 95%
  - b) Depend on the water conditions: 5%

The second part of the question was asked of those who answered that it would depend on the conditions. The question placed the boater in a hypothetical situation (see Appendix I-A, Question 18) and asked what he would do. The situation posed is that a party of eight plus gear (fishing and skiing) and food must be put in one boat rather than divided between two boats, as planned. When placed in the situation all respondents answered that they would not take all the people at once.

#### 4.0 DISCUSSION OF RESULTS

Based upon the available data, capacity plates have no significant effect on the probability that a boat will be involved in an overloading-related accident. However, since there was a large number of "unknown" data within our sample, the conclusion stated above might be different if these data were available. There is no reason to believe that the proportion of boats within this subsample (unknown data) with capacity plates is similar to that of the "known" subsample. Indeed, depending upon the proportion in the unknowns, our estimation of the percentage of boats with plates in overloading-related accidents could range from 26% to 92%. This is critical. Depending upon this result, the evidence could indicate that capacity plates are preventing accidents, contributing to accidents, or having no effect. Without the data on the unknowns, one simply cannot know which is the case. It is possible that many of the unknowns do not have labels. Good records are kept of boats that are labeled, but few manufacturers keep track of how many boats they don't label. If this were true, then it may mean that there are significantly fewer boats with plates in these accidents; i.e., that plates are more effective than nothing. Does this mean that capacity plates cannot be improved? Of course, the answer is no. During a telephone survey of nighttime collision victims in 1975 (results in MacNeill, "Capacity Plate Effectiveness: Pleasure Boats" (Reference 2)), it was found that a maximum of only two-thirds of the plates were located such that they were easily read. Some plates were in glove boxes, under seats, in storage compartments, under dashboards, on bows, etc. No label, no matter how well it is designed, will be seen if it is in a poor location.

Assuming a good location can be found, the labels themselves can be improved. A lengthy discussion can be found in MacNeill's study of the problem. His work concludes that there are at least eight changes that could be made in capacity plates to improve their design.

The research effort involved in this report raised several questions.

- What causes overloading-related accidents? . . . People do.
- Do people know what their boat's capacity limit is? . . . Generally, yes.
- Do they understand what the limit means?

- Do they know why limits are set?
- Do they care?

The last three questions cannot be adequately answered using a telephone survey technique. Proposed future research will be discussed later.

If the three (including BIA) estimates we computed are used, the indications are that boats with capacity plates are involved in overloading-related accidents just as often as boats without plates. There are many factors, in addition to the unknown data, that may contribute to the apparent lack of effectiveness of capacity labels. Probably the major reason for the apparent ineffectiveness of labels is that they are often not in a visible location. Another factor may be variations in boat exposure with age. Boats built after 1965 could be used more often and out for more hours than boats built before 1965. Of the 97 boats involved in overloading-related accidents whose age was known, 74.3% were boats built after 1965, while only 25.7% were built before 1965. These figures are comparable to the total boat population; 72.7% comprise boats built after 1965, while 27.3% comprise boats built before 1965. Further research is needed to determine whether boat exposure varies significantly with age. Other factors which may be involved include: the length of the boat (some lengths are not required to have labels, and are difficult to overload), characteristics of the operators (age, experience, etc.), and social changes (are more people partaking of leisure activities in groups nowadays?).

Of the 100 people surveyed, only 10% admitted to loading their boat beyond its capacity limit. When these people were put in the hypothetical social pressure situation, 100% said that they would not let all the people go at one time. Since not overloading is a socially desirable response, it is possible that overloading behavior is more prevalent than these figures indicate.

Almost two-thirds of the BARs contained unknowns, while only 5% of the interviews contained unknowns. If the BARs had contained the relevant information (year and manufacturer), more definitive conclusions could be drawn.

## 5.0 PROPOSED FUTURE RESEARCH

One possible method of reducing overloading of pleasure boats is in the area of education, such as:

- Buyer information programs which tell potential boat buyers why capacity limits are set for pleasure craft.
- Dealer motivation programs designed to inform the buyer at the dealer level.
- Manufacturer manuals that stress capacity limits.
- Mass media programs in areas where a high percentage of overloading accidents occur.

To find out more about why operators overload their boats, on-site observations should be taken in geographical areas where a high percentage of overloading-related accidents occur. Photographs could be taken of overloaded boats, especially those that are grossly overloaded, for data analysis purposes. Operators of overloaded boats could be interviewed to find out why they overload their boats.

New and better-designed capacity plates could be installed on selected boats, and the prospective buyers and new owners of these boats could be monitored to determine their attitudes and behaviors. These data could be compared to observations of other boaters to determine if the tendency to overload has been reduced.

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2. MacNeill, Robert F., Capacity Plate Effectiveness: Pleasure Boats, DOT-CG-40672-A; Final report for the U. S. Coast Guard by Wyle Laboratories, July 1975. NTIS AD-A014 094

APPENDIX I-A — SURVEY QUESTIONNAIRE

Hello, my name is \_\_\_\_\_. I'm working for the U.S. Coast Guard on a boating safety program. In April 1974, someone in your household gave us information concerning you and your boat. Do you still own a boat? (If yes, continue with interview. If not used within last two years, end interview and thank them for their time.)

May I speak to the person who operates the boat most of the time? (If this person is not there, find out when it would be convenient to call back and talk to him.) We need to get some more information which was not obtained at that time concerning you and your boat. Your answers will be used only to help us prepare data to assess the effectiveness of capacity plates or capacity information.

NO NAMES WILL BE USED.

The first few questions concern the operator of the boat.

1) What is your age? \_\_\_\_\_

(age)

2) In total, how many hours of boat operating experience do you have?

Would it be: (read list)

- a) under 20 hours \_\_\_\_\_
- b) 20 to 100 hours \_\_\_\_\_
- c) 101 to 500 hours \_\_\_\_\_
- d) 501 or over \_\_\_\_\_

(do not read)

e) unknown or don't know \_\_\_\_\_

3) Have you ever taken a boating safety course?

No \_\_\_\_\_

Yes \_\_\_\_\_ (explain)

(what kind) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

The next questions will concern your boat.

4a) What kind of boat do you own?

Length \_\_\_\_\_

Manufacturer \_\_\_\_\_

Model \_\_\_\_\_

4b) What is the age of your boat?

No. of years or year built \_\_\_\_\_

5a) Is this the first boat that you have owned?

Yes \_\_\_\_\_ (go to no. 6)

No \_\_\_\_\_

5b) How many boats have you owned prior to the one you have now?

No. of boats \_\_\_\_\_

5c) Were these the same type of boat that you now own?

Yes \_\_\_\_\_

No \_\_\_\_\_

5d) What type(s) of boat(s) was (were) it (they)?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

6) What type engine do you have on your boat? (check one)

- Go to  
No. 8
- a) Outboard - Sing'le engine \_\_\_\_\_  
Twin engine \_\_\_\_\_
  - b) Inboard - Gas - Single engine \_\_\_\_\_  
Twin engine \_\_\_\_\_  
Diesel - Single engine \_\_\_\_\_  
Twin engine \_\_\_\_\_
  - c) Inboard/Outboard - Single engine \_\_\_\_\_  
Twin engine \_\_\_\_\_  
Jet drive \_\_\_\_\_
  - d) None (go to no. 7) \_\_\_\_\_

7) What type of propulsion system is used on the boat?

- a) Sail \_\_\_\_\_
- b) Paddles or oars \_\_\_\_\_

8) What is the total horsepower of the boat?

\_\_\_\_\_ (If twin engine, combined horsepower)

9) Who is the manufacturer of the engine?

Name of manufacturer \_\_\_\_\_

Don't know \_\_\_\_\_

10) What material(s) is your boat hull made of?

- a) Fiberglass \_\_\_\_\_
- b) Aluminum \_\_\_\_\_
- c) Wood \_\_\_\_\_
- d) Steel \_\_\_\_\_
- e) Canvas \_\_\_\_\_
- f) Other \_\_\_\_\_ (specify)
- g) Don't know \_\_\_\_\_

11a) During the 1974 boating season about how many times a month was your boat used, on the average?

No. of times \_\_\_\_\_

11b) Of the boating activities in which the people in your household participated in 1974, what percent of the total boating time was spent:

(read list)

Pleasure cruising \_\_\_\_\_

Water skiing \_\_\_\_\_

Recreational fishing \_\_\_\_\_

Hunting \_\_\_\_\_

Racing \_\_\_\_\_

Commercial use \_\_\_\_\_

Skin diving or scuba diving \_\_\_\_\_

Sailing \_\_\_\_\_

Other \_\_\_\_\_ (specify)

12) On the average, about how many persons, including the operator, were carried aboard your boat on a normal outing in 1974?

No. of people \_\_\_\_\_

13a) Are you aware that your boat has a capacity limit?

Yes \_\_\_\_\_

No \_\_\_\_\_

13b) Can you tell just by the way the boat sits or handles in the water if it is overloaded?

Yes \_\_\_\_\_

No \_\_\_\_\_

14a) Does your boat have capacity information such as a label or plate on it?

Yes \_\_\_\_\_

No \_\_\_\_\_ (go to no. 15)

Don't know \_\_\_\_\_ (go to no. 15)

14b) Where is the plate located?

Location of plate \_\_\_\_\_

14c) Do you know what information is given on the capacity plate?

Yes \_\_\_\_\_

No \_\_\_\_\_ (go to no. 15)

14d) What is the capacity limit given for:

1) Persons \_\_\_\_\_ (this may be given in no. of people or poundage)

2) Horsepower \_\_\_\_\_

3) Persons, motor and gear maximum capacity \_\_\_\_\_

15) What does capacity information mean to you?

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16a) Have you ever loaded your boat beyond its capacity limit?

No \_\_\_\_\_ (go to no. 17)

Yes \_\_\_\_\_

16b) What were the circumstances in this situation? \*\*

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\*\* If the circumstances are such that he/she does it all the time and it is a social situation, do not ask Question 17.

17) How would you react if you discovered that you had more potential passengers for an outing than the capacity limit of your boat?

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18) (Social pressure situation)- I would like to place you in a hypothetical situation to find out what you would do? Please answer as best you can.

Suppose that you and a number of friends and relatives have planned an outing for the weekend. The schedule includes picnicing, skiing, fishing and camping. Two boats are to be used, yours and someone else's. According to plan, you and seven members of the party meet at the launch site, but the person with the other boat fails to show up at the scheduled time.

Now the area where the picnic is going to be is accessible only by boat and is approximately 16 miles from the launch site. You and your party have all the food, the skiing equipment and the fishing gear.

You plan to take some of the members to the area, then come back and pick up the rest of the party, but they don't want to do that. The other people want to go all at the same time. If you take all the people at one time, you will be overloading your boat.

Would you take all of the people at once?

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19a) Was anyone in your household involved in an accident of any kind while operating a boat in the last five years?

Yes \_\_\_\_\_ (go to no. 19b)

No \_\_\_\_\_ (go to no. 22)

Don't know \_\_\_\_\_

19b) Describe the accident?

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(Get person to give information on time, weather, water conditions, where it occurred, how it happened, etc.)

If the accident was a capsizing or swamping, go to Question 20a.

If it is another type of accident, go to Question 21a.

20a) How many people, including the operator, were aboard the boat at the time of the accident?

No. of people \_\_\_\_\_

20b) How much equipment was aboard the boat at the time of the accident?

Weight in lbs \_\_\_\_\_

21a) How many people wound up in the water? (If none go to no. 22)

\_\_\_\_\_ # of People

<u>Person *</u>	<u>Age</u>	<u>Sex</u>	<u>Holding Or Wearing PFD</u>	<u>When PFD Secured</u>
1	—	—	—	—
2	—	—	—	—
3	—	—	—	—
4	—	—	—	—
5	—	—	—	—
6	—	—	—	—

\* If more than 6, use back of page.

Code:      Age:      Adult (A) 20 or over  
                             Teenager (T) 13-19  
                             Child (C) 0-12

Sex:      Male (M)  
                     Female (F)

Holding (H)  
 Wearing(W)

When secured:      After in water (A)  
                                     Before in water (B)

(Place appropriate letter in blank)

21b) How many had life preservers or some flotation device? (If none go to No. 22)

\_\_\_\_\_ # of people.

21c) Can you tell me how many people were wearing them or holding them?

21d) When did each of those using a life preserver put it on or grab it?

21e) After the accident, was the boat or any part of it floating?

Yes \_\_\_\_\_

No \_\_\_\_\_ (Go to No. 22)

21f) Did anyone hold on to it? For how long? What happened?

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22) When you go out in the boat, what do you do with your life jackets?

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23) (Ask if PFD's not worn) What kind of situation would induce you to wear a life jacket or tell the other people on the boat to wear life jackets? (Get example.)

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The next few questions do not apply to boating, but to automobile operation.

24a) In the last five years have you had any automobile accidents?

Yes \_\_\_\_\_ (go to no. 24b)

No \_\_\_\_\_ (go to end of interview)

24b) How many?

No. of accidents \_\_\_\_\_



APPENDIX I-B  
CORRELATIONS

<u>Boat Types</u>	<u>Correlations</u>	<u>Sample Size</u>	<u>Significance</u>	<u>Percent of Variance Accounted For</u>
All	$r = 0.85$	$N = 159$	$t = 20.22, df = 157, p < 0.001$	72
Type 1 - Bass Boat	$r = 0.87$	31	$t = 9.50, df = 29, p < 0.001$	76
Type 2 - Johnboat	$r = 0.96$	13	$t = 11.37, df = 11, p < 0.001$	92
Type 3 - V Runabout	$r = 0.65$	42	$t = 5.41, df = 40, p < 0.001$	42
Type 4 - W Runabout	$r = 0.80$	58	$t = 9.98, df = 56, p < 0.001$	64
Type 5 - Cabin	none possible	1	—	—
Type 9 - Dinghy	$r = 0.52$	6	$t = 1.22, df = 4, p > 0.10$	27
Type 10 - V Johnboat*	$r = 0.73$	8	$t = 2.62, df = 6, p < 0.05$	53

\* Semi-V, lightweight boat

Thus, all of the correlations are significantly different from  $\rho = 0$  except for dinghys. Thus, the use of the formula in Section 2.0 to determine whether or not a boat was overloaded is not unreasonable. However, the formula was used for research purposes and this is not to be confused with compliance testing. In compliance testing, the problem is more like that of quality control, and the capacities are measured more precisely in order to determine the true compliance capacity. Indeed, the formula, although it correlates very highly with compliance test results, overestimates the compliance capacity for nearly three quarters of the boats tested, as shown below. Thus, the formula is adequate for research use, but not for compliance testing. Since it tends to overestimate capacities when it is off, the data concerning the frequencies of overloading contained in this report may underestimate the true magnitude of the problem.

<u>Boat Types</u>	<u>Number of boats where the formula capacity &gt; compliance capacity</u>
All boats	116
Type 1 - Bass Boat	24
Type 2 - Johnboat	13
Type 3 - V Runabout	32
Type 4 - W Runabout	35
Type 5 - Cabin	0
Type 9 - Dinghy	5
Type 10 - V Johnboat*	7

\* Semi-V, lightweight boat

APPENDIX I-C  
COMPILATION OF REMAINING QUESTIONS

1. Length of boat.

Mean	15 ft
Mode	14 ft
  
2. Age of boat.

Mean	7.49 years
Mode	6.00 years
  
3. Is this the first boat that you have owned?

Yes	32%
No	68%
  
4. How many boats have you ever owned?

Median	2.78
Mode	1.00
Mean	3.22
  
5. Were these the same type of boat that you now own?

Yes	42.6% (29)
No	57.4% (39)
  
6. What type engine do you have on your boat?

Outboard	
Single	95%
Twin	2%
Manual	3%
  
7. What is the total horsepower of the boat?

Mean	36 hp
Mode	10 hp
  
8. What material(s) is your boat hull made of?

Fiberglass	40%
Aluminum	48%
Wood	12%

9. During the 1974 boating season, about how many times a month was your boat used, on the average?
- |      |     |
|------|-----|
| Mean | 7.1 |
| Mode | 2.0 |
10. Boating activities - percent of the total boating time (mean percentage).
- |                      |     |
|----------------------|-----|
| Pleasure cruising    | 56% |
| Water skiing         | 45% |
| Recreational fishing | 82% |
| Other                | 25% |
11. Number of people carried aboard boat on normal outing.
- |      |      |
|------|------|
| Mean | 2.87 |
| Mode | 2.00 |
12. Was anyone in your household involved in an accident of any kind while operating a boat in the last five years?
- |     |      |
|-----|------|
| Yes | 0%   |
| No  | 100% |
13. PFD usage — two questions: What do you do with your life jackets when in the boat, and what kind of situation would induce you to wear a life jacket?
- |   |     |
|---|-----|
| Wears them all the time                   | 28% |
| Uses cushions                             | 11% |
| Wears only in rough water                 | 39% |
| Makes children and non-swimmers wear them | 22% |
14. In the last five years, have you had any automobile accidents?
- |     |      |
|-----|------|
| Yes | 0%   |
| No  | 100% |

## SUBTASK II — EDUCATION STUDY

### 1.0 INTRODUCTION

The main purposes of this subtask were to:

- identify causes of loading-related accidents, conditions associated with an accident, and characteristics of the accident victims and their boats,
- identify areas where educational programs could have helped to prevent the accidents, including those human operator responses which are repeatedly involved in loading-related accidents; and,
- identify areas where two of the current educational program texts deal with loading-related accident causes.

Boating accidents result from a combination of three components: the boat, the environment, and the operator. This subtask concentrates on the causes of loading-related accidents and the role that operator education could play in preventing or recovering from these accidents.

The data for this subtask were gathered from several sources: boating accident reports (BARs), Nationwide Boating Survey (Reference 1), U.S. Coast Guard Auxiliary, and U.S. Power Squadron educational material. Reports of 261 loading-related accidents from 1969 and 1973 were reviewed and analyzed relative to the objectives outlined above. The data indicated that operators involved in loading-related accidents are no more or less likely to have had a boating safety course than operators from the general boating population. Operators who have taken a boating safety course and had a fatal accident tended to have more boat operating exposure.

Other results included:

- the most frequent initiator of a loading-related accident is a load shift (127 accidents compared to the next most frequent initiator, waves, with 72 accidents); many of these accidents involved a person standing up;
- the review of two boating safety course texts indicated that more emphasis can be given to safety in smaller craft (under 16 ft (4.9 m)) in those texts; and,
- the operators in loading-related accidents were found to be different in terms of their age and boating experience: comparisons were made with the population of operators in the Nationwide Boating Survey.

The findings of the present study are organized into four sections. Section 2.1 discusses the conditions and events which lead to loading-related accidents. The analysis began by classifying contributors into two categories: (a) pre-accident conditions, or (b) accident initiators. The relative incidence of conditions and initiators was discussed. The next section (2.2) reviews the characteristics of the people involved in loading-related accidents and comparisons are made to the general boating population. Section 2.3 discusses boating safety instruction and the incidence of loading-related accidents. This is followed by Section 3.0 which presents the conclusions of the study.

## 2.0 METHOD AND RESULTS

Data for this study resulted from 261 detailed BAR questionnaires concerning loading-related accidents selected for study by the USCG R and D Center (Reference 2). The R and D Center used the following definition of a "loading-related accident":

Accidents which are related to a recreational boat's stability, freeboard, capacity, and 'motions' characteristics. 'Motions' is defined as a boat's performance while drifting, proceeding on a straight course at moderate speed, slow speed maneuvering or undergoing changes in throttle (on/off plane) or direction in such a manner as to cause suspicion of the boat's ability to react properly to the imposed maneuver.

The questionnaire data were pulled from 1969 and 1973 BARs of loading-related accidents, and filled out by personnel at the R and D Center. For this study, these 261 loading-related accidents were classified into one of four groups:

1. capsizing,
2. swamping leading to capsizing,
3. swamping, or
4. falls overboard.

The reader will recall from Subtask I that loading-related accidents were defined as all accidents where the load (amount or distribution) was a factor, while overloading-related accidents included the subset of loading-related accidents where the boat was loaded beyond its known or estimated capacity.

### 2.1 Characteristics of Loading-Related Accidents

#### 2.1.1 Loading-Related Accidents and Major Accident Variables

The 261 loading-related accidents were categorized to determine what type of accident is the most frequent. Table II-1 shows the breakdown of the accidents. According to the 261 accidents reviewed, the most prevalent loading-related accidents are capsizings (112 accidents or 42.91%) followed by falls overboard (62 accidents or 23.75%).

TABLE II-1. FREQUENCIES OF VARIOUS ACCIDENT TYPES  
IN A SAMPLE OF 261 LOADING-RELATED ACCIDENTS

ACCIDENT TYPE	ACCIDENTS	
	NUMBER	PERCENTAGE
Capsizing	112	42.91
Swamping Leading to Capsizing	59	22.61
Swamping	28	10.73
Falls Overboard	62	23.75
TOTALS	261	100.00

According to CG-357 — 1974 (Reference 3), capsizings (N = 788) are the most frequent type of loading-related accident followed by falls overboard (N = 362). Thus, the rates of capsizings and falls overboard in the selected accidents correspond well with the rates in CG-357. For more than 15 years, the two dominant types of loading-related accidents have been capsizings and falls overboard.

Table II-2 shows the frequencies of loading-related accidents by kind of accident and boat type. The boat type most often involved in loading-related accidents is lightweight boats (114 accidents or 43.68% of all accidents). Of the 114 lightweight boats involved in these accidents, all but one were under 16 ft (4.9 m) in length. The lightweight boats also accounted for the highest frequency of capsizings (53 accidents or 47.32% of all capsizings). Runabouts accounted for the highest frequency of falls overboard (25 accidents or 40.32% of all falls overboard accidents).

TABLE II-2. FREQUENCY OF LOADING-RELATED ACCIDENTS  
BY ACCIDENT TYPE AND BOAT TYPE  
(FROM A SAMPLE OF 261 ACCIDENTS)

ACCIDENT TYPE	BOAT TYPE					TOTAL
	CANOE	LIGHTWEIGHT	RUNABOUT	OTHER	UNKNOWN	
<u>Capsizing</u>						
Number	25	53	14	18	2	112
Percent	9.58*	20.31	5.36	6.90	0.77	42.91
<u>Swamping Leading to Capsizing</u>						
Number	2	33	14	10	0	59
Percent	0.77	12.64	5.36	3.83	0	22.61
<u>Swamping</u>						
Number	2	10	9	6	1	28
Percent	0.77	3.83	3.45	2.30	0.38	10.73
<u>Falls Overboard</u>						
Number	2	18	25	17	0	62
Percent	0.77	6.90	9.58	6.51	0	23.75
<u>Totals</u>						
Number	31	114	62	51	3	261
Percent	11.88	43.68	23.75	19.54	1.15	100.00

\*Where  $9.58 = \frac{25}{261}$ , N = 261.

Definitions of Boat Categories:

Canoes - Aluminum, fiberglass, or wood

Lightweight - Typically aluminum hull, flat or semi-V bottom with outboard power

Runabout - Outboard, I/O, inboard, and ski boat

Other - Dinghy, cabin motorboat, rowboat, heavy skiff, and boats coded as "other"

Data concerning the operation of the boat at the time of the accident are tabulated in Table II-3. This table contains data categorized under the two major loading-related accident types: 1) capsizing/swamping accidents, and 2) falls overboard accidents. The table shows the breakdown by number and percentage for each operation according to each accident type category and the totals.

As can be seen from Table II-3, the highest percentage of capsizing/swamping accidents took place while the boat was drifting (54 accidents or 27.14%). However, the highest percentage of falls overboard accidents occurred while the boat was operating at normal planing speed (24 accidents or 38.71%). Falls overboard accidents apparently occurred often while the boat was moving relatively fast (normal planing/mode of operation). On the other hand, capsizing/swampings occurred frequently under conditions where the boat was relatively immobile (anchored or drifting/mode of operation).

As mentioned previously, CG-357 for 1974 indicates that capsizing/swampings and falls overboard are major categories of loading-related accidents leading to fatalities. Of the 753 people involved in the 261 sampled accidents, 329 (43.69%) were fatalities. These were categorized to determine fatalities by kind of accident and boat type. Table II-4 shows these data. The highest number of fatalities for this kind of accident were the result of capsizings (137 fatalities or 41.64% of all fatalities). The most fatalities occurred in accidents involving lightweight boats (142 fatalities or 43.16% of all fatalities).

Table II-4 also reveals that the fatality data matches the frequency of accident data from Table II-2 (i.e., the highest number of accidents for falls overboard involved runabouts, and fatalities from falls overboard most frequently involved runabouts; the highest number of accidents for capsizings and swampings involved lightweight craft and fatalities from capsizings and swampings most frequently involved lightweight craft).

### 2.1.2 Loading-Related Accidents and Pre-Accident Parameters

In order to evaluate educational programs and loading-related accident causes, a more detailed analysis was needed. A loading-related accident cause analysis tree was developed as outlined

TABLE II-3. OPERATION OF THE BOAT AT TIME OF ACCIDENT  
(FROM A SAMPLE OF 261 ACCIDENTS)

OPERATION	ACCIDENT TYPE					
	CAPSIZING/SWAMPING		FALLS OVERBOARD		TOTAL	
	Number	Percent	Number	Percent	Number	Percent
High Speed	2	1.01*	5	8.06**	7	2.68***
Normal Planing	15	7.54	24	38.71	39	14.94
Transition (On/Off Plane)	7	3.52	1	1.61	8	3.07
Drifting	54	27.14	14	22.58	68	26.05
Rowing or Paddling	31	15.58	3	4.84	34	13.03
Displacement Mode	41	20.60	6	9.68	47	18.01
Anchored	28	14.07	6	9.68	34	13.03
Backing Down	3	1.51	0	0.00	3	1.15
Other	6	3.02	2	3.23	8	3.07
Unknown	12	6.03	1	1.61	13	4.98
TOTALS	199	100.00	62	100.00	261	100.00

\*Where  $1.01 = \frac{2}{199}$

\*\*Where  $8.06 = \frac{5}{62}$

\*\*\*Where  $2.68 = \frac{7}{261}$

TABLE II-4. NUMBER OF PEOPLE AND FATALITIES INVOLVED IN LOADING-RELATED ACCIDENTS BY BOAT AND ACCIDENT TYPE (FROM A SAMPLE OF 261 ACCIDENTS)

ACCIDENT TYPE	BOAT TYPE						TOTAL ALL PEOPLE	TOTAL FATALITIES
	LIGHTWEIGHT	RUNABOUT	CANOE	OTHER	UNKNOWN			
<u>Capsizing</u>								
Total People								
Number	119*	51	67	56	3	296		
Percent	15.80	6.77	8.90	7.44	0.40	39.31		
Fatalities								
Number	60**	21	30	24	2	137***	137****	
Percent	18.24	6.38	9.12	7.29	0.61	18.19	41.64	
<u>Swamping</u>								
Total People								
Number	36	32	4	18	5	95		
Percent	4.78	4.25	0.53	2.39	0.66	12.62		
Fatalities								
Number	17	15	2	7	1	42	42	
Percent	5.17	4.56	0.61	2.13	0.30	5.58	12.77	
<u>Swamping Leading to Capsizing</u>								
Total People								
Number	115	61	4	35	0	215		
Percent	15.27	8.10	0.53	4.65	0	28.55		
Fatalities								
Number	47	20	3	13	0	83	83	
Percent	14.29	6.08	0.91	3.95	0	11.02	25.23	

TABLE II-4 (concluded). NUMBER OF PEOPLE AND FATALITIES INVOLVED IN LOADING-RELATED ACCIDENTS BY BOAT AND ACCIDENT TYPE (FROM A SAMPLE OF 261 ACCIDENTS)

ACCIDENT TYPE	BOAT TYPE						TOTAL ALL PEOPLE	TOTAL FATALITIES
	LIGHTWEIGHT	RUNABOUT	CANOE	OTHER	UNKNOWN			
<u>Falls Overboard</u>								
Total People								
Number	30	72	2	43	0	147		
Percent	3.98	9.56	0.21	5.71	0	19.52		
Fatalities								
Number	18	28	2	19	0	67	67	
Percent	5.47	8.51	0.61	5.78	0	8.90	20.36	
<u>TOTALS</u>								
People on Board								
Number	300	216	77	152	8	753		
Percent	39.84	28.69	10.23	20.19	1.06	100.00		
Fatalities								
Number	142	84	37	63	3	329	329	
Percent	43.16	25.53	11.25	19.15	0.91	43.69	100.00	

\*  $\frac{119 \text{ POB}}{753 \text{ total POB in accidents selected}} = 15.80\%$

\*\*  $\frac{60 \text{ fatalities}}{329 \text{ total fatalities in accidents selected}} = 18.24\%$

\*\*\*  $\frac{137 \text{ total capsizing fatalities}}{753 \text{ total POB in accidents selected}} = 18.19\%$

\*\*\*\*  $\frac{137 \text{ total capsizing fatalities}}{329 \text{ total fatalities in accidents selected}} = 41.64\%$

below to enable answers to questions such as, "In what kind of conditions do loading-related accidents occur?" The accidents were grouped according to the following pre-accident parameters:

- Boat Type
  - Under 16 ft (4.9 m)
  - Sixteen ft (4.9 m) and over
- Water Conditions
  - Choppy - Choppy water (hazardous) was defined as any water condition marked on the BARs as "choppy," "rough," "very rough," or "strong current." These categories were given by the people involved in the accidents when the BARs were filled out.
  - Calm water (non-hazardous)
- Load Amount

Load amount was defined as dependent upon three things: estimation of the boat's load prior to the accident, estimation of the capacity of the boat and the water conditions prior to the time of the accident. Water conditions were relevant only when the estimations of boat load and boat capacity were very close (within 75 lb (34 kg)).

  - Overloaded: when estimations of the actual boat load and boat capacity were within 75 lb (34 kg) and the water conditions were hazardous.
  - Not overloaded: when the differences in estimations of the actual boat load and boat capacity exceeded 75 lb (34 kg).
- Load Distribution

Load distribution was defined as a pre-accident condition.

  - Balanced: when there was no specific evidence given in the BAR that the load distribution was not balanced.
  - Unbalanced: when BAR narratives indicated the boat was unbalanced prior to the accident.

- Resulting Accident Type
  - Capsizing
  - Swamping Leading to Capsizing
  - Swamping
  - Falls Overboard

The subsequent analyses were based upon combinations of boat type, water conditions, load amount, load distribution and accident type (capsizing, swamping leading to capsizing, swamping and falls overboard). Figures II-1, II-1(a) and II-1(b) show the frequencies by all loading-related accidents, capsizing/swamping accidents (capsizing, swamping, and swamping leading to capsizing), and falls overboard accidents, respectively.

Frequencies at higher nodes of the analysis trees may be greater than the sum of frequencies at lower nodes because BAR data was incomplete for accidents. In Figure II-1, the box labeled "Accidents" shows 261 total accidents were reviewed; however, only 234 boats were coded at the next level in the tree, "Boat Type." This is because the boat type was unknown for the boats involved in 27 accidents and these accidents were dropped from the tree at this point.

The most frequent pre-accident conditions in loading-related accidents regardless of boat size were choppy water conditions, not overloaded, and balanced load distribution. The results were the same for capsizing/swamping accidents, but were slightly different for falls overboard. Here, the results were the same for the 16 ft (4.9 m) and over group, but for the under 16 ft (4.9 m) group the most frequent combination was calm, not overloaded, and balanced. In all these accident types, there were many accidents for the under 16 ft (4.9 m) group in calm water.

### 2.1.3 Loading-Related Accidents and Accident Initiators

The previous analyses determined the most frequent pre-accident parameters. The question arises, "What initiates an accident?"

Two separate, yet similar, fault trees were designed for capsizing/swamping accidents and falls overboard accidents. The initiators were grouped under four major categories:

- Load Shift
- Wave
- Wake
- Sudden Maneuver

Figures II-2 and II-4 summarize capsizing/swamping and falls overboard accidents according to accident initiators and boat size (all boats, boats less than 16 ft (4.9 m), and boats 16 ft (4.9 m) and over). The fault trees in Figures II-3 and II-5 define the precise accident initiators for accident categories and for boat length. As in the pre-accident parameter tree, insufficient data on some BARs prevented coding beyond certain levels in the fault trees.

As can be seen from Figure II-3, the most frequent initiator of capsizing/swampings is a load shift of some type. The results are similar for the boats less than 16 ft (4.9 m) (Figure II-3(a)), but vary considerably for boats 16 ft (4.9 m) in length and larger (Figure II-3(b)). The most frequent initiator in the larger boats was waves. Frequent causes of capsizings for all boats were persons changing positions or leaning over the side.

All of the figures in the II-5 series show the fault trees for falls overboard. Overall, load shifts accounted for 61.29% of the falls overboard, with sudden maneuvers accounting for an additional 16.13%. The load shift accidents often involved people standing or changing positions on the boat. These activities were undertaken usually in order to work on or start the motor, urinate, or lean over the side for some reason. The only sudden maneuver leading to a fall overboard was turning the boat. Often, the operator was not standing when operating the boat and yet he fell overboard.

Of the 68 capsizing/swamping accidents caused by waves, hazardous weather was a factor in 26 (38%) of the accidents. Of the four falls overboard accidents, two (50%) were related to hazardous weather. Table II-5 shows the breakdown by types of hazardous weather.



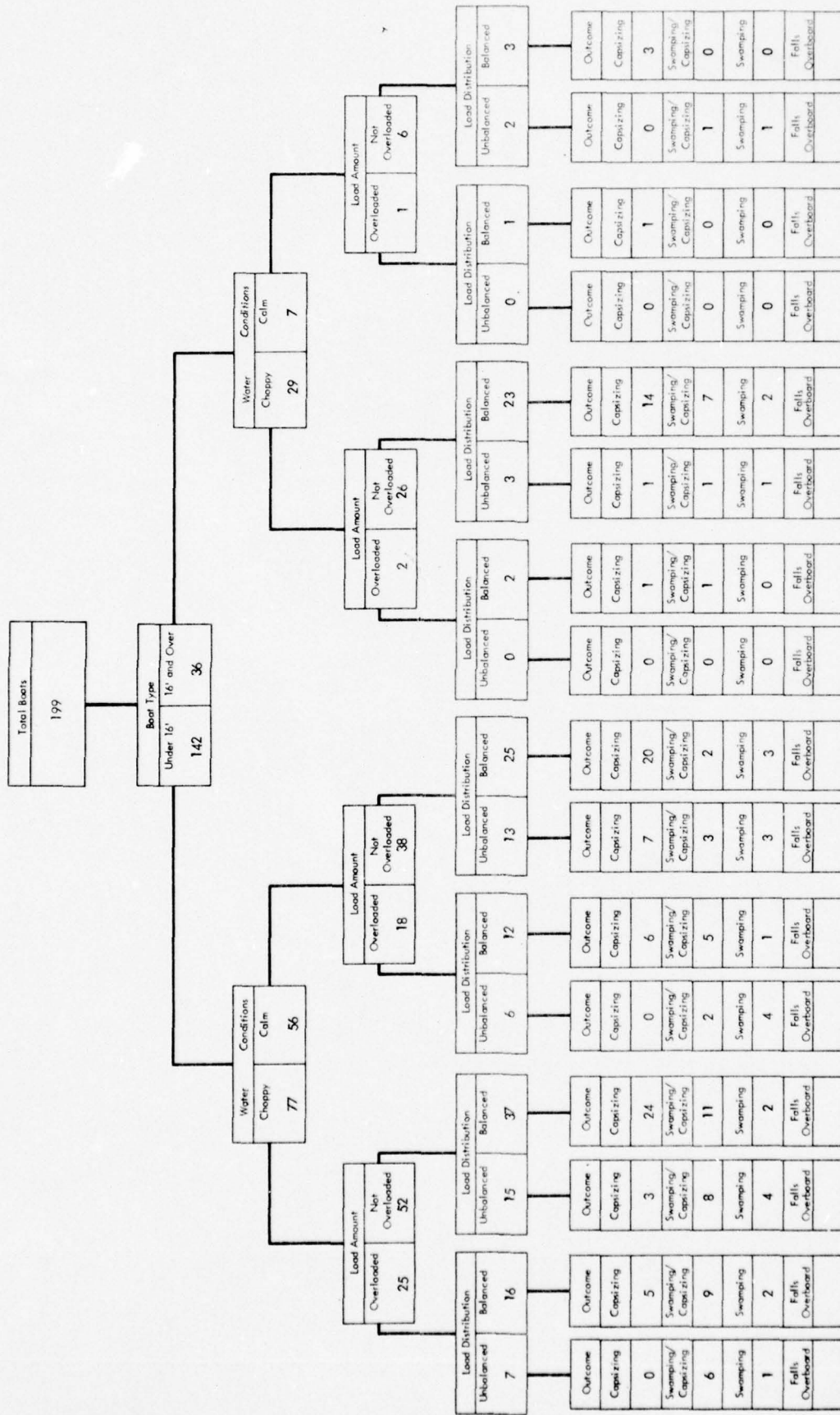


FIGURE II-1(a). CAPSIZING/SWAMPING ACCIDENTS — FREQUENCY OF COMBINATIONS OF PRE-ACCIDENT PARAMETERS

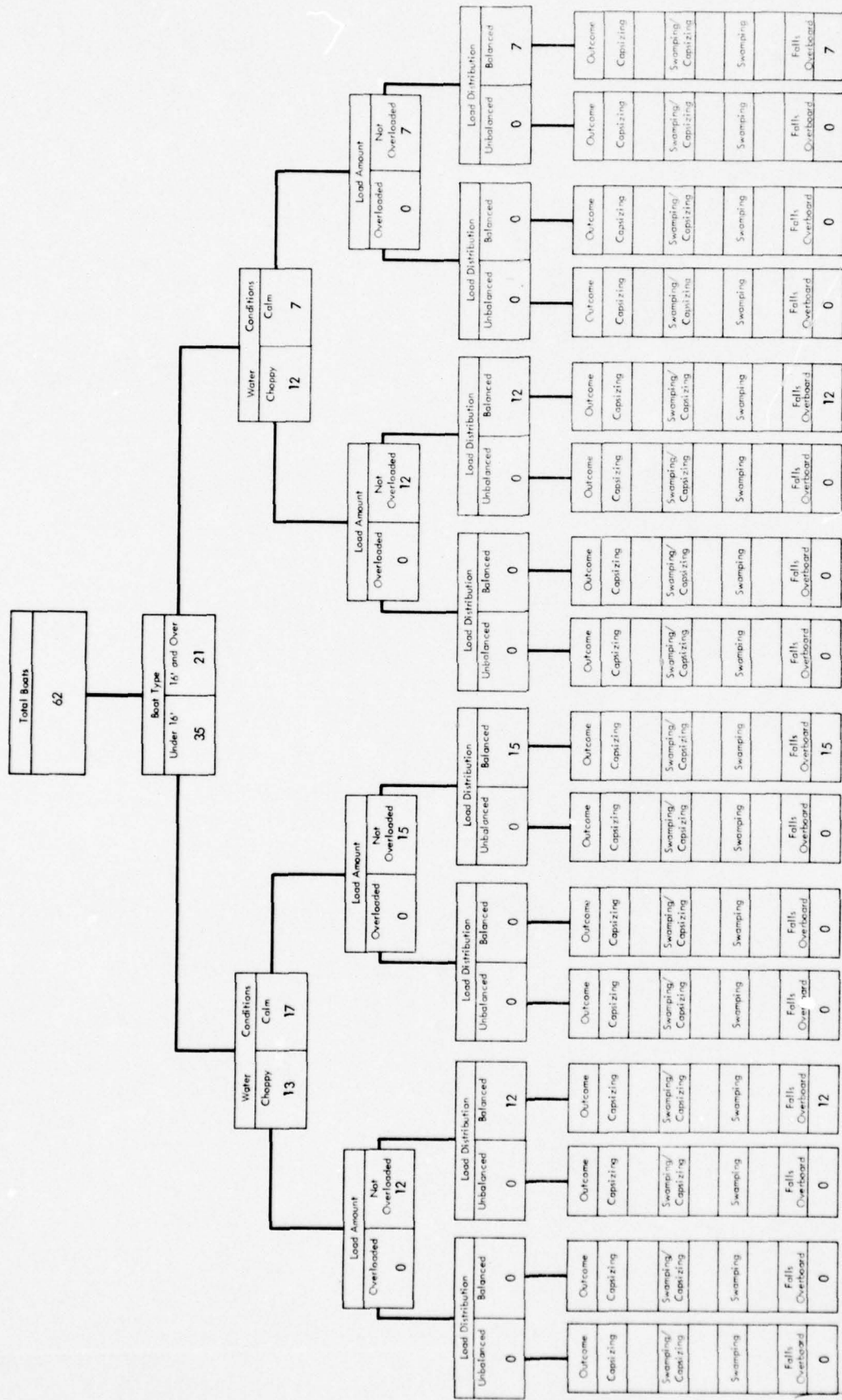


FIGURE 11-1 (b). FALLS OVERBOARD ACCIDENTS — FREQUENCY OF COMBINATIONS OF PRE-ACCIDENT PARAMETERS

ALL BOATS
  BOATS UNDER 16 ft (4.9 m)
  BOATS 16 ft AND OVER (4.9 m)

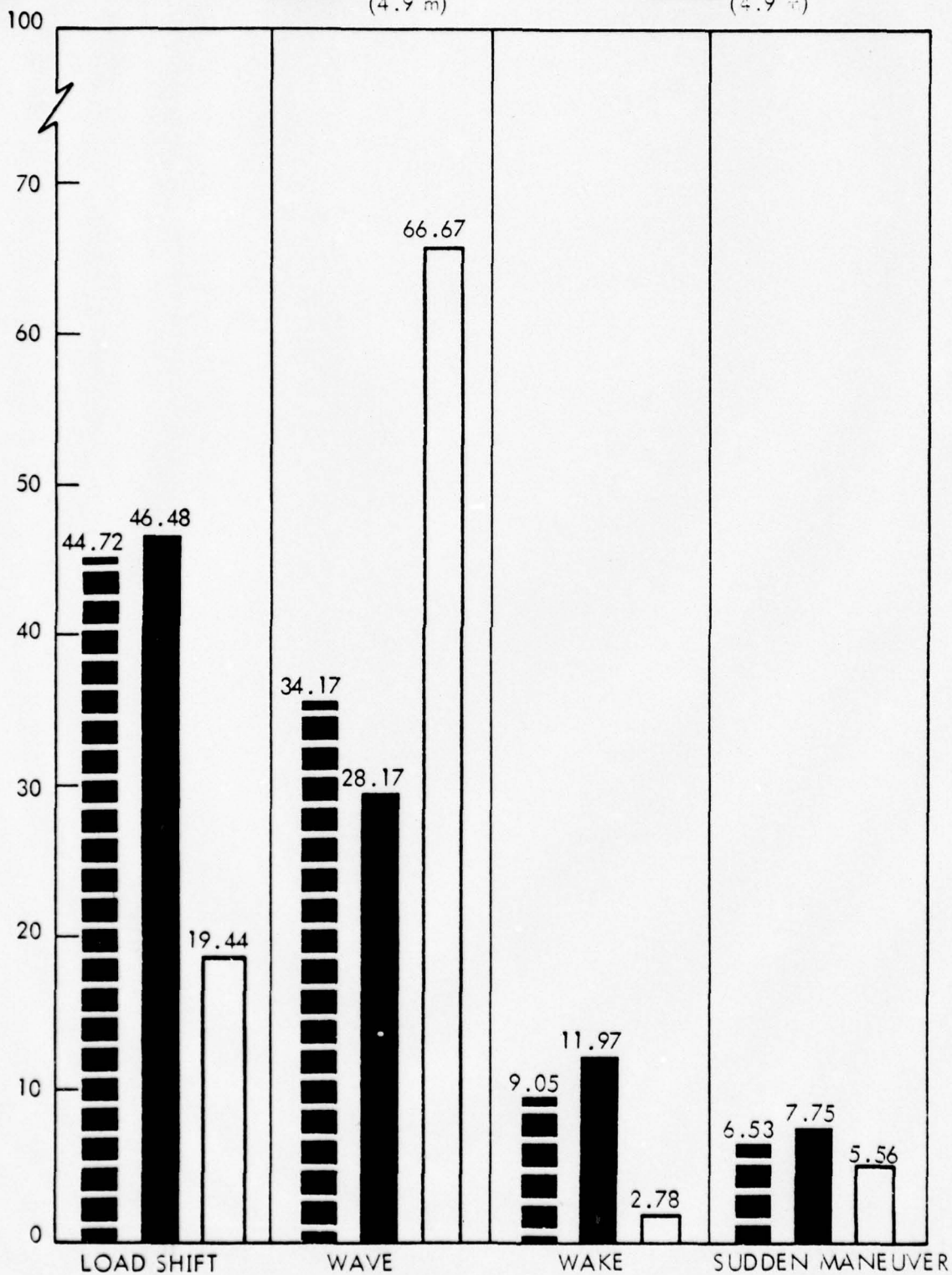


FIGURE II-2. PERCENTAGES OF OCCURRENCES OF ACCIDENT INITIATORS GROUPED BY MAJOR INITIATOR FOR CAPSIZING/SWAMPINGS

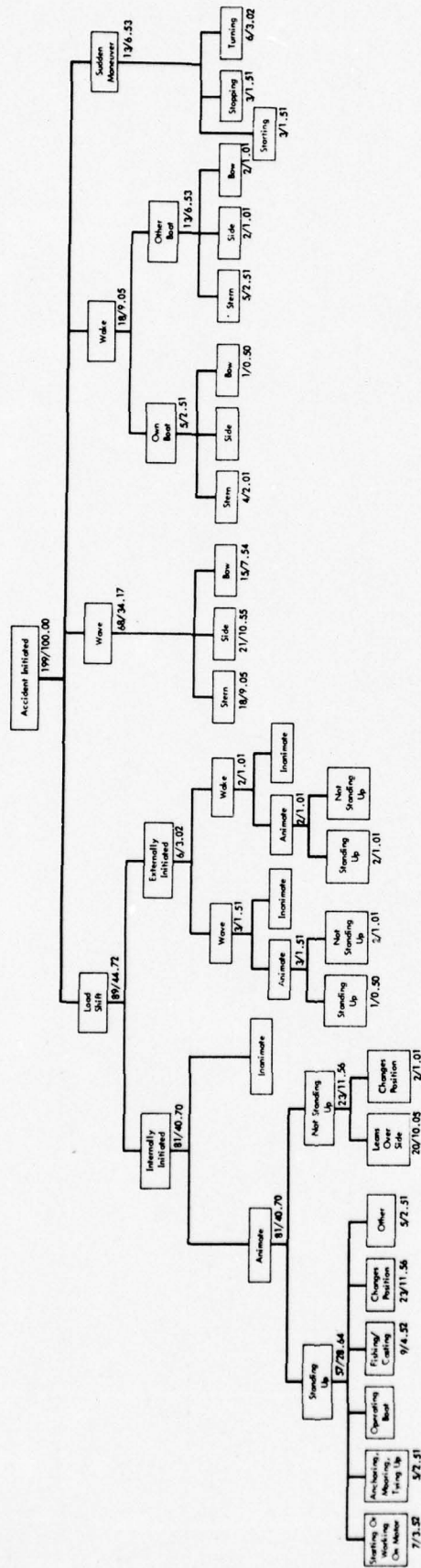


FIGURE II-3. FREQUENCY OF OCCURRENCES OF ACCIDENT INITIATORS INVOLVING ALL BOATS RESULTING IN A CAPSIZING/SWAMPING

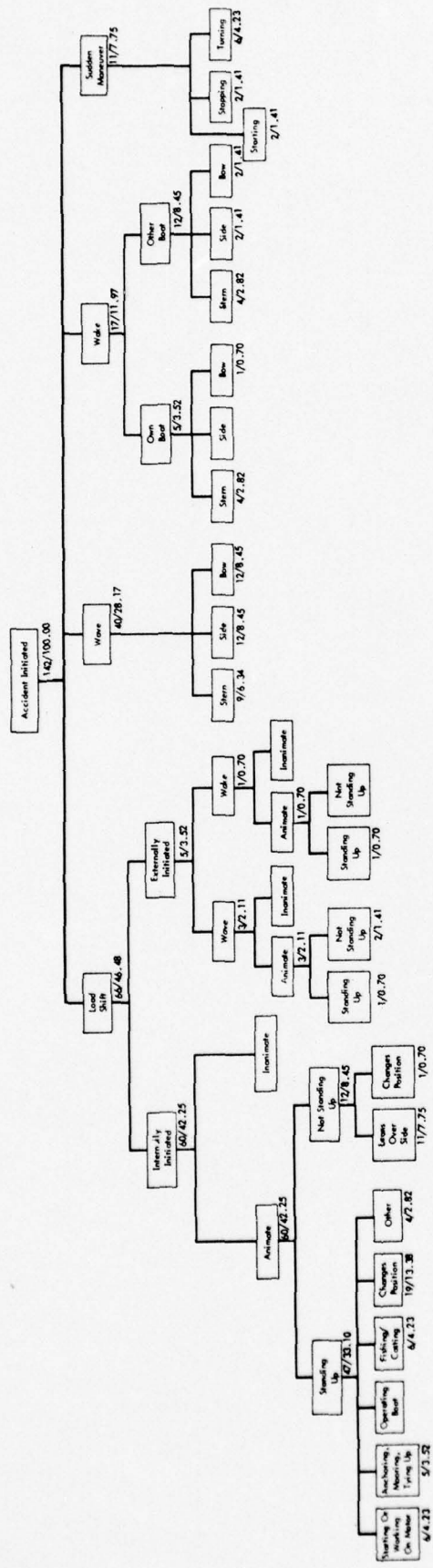


FIGURE II-3(6). FREQUENCY OF OCCURRENCES OF ACCIDENT INITIATORS INVOLVING BOATS UNDER SIXTEEN FEET (4.9 M) RESULTING IN A CAPSIZING/SWAMPING

II-23/24

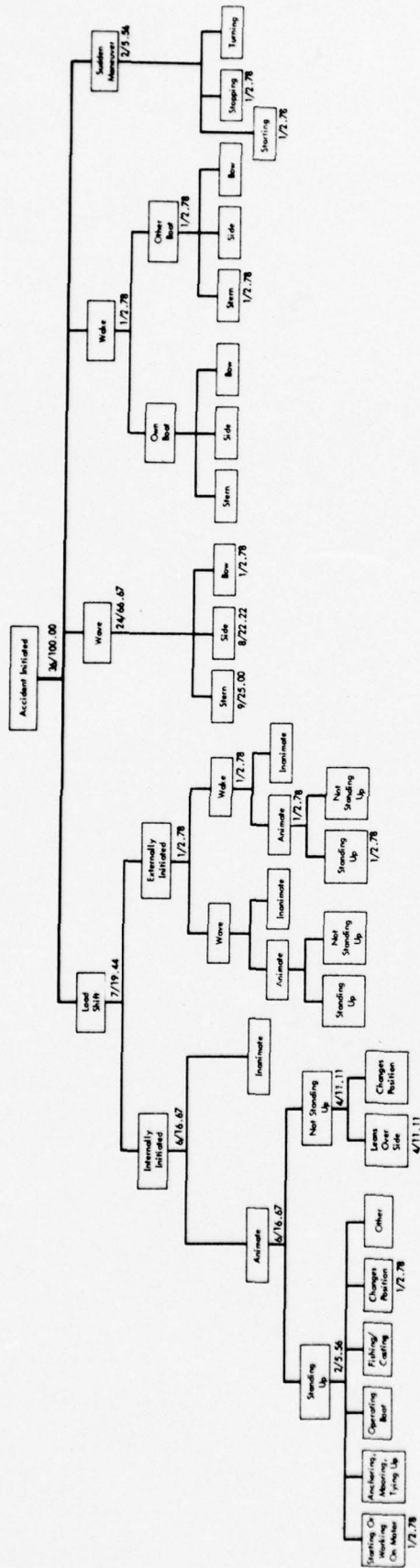


FIGURE II-3(b). FREQUENCY OF OCCURRENCES OF ACCIDENT INITIATORS INVOLVING BOATS SIXTEEN FEET (4.9 M) AND OVER RESULTING IN A CAPSIZING/SWAMPING

II-25/26

ALL BOATS
     
 
 BOATS UNDER 16 ft  
 (4.9 m)
     
 
 BOATS 16 ft AND OVER  
 (4.9 )

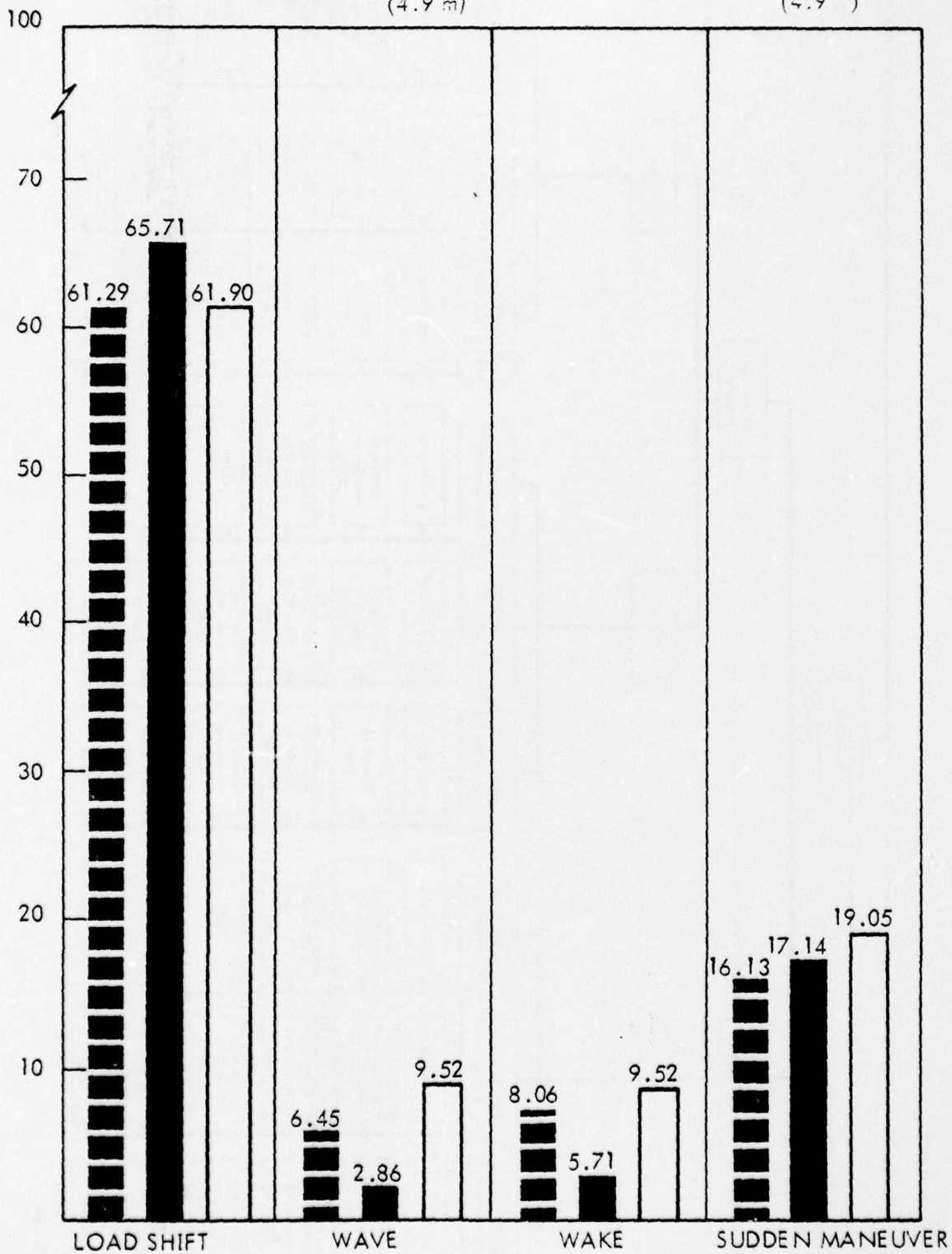
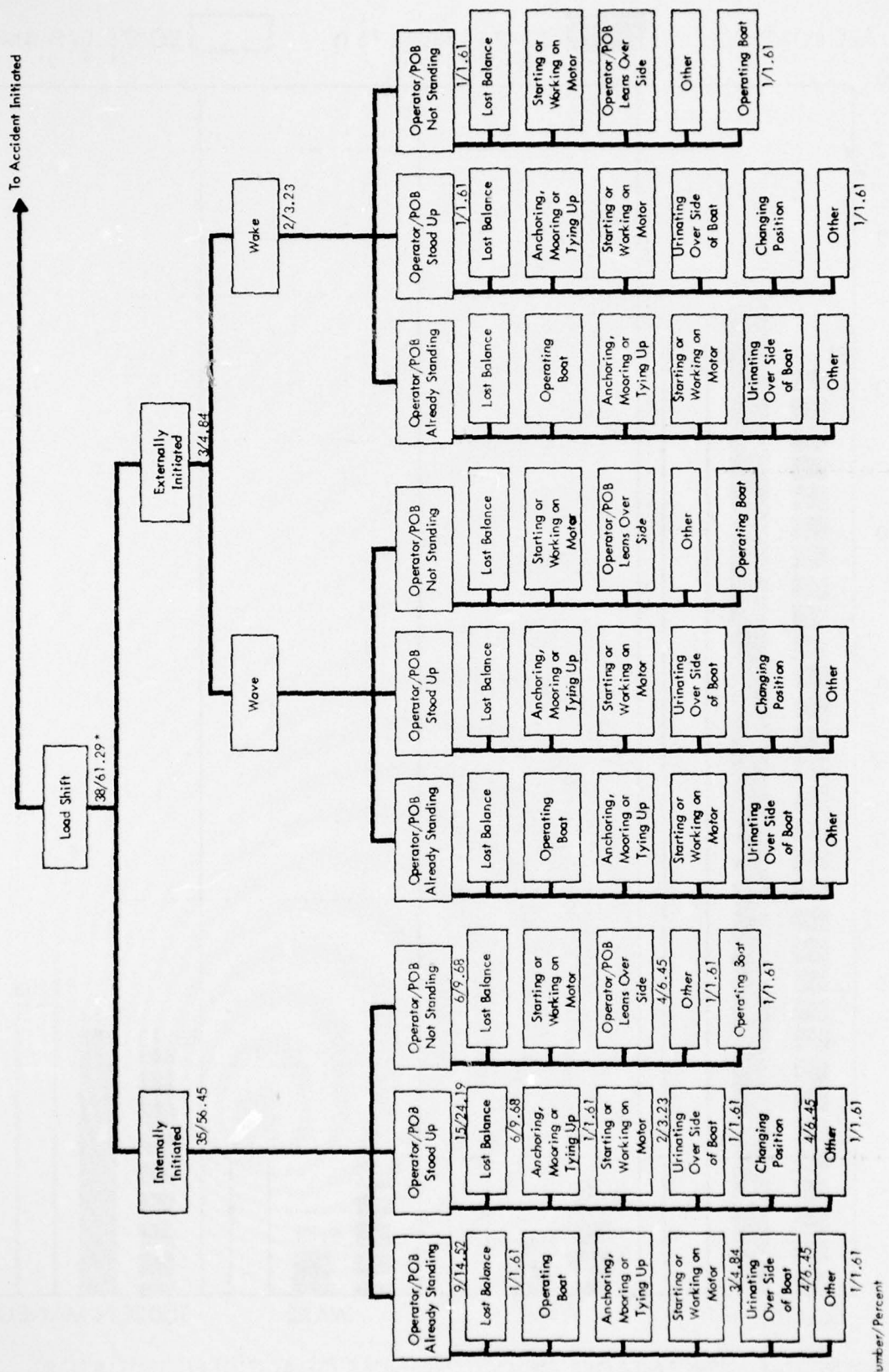


FIGURE II-4. PERCENTAGES OF OCCURRENCES OF ACCIDENT INITIATORS GROUPED BY MAJOR INITIATORS FOR FALLS OVERBOARD ACCIDENTS



\* Number/Percent

FIGURE II-5(g-1). FALLS OVERBOARD INVOLVING ALL BOATS

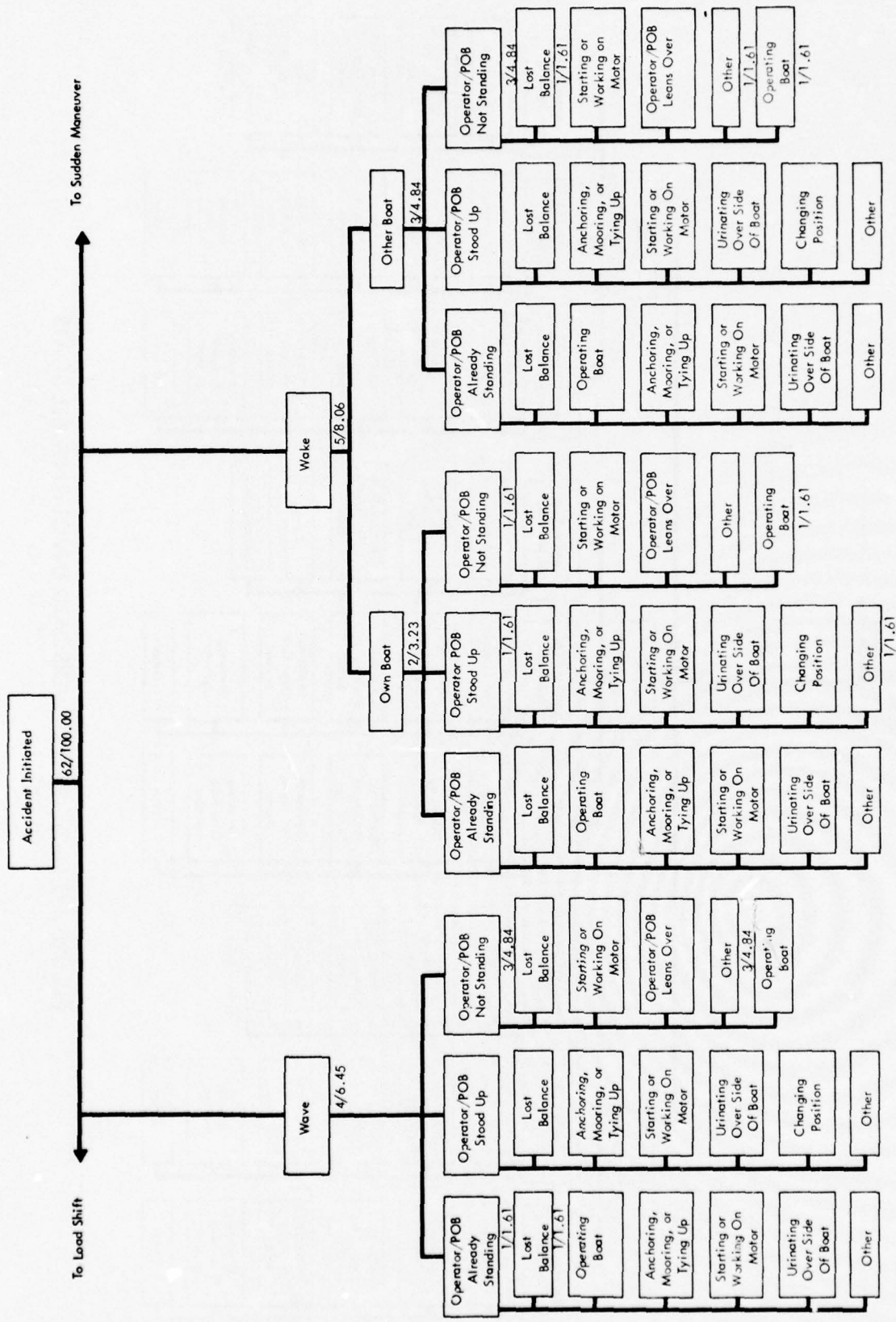


FIGURE II-5 (a-2). FALLS OVERBOARD INVOLVING ALL BOATS

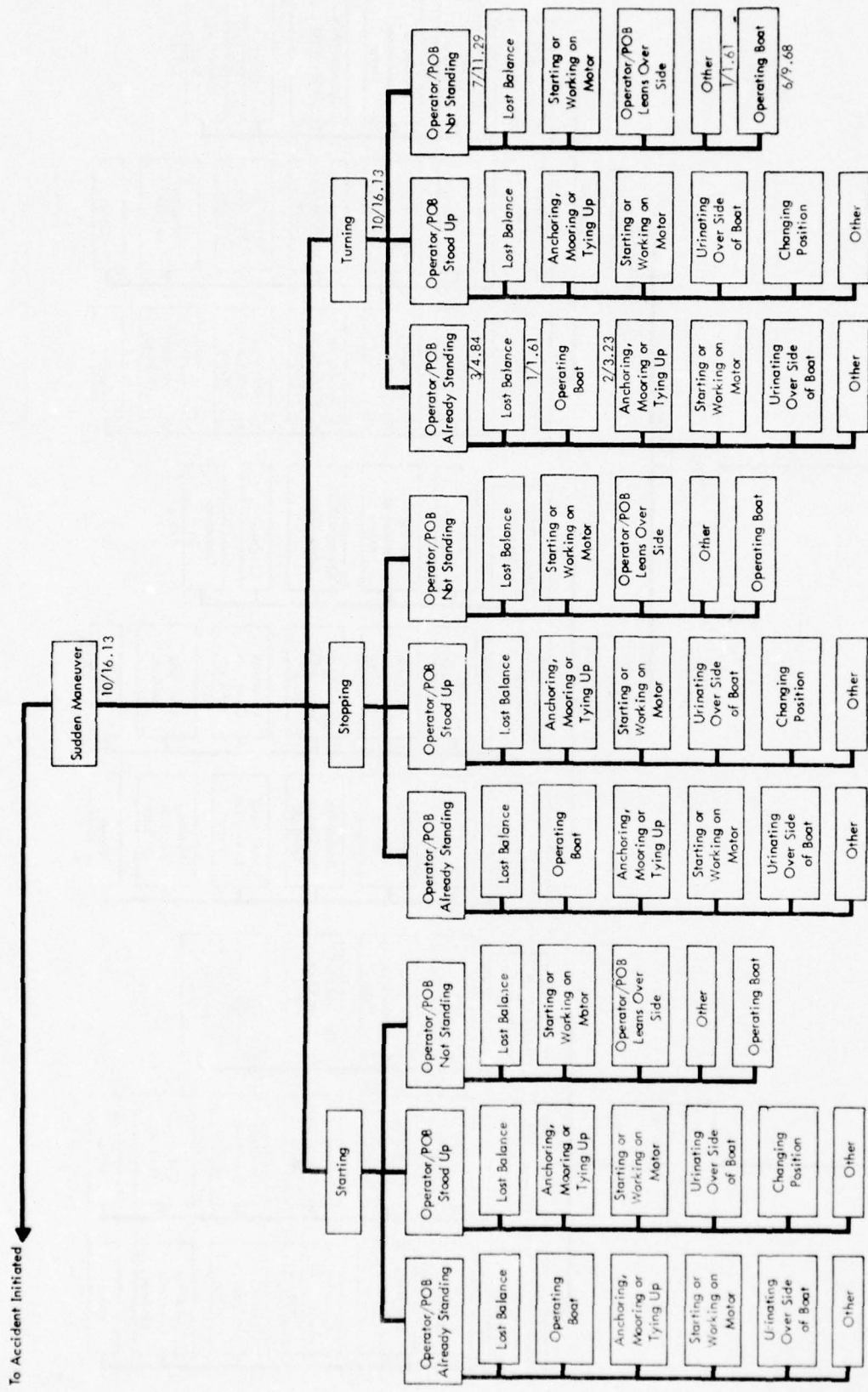
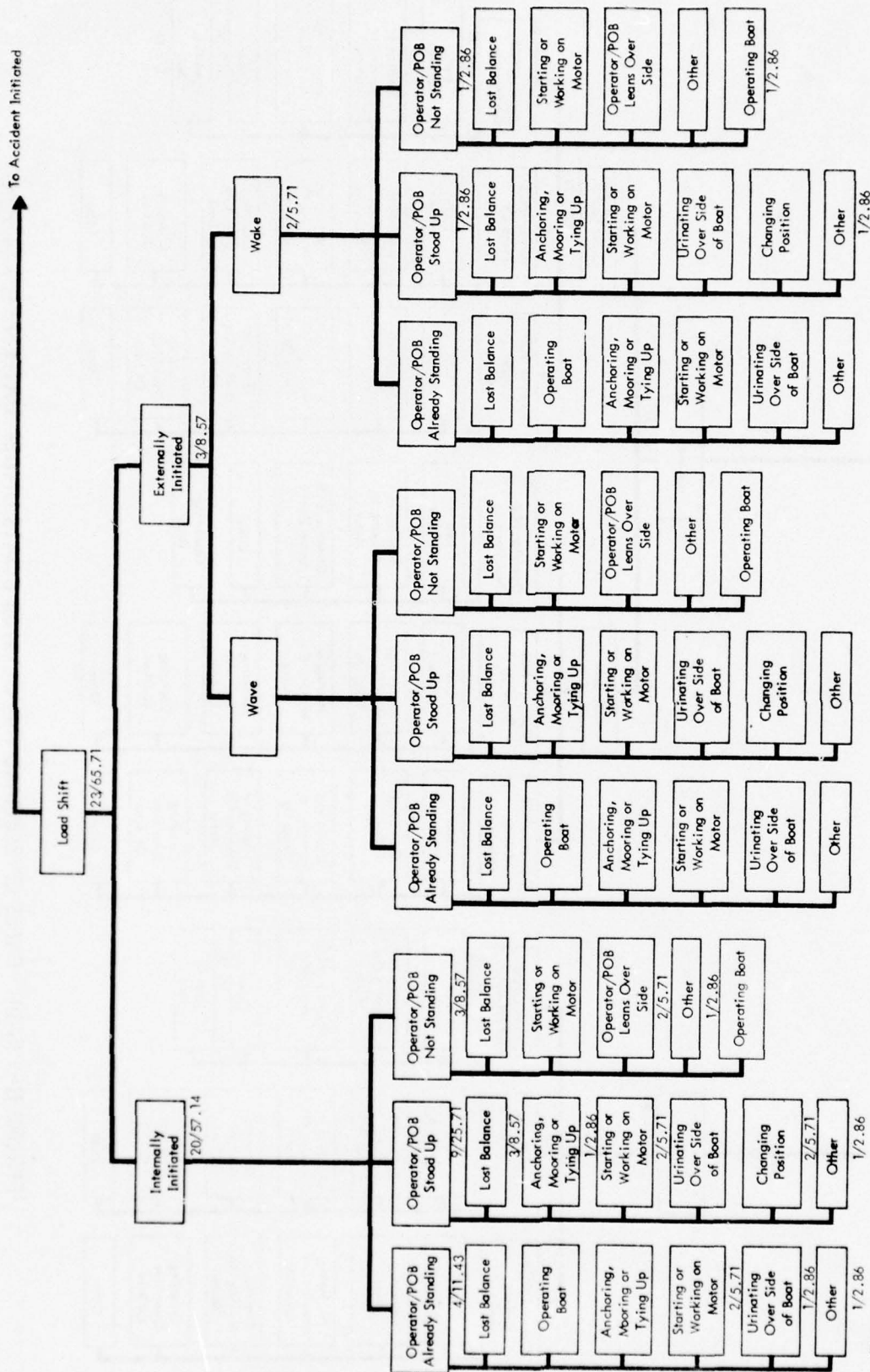


FIGURE II-5 (a-3). FALLS OVERBOARD INVOLVING ALL BOATS

To Accident Initiated



\* Number/Percent

FIGURE II-5 (b-1). FALLS OVERBOARD INVOLVING BOATS UNDER SIXTEEN FEET (4.9 M)

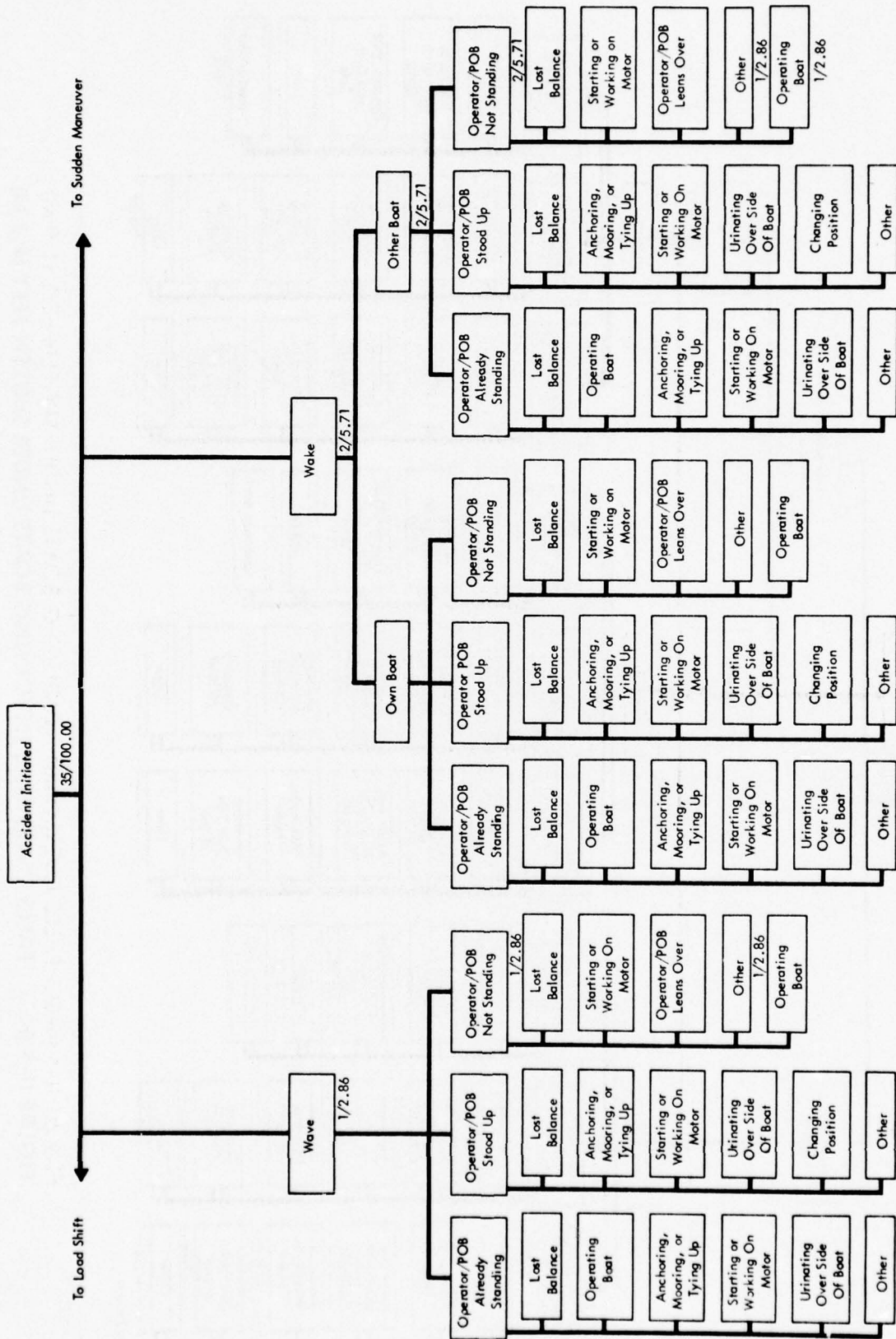


FIGURE II-5 (b-2). FALLS OVERBOARD INVOLVING BOATS UNDER SIXTEEN FEET (4.9 M)

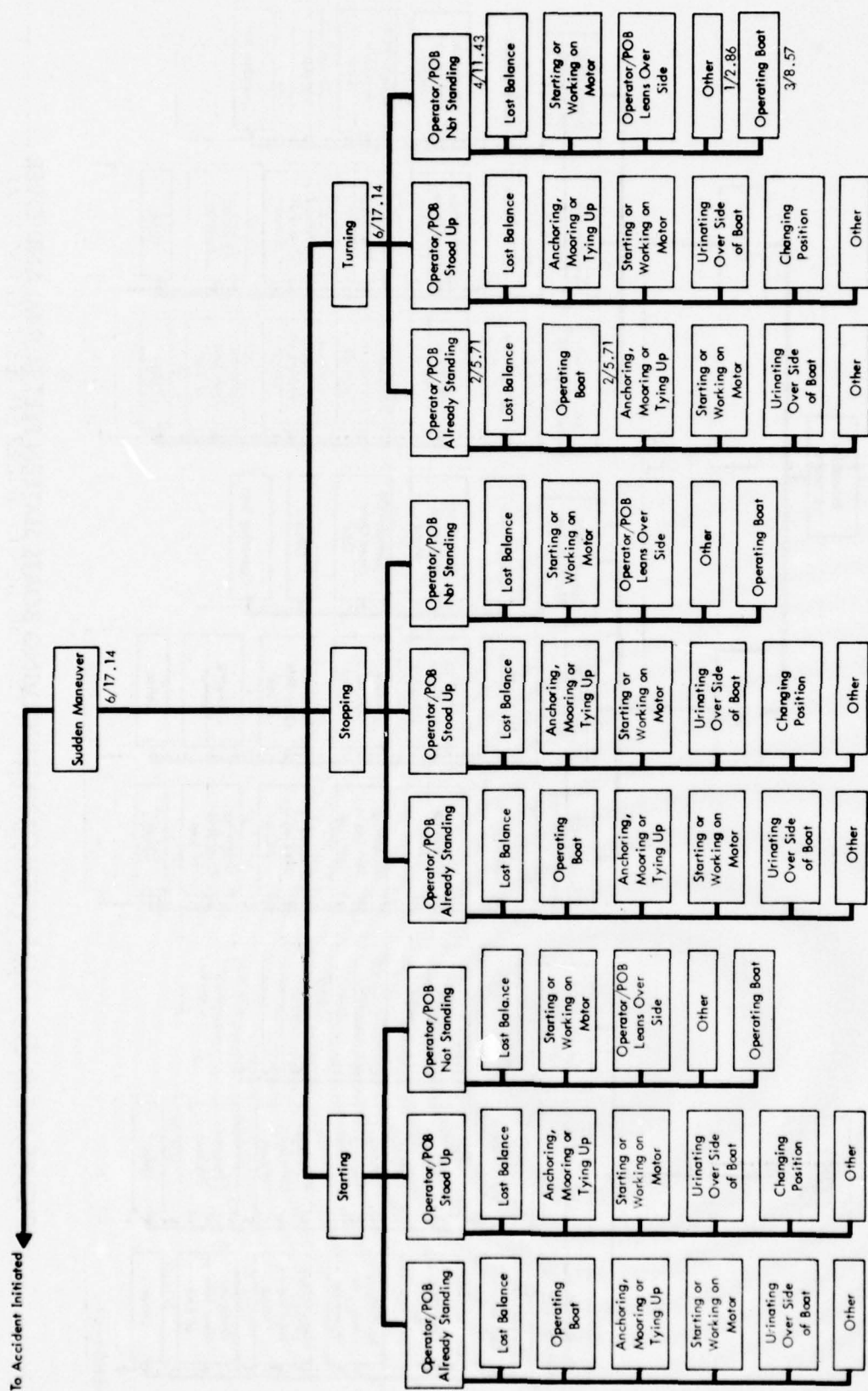
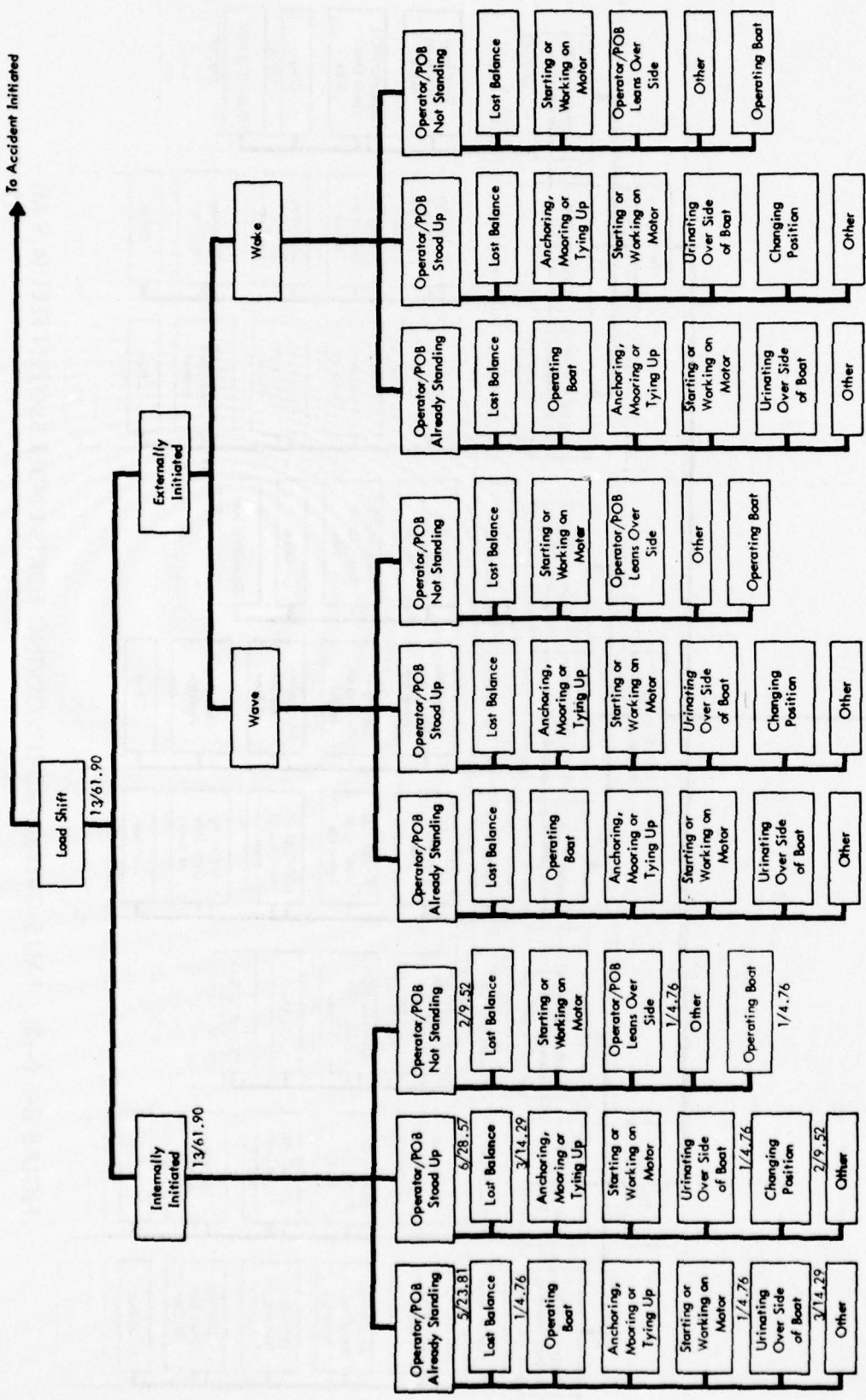


FIGURE II-5 (b-3). FALLS OVERBOARD INVOLVING BOATS UNDER SIXTEEN FEET (4.9 M)



\* Number/Percent

FIGURE II-5 (c-1). FALLS OVERBOARD INVOLVING BOATS SIXTEEN FEET (4.9 M) AND OVER

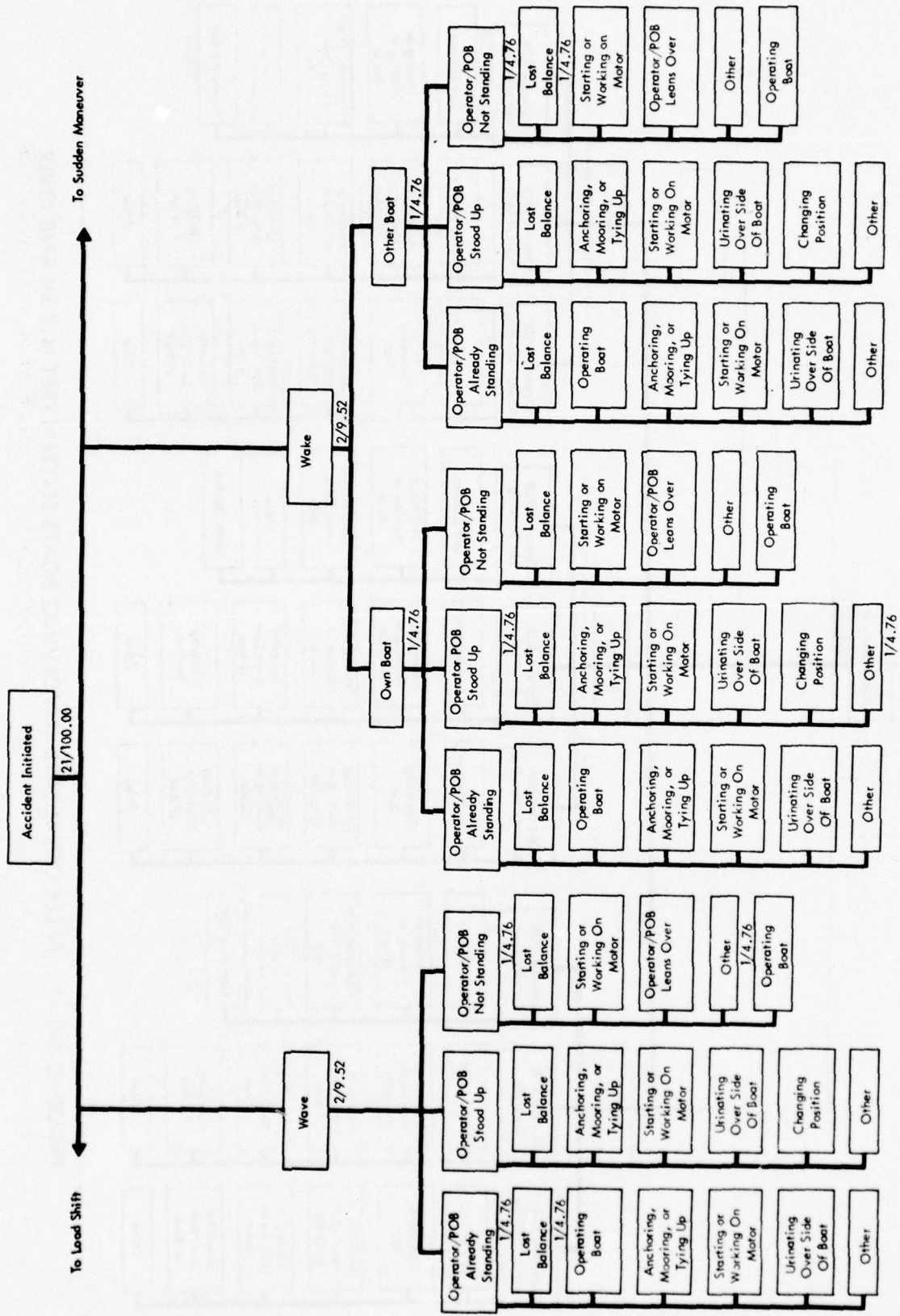


FIGURE II-5 (c-2). FALLS OVERBOARD INVOLVING BOATS SIXTEEN FEET (4.9 M) AND OVER

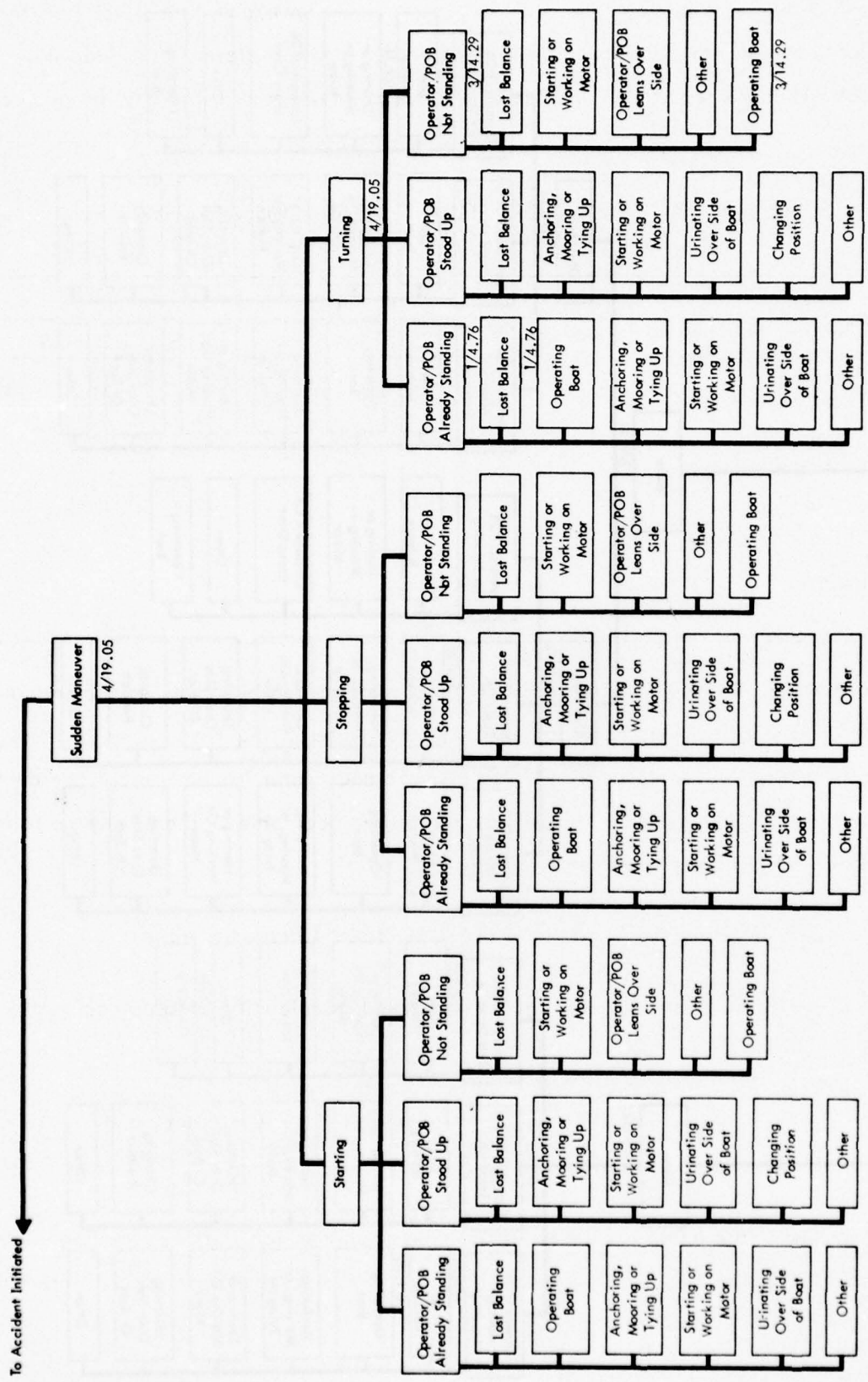


FIGURE II-5 (c-3). FALLS OVERBOARD INVOLVING BOATS SIXTEEN FEET (4.9 M) AND OVER

The "storm" category refers to those accidents in which it was known that a storm occurred, but was not known whether it was a forecasted storm or a sudden storm. A sudden storm is a storm which was not forecasted; a forecasted storm was forecasted for the day the accident occurred.

TABLE II-5. ACCIDENTS CAUSED BY HAZARDOUS WEATHER FOR THE WAVE ACCIDENT INITIATOR

TYPE OF HAZARDOUS WEATHER	ACCIDENT TYPE	
	CAPSIZING/SWAMPING	FALLS OVERBOARD
Storm (Unknown whether forecasted)	6 ( 23.08%)	0
Sudden Storm (not forecasted)	3 ( 11.54%)	1 ( 50.00%)
Forecasted Storm	3 ( 11.54%)	1 ( 50.00%)
Small Craft Warnings	3 ( 11.54%)	0
High Winds	11 ( 42.31%)	0
TOTALS	26 (100.00%)	2 (100.00%)

The other factor in the 68 capsizing/swamping accidents caused by waves was hazardous water such as rapids, breakers, and dam spillway area waters. Eighteen (26%) of the capsizing/swamping accidents were initiated by hazardous water (rapids - eight accidents, breakers - eight accidents, and dam spillway area - two accidents). There were no falls overboard occurring in hazardous water conditions.

#### 2.1.4 Analyses of Loading-Related Accident Characteristics

In preceding sections, three types of data were derived from loading-related accidents:

- the action that initiates an accident,
- pre-accident conditions under which accidents take place, and
- sizes of boats involved in accidents.

This section reports the analysis of these data. The actions which initiated loading-related accidents were categorized in two groups: 1) internal initiators (which included internal

load shifts and the sudden maneuver categories); and 2) external initiators (which referred to externally initiated load shifts, waves and wakes). Internal initiators were cited as a cause of 139 (53%) of all loading-related accidents, while external initiators were cited as a cause of 104 (40%) of all loading-related accidents. (These figures do not total 100% because of unknowns.)

These data were used to investigate the association between the initiator of the accident and boat length. The sample of accidents was classified according to the following variables:

- Accident initiator - internal versus external
- Boat length - under 16 ft (4.9 m) versus 16 ft (4.9 m) and over.

The results showed that there is no reason to expect that boat length ( $< 16$  ft (4.9 m) and  $\geq 16$  ft (4.9 m)) had any effect on whether the accident was initiated by internal or external factors ( $\chi^2 = 2.45$ ,  $df = 1$ ,  $p > 0.05$ ). See Table II-6.

TABLE II-6. ACCIDENTS ACCORDING TO BOAT LENGTH AND ACCIDENT INITIATOR (INTERNAL vs. EXTERNAL)

SIZE	INTERNAL	EXTERNAL
$< 16$ ft (4.9 m)	97	68
$\geq 16$ ft (4.9 m)	25	30

$$(\chi^2 = 2.45, df = 1, p > 0.05)$$

The data were then examined for an association between the major accident initiators and boat length. The sample of accidents was classified according to the following variables:

- Accident initiator - load shift versus all other initiators (wave, wake, and sudden maneuvers)
- Boat length - under 16 ft (4.9 m) versus 16 ft (4.9 m) and over.

The results suggest that for boats under 16 ft (4.9 m) a greater proportion of accidents were initiated by a load shift than for boats 16 ft (4.9 m) and over ( $\chi^2 = 4.25$ ,  $df = 1$ ,  $p \leq 0.05$ ). See Table II-7. In addition, the distribution of accidents in the table tends to imply that other causes of accidents (waves, wakes, and sudden maneuvers) occur more frequently for the larger boats.

TABLE II-7. ACCIDENTS ACCORDING TO LOAD SHIFT AND OTHERS (WAVES, WAKES, AND SUDDEN MANEUVERS)

SIZE	LOAD SHIFT INITIATOR	OTHER INITIATORS*
< 16 ft (4.9 m)	89	77
$\geq$ 16 ft (4.9 m)	20	35

( $\chi^2 = 4.25$ ,  $df = 1$ ,  $p \leq 0.05$ )

\* Waves, wakes, sudden maneuvers

In addition it was observed that 47 accidents (33%) were caused by someone standing up in the smaller boats; only two accidents (6%) were caused by someone standing up in the larger boat.

Figure II-1 shown earlier presented the different combinations of water condition, boat size, load amount, and load distribution for loading-related accidents. Is there an association between pre-accident conditions and boat length? Fifty percent of the loading-related accidents occurred in choppy water while 33% occurred in calm water. The classifications for further analysis of water conditions were as follows:

- Pre-accident parameter - choppy water versus calm water
- Boat length - small boats < 16 ft (4.9 m) versus large boats  $\geq$  16 ft (4.9 m).

TABLE II-8. ACCIDENTS ACCORDING TO BOAT LENGTH AND WATER CONDITIONS

SIZE	CHOPPY	CALM
< 16 ft (4.9 m)	90	73
≥ 16 ft (4.9 m)	41	14

$(\chi^2 = 5.627, df = 1, p \leq 0.05)$

The results showed more accidents occurred in choppy water than in calm water for both boat sizes. In accidents involving small boats, a proportionately smaller number occurred in calm water than for larger boats. The  $\chi^2$  value obtained for the overall comparison ( $\chi^2 = 5.627, df = 1, p \leq 0.05$ ) was statistically significant. A comparison of the accidents for the combination of load amount, water conditions, and boat size is presented in Table II-9.

TABLE II-9. ACCIDENTS ACCORDING TO LOAD AMOUNT, WATER CONDITIONS, AND BOAT SIZE

BOAT SIZE	OVERLOADED		NOT OVERLOADED	
	CHOPPY	CALM	CHOPPY	CALM
< 16 ft (4.9 m)	25	18	64	53
≥ 16 ft (4.9 m)	2	1	38	13

No legitimate tests of significance could be calculated for this data since comparisons of water conditions were confounded by the definition of overloaded/not overloaded. Choppy water conditions (hazardous water) were used in part to estimate whether a boat was overloaded or not (see Section 2.1.2). However, the following observations were possible:

- There were fewer fatal overloading accidents for boats 16 ft (4.9 m) in length and over.

- Considering each boat size category separately, the most accidents occurred in the not overloaded/choppy conditions.

A comparison of the accidents for the combination of load distribution, water condition, and boat size is presented in Table II-10.

TABLE II-10. ACCIDENTS ACCORDING TO LOAD DISTRIBUTION, WATER CONDITIONS AND BOAT SIZE

BOAT SIZE	BALANCED		UNBALANCED	
	CHOPPY	CALM	CHOPPY	CALM
< 16 ft (4.9 m)	65	52	22	19
≥ 16 ft (4.9 m)	37	11	3	2

Observation of the accidents in the table indicated that the load distribution in most boats was balanced prior to the occurrence of the accident. Two specific comparisons were made in order to determine the possible associations of load distribution and boat size for choppy water, and load distribution and boat size for calm water. These comparisons required separate analyses and are presented in Tables II-11 and II-12.

TABLE II-11. ACCIDENTS ACCORDING TO LOAD DISTRIBUTION AND BOAT SIZE FOR CHOPPY WATER

BOAT SIZE	BALANCED	UNBALANCED
< 16 ft (4.9 m)	65	22
≥ 16 ft (4.9 m)	37	3

$$(\chi^2 = 4.416, df = 1, p \leq 0.05)$$

Most accidents occurred in the balanced/less than 16 ft (4.9 m) boating category. There appeared to be very few boats 16 ft (4.9 m) or larger that were involved in accidents where the boat was not balanced prior to the accident. Chi-square analysis of the table was statistically significant ( $\chi^2 = 4.416$ ,  $df = 1$ ,  $p \leq 0.05$ ).

TABLE II-12. ACCIDENTS ACCORDING TO LOAD DISTRIBUTION AND BOAT SIZE FOR CALM WATER

BOAT SIZE	BALANCED	UNBALANCED
< 16 ft (4.9 m)	52	19
$\geq$ 16 ft (4.9 m)	11	2

( $\chi^2 = 5.052$ ,  $df = 1$ ,  $p \leq 0.05$ )

Again, as in the choppy water conditions, most accidents occurred in the balanced/less than 16 ft (4.9 m) boat size category. Also as in the choppy water condition, very few boats 16 ft or larger were involved in the calm water condition. Chi square analysis of the table was statistically significant ( $\chi^2 = 5.052$ ,  $df = 1$ ,  $p \leq 0.05$ ). The small number of boats in the 16 ft (4.9 m) and over category that were involved in accidents where the load was unbalanced is not too surprising. It is probably more difficult for an operator to accidentally overload a larger boat.

According to the Nationwide Boating Survey, there are more than eight million boats: 58.3% of these are in the under 16 ft (4.9 m) group, while 41.7% are in the 16 ft (4.9 m) and over group. Are boats under 16 ft (4.9 m) in length more likely to be involved in loading-related accidents than boats 16 ft (4.9 m) and over? In the accident sample, 75.6% of the loading-related accidents occurred in smaller boats (where boat size was reported); 24.3% of the loading-related accidents occurred in the larger boats. A "goodness of fit"  $\chi^2$  test was calculated to determine if there was any statistically significant difference between the two groups (accident sample and general population). The  $\chi^2$  analysis

indicated that the accident sample does differ from the proportions given for the general population ( $\chi^2 = 28.947$ ,  $df = 1$ ,  $p \leq 0.05$ ).

The previous analyses point to several areas of importance, some of which have implications for boater education. The data show some influences of water conditions, weather conditions, boat size, and various accident initiators. Future boater education efforts may be directed to some of the findings of this project.

#### 2.1.5 Summary of Loading-Related Accident Characteristics

The data dealing directly with the accidents concerned three areas:

- Action of boaters that initiate an accident
- Pre-accident conditions under which accidents take place
- Sizes of boats involved in accidents.

The analyses concerning the actions of boaters that initiate accidents suggest the following outcomes:

- for small boats, boat size tended to be independent of whether the accidents were caused by internal or external initiators,
- loading-related accidents involving small boats seemed to involve a load shift more frequently than accidents involving large boats, and
- a greater number of accidents for small boats were initiated by someone standing up than for large boats.

The analyses concerning the conditions in which loading-related accidents occur suggest the following outcomes:

- for small boats, a larger number of accidents occurred in calm water than for large boats,
- small boats appeared to be more frequently involved in overloading accidents in choppy water than large boats, and

- most boats were balanced prior to the occurrence of the accident; small boats appeared to be more frequently involved in unbalanced loading accidents regardless of water conditions.

The analysis on boat sizes indicates that more small boats were involved in loading-related accidents than larger boats (small boats: 177; larger boats: 32).

The analyses concerning accident initiators indicated that several boater behaviors were causes of loading-related accidents. These include:

- boating in hazardous weather (which was often forecasted), or hazardous water (i.e., rapids, etc.).
- standing up to work on the motor,
- standing up to change positions, or move for a similar reason,
- standing up to urinate,
- leaning over the side, and
- turning the boat suddenly.

## 2.2 Characteristics of the People Involved in Loading-Related Accidents

Information pertaining to the boaters themselves consisted of analyses of the backgrounds of all persons in the 261 loading-related accidents. Background data gathered for each boater (operator or passenger) were somewhat incomplete. These data related to:

- age,
- boating experience,
- educational level, and
- occupation.

The age factor was divided into two categories: 1) ages of all people involved and 2) ages of operators. The ages were known for 323 (43%) of 753 persons. Ages were known for 221 (85%) of 261 operators.

Table II-13 below shows the mean ages for all people and for boat operators.

TABLE II-13. MEAN AGES OF PEOPLE INVOLVED  
IN LOADING-RELATED ACCIDENTS — 1969 AND 1973

GROUP	MEAN YEARS
All People Involved In Loading-Related Accidents	32.17
Boat Operators Involved In Loading-Related Accidents	37.32

The mean age of boat operators involved in loading-related accidents is slightly higher than the national statistic. According to the Nationwide Boating Survey, the mean age of all operators (principle operator for each boating household) was 34.2 years old. The distribution of ages for operators from the general boating population and from the operators involved in loading-related accidents is presented in Table II-14.

TABLE II-14. AGE DISTRIBUTION OF OPERATORS FROM THE GENERAL BOATING  
POPULATION AND FROM THE LOADING-RELATED ACCIDENT SAMPLE

Age (Years)	Nationally*		Accident Sample	
	Frequency	Percentage	Frequency	Percentage
Under 12	577,127	3.53	0	0.00
12 - 15	928,899	5.67	4	1.81
16 - 19	2,020,183	12.34	20	9.05
20 - 25	2,363,356	14.44	34	15.38
26 - 30	2,035,444	12.43	21	9.50
31 - 40	2,932,781	17.92	64	28.96
41 - 50	2,726,306	16.65	30	13.57
51 - 60	1,648,709	10.07	29	13.12
Over 60	1,137,697	6.95	19	8.60
TOTALS	16,370,502	100.00	221	100.00

\* Nationwide Boating Survey

( $\chi^2 = 36.400$ ,  $df = 8$ ,  $p \leq 0.05$ )

A comparison between the age distributions of the NBS population and the loading-related accident sample indicated a statistically significant difference using the  $\chi^2$  "goodness of fit" statistic ( $\chi^2 = 36.40$ ,  $df = 8$ ,  $p < 0.05$ ). Differences were apparent in the "under 12," "26-30," and "31-40" age categories.

It should be noted that there is at least one source of variation for the accident data and the NBS data other than possible accident proneness. The data for the accident sample used the actual boat operator at the time of the accident for identification of operator age and experience. NBS data was based upon the "primary" or "most frequent" operator in the sampled household. Differences, therefore, between the two sets of data cannot be attributed to any single factor.

Information on boating experience and boating safety instruction was available only for the actual operators involved in loading-related accidents; the BAR forms do not provide such information for passengers.

Boating experience data was known for 166 operators. Using NBS data to obtain expected frequencies, the  $\chi^2$  "goodness of fit" statistic was computed for the boating experience distributions. The result was statistically significant which does not exclude the possibility that the loading-related accident operators were actually less experienced ( $\chi^2 = 19.57$ ,  $df = 3$ ,  $p \leq 0.05$ ). See Table II-15.

TABLE II-15. OPERATOR'S EXPERIENCE  
FOR ACCIDENT SAMPLE AND NATIONAL PERCENTAGES

Boating Experience*	Accident Sample Frequency	Accident Sample Percentage	National Percentage
Less than 20 hrs	31	18.68	9.40
20 - 100 hrs	43	25.90	24.40
100 - 500 hrs	44	26.51	27.40
Over 500 hrs	48	28.92	38.80
TOTAL	166	100.00	100.00

\* Data does not include 95 operators for whom experience was unknown.

( $\chi^2 = 19.57$ ,  $df = 3$ ,  $p \leq 0.05$ )

The breakdown of the sample data by experience and formal instruction as compared to the general boating population is presented in Table II-16.

Formal instruction data was known for only 116 (44%) of the operators in the sample accident data. Again using NBS data to obtain expected frequencies, the  $\chi^2$  "goodness of fit" statistic was computed.

TABLE II-16. OPERATORS' FORMAL BOATING SAFETY INSTRUCTION FOR ACCIDENT SAMPLE AND NATIONAL PERCENTAGES

Formal Instruction	Accident Sample Frequency	Accident Sample Percentages	National Percentages
Course	22	18.97	25.7
No Course	94	81.03	74.3
Total	116	100.00	100.0

( $\chi^2 = 2.755$ ,  $df = 1$ ,  $p > 0.05$ )

The results were not statistically significant ( $\chi^2 = 2.55$ ,  $df = 1$ ,  $p > 0.05$ ). This indicates that operators involved in loading-related accidents were no more or less likely to have had a boating safety course than operators at large.

The Nationwide Boating Survey does not provide data for the distribution of formal boating instructions by boat length and boat type. Hence, no comparisons were possible.

Educational and/or occupational data were obtained on 213 people involved in the accident sample. Of these, 74% were adults (19 years or older) and 26% were children (up to and including 18 year-olds).

The educational levels are categorized into three major headings: 1) elementary - including any child between the ages of seven and fourteen (1st grade through 8th grade); 2) high school - including any child between the ages of fifteen and eighteen; and 3) college - comprised of only those people who were listed as students at a university or college. This information was given on the BARs, or obtained from the actual death certificates, or local newspaper clippings. Table II-17 shows the breakdown of the educational level of students by the years of school completed.

TABLE II-17. EDUCATIONAL LEVEL OF STUDENTS INVOLVED  
IN LOADING-RELATED ACCIDENTS (1969 AND 1973)

Education Category	Number Of People	Percentage
Elementary, 8th grade or less	24	42.86
High School	25	44.64
College	7	12.50
TOTAL	56	100.00

The educational levels of the adults (as opposed to the students) were very rarely stated in the BARs or MIO reports. Again, some educational backgrounds were listed in newspaper clippings. The education data was supplemented using the known occupations of the adults and determining average educational background from the stated occupation. Occupations were available for those people who were fatalities; these data were obtained for 157 adults.

The occupation groups were categorized under four major headings as listed by the Manpower Report of the President: 1975 (References 4 and 5). The numbers of persons involved in the accidents are presented according to the Manpower Report classification (see Table II-18).

The educational level for each occupation group was estimated from the Manpower Report. This lists the median years of school completed by the employed labor force in occupational categories. These listings are presented in Table II-19.

The data for the educational levels of the adults (extrapolated from occupational level) involved in loading-related accidents were combined to determine the distribution by educational level for the entire sample. It should be noted that this procedure was used only because actual educational data was not available in the BARs.

According to the education data, a high percentage of the people involved in loading-related accidents appear to have at least four years of high school. According to The Recreational Imperative (Reference 6), persons 25 years of age or older who have finished four years of high school constitute a large proportion of the general boating and canoeing population.

TABLE II-18. OCCUPATIONS OF PEOPLE INVOLVED IN LOADING-RELATED ACCIDENTS BY TOTAL NUMBER AND PERCENTAGE IN EACH GROUP

Occupation Group	Number of People	Percentage
White Collar		
Professional and Technical	15	9.55
Managers and Administrators	24	15.29
Sales Workers	9	5.73
Clerical Workers	1	0.64
TOTAL	49	31.21
Blue Collar		
Craft and Kindred (Skilled)	40	25.48
Operatives (Semi-Skilled)	15	9.55
Laborers (Unskilled)	18	11.46
TOTAL	73	46.50
Farmers and Farm Laborers	4	2.55
TOTAL	4	2.55
Service Workers, Armed Forces, and Housewives	31	19.75
CUMULATIVE TOTAL	157	100.00

TABLE II-19. MEDIAN YEARS OF SCHOOL COMPLETED  
BY THE EMPLOYED LABOR FORCE BY OCCUPATION GROUP

Occupation Group	March 1974	March 1973	March 1969
White Collar	14.2	14.1	13.8
Professional and Managerial	15.7	15.6	14.9
Professional and Technical	16.4	16.4	16.3
Managers and Administrators	13.0	12.9	12.7
Sales and Clerical Workers	12.6	12.6	12.6
Sales Workers	12.7	12.7	12.6
Clerical Workers	12.6	12.6	12.6
Blue Collar	12.1	12.1	11.4
Craft and Kindred (Skilled)	12.3	12.2	12.1
Operatives (Semi-Skilled)	12.0	11.8	11.1
Except Transport	11.9	11.8	(*)
Transport	12.1	11.8	(*)
Laborers (Unskilled)	11.4	11.4	10.0
Farm			
Farmers and Farm Laborers	11.0	10.7	9.3
Service			
Service Workers	12.1	12.0	11.3

(\*) Not Available

Three-fourths of the canoeists in the 25-and-over age bracket have finished at least four years of high school; the figure drops to two-thirds for general boaters.

Educational levels for the general boating population (taken from The Recreational Imperitive) and those education levels given in the Manpower Report of the President: 1975 are presented in Figure II-6. The education profiles of the two groups appear similar, but do not seem to reflect an intuitive expectation of the actual loading-related accident population. That is, the education profiles seem to over estimate the boaters with four years of high school and under estimate the boaters with four years of college. No further analysis was undertaken.

The next analyses addressed the following questions:

- Are operators who have taken a boating safety course likely to have more boat operating experience than operators who have not taken a course?
- Are operators who have taken a boating safety course less likely to initiate the accident (when an accident actually occurred)?

This analysis of the operators' formal boating instruction attempted to take into account a possible confounding relationship. That is, boaters who have taken boating safety courses may actually have spent more hours on the water than those who have not taken a course. If they have spent more time on the water, they may increase their likelihood of an accident by pure chance.

In order to control for operating exposure, the operators (with and without a boating safety course) were cross-tabulated with their hours of boat operation (100 hours or less operating experience and more than 100 hours of operating experience). This comparison is presented in Table II-20.

TABLE II-20. OPERATORS' FORMAL BOATING INSTRUCTION AND HOURS OF BOATING EXPERIENCE

Hours	Course	No Course
≤ 100	1	47
≥ 100	10	41

$(\chi^2 = 6.077, df = 1, p \leq 0.05)$

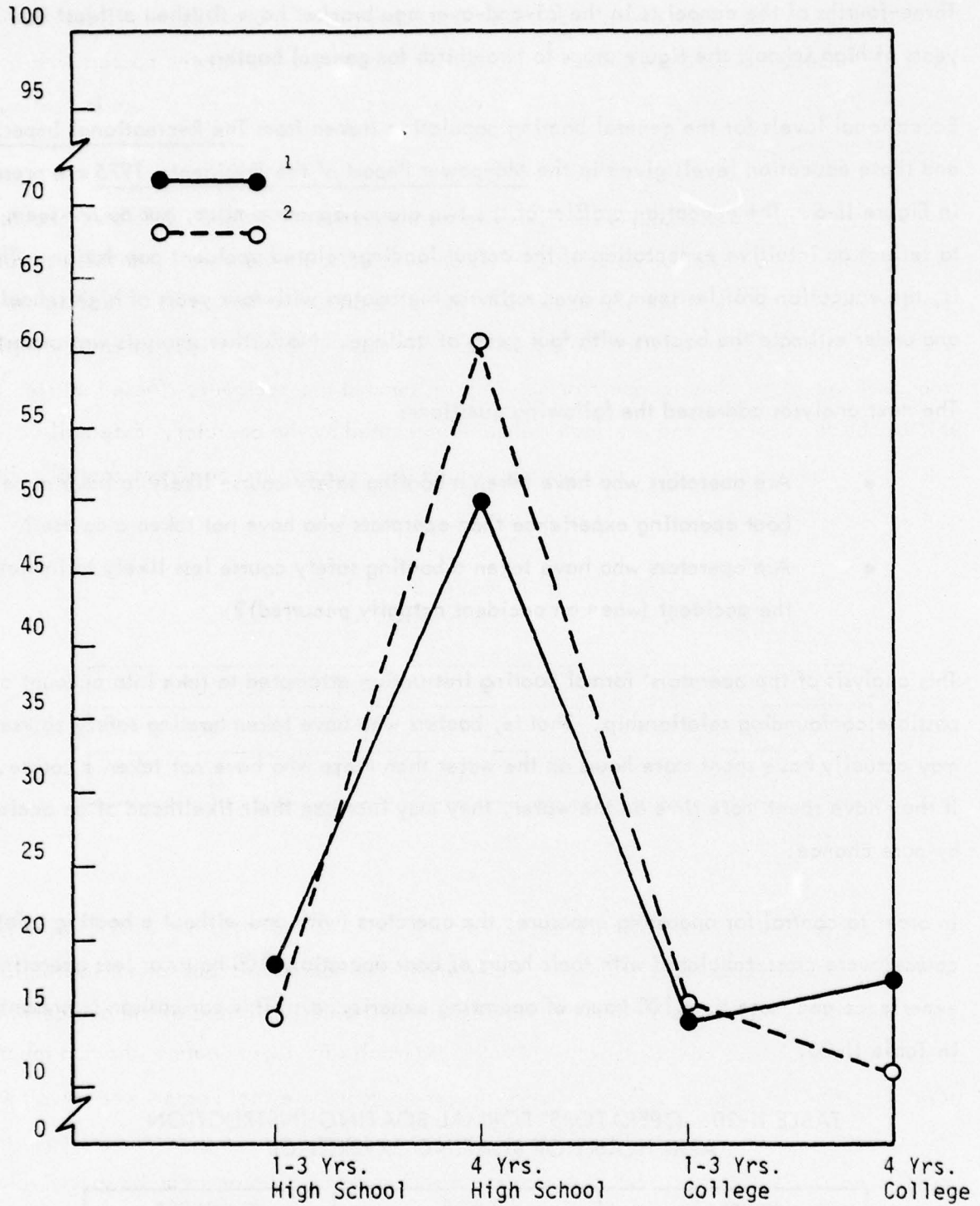


FIGURE II-6. GENERAL BOATING POPULATION AND ACCIDENT POPULATION EDUCATION USING THE RECREATIONAL IMPERITIVE AND MANPOWER REPORT SOURCES

- 1 General boating population (from The Recreational Imperitive)
- 2 Manpower Report extrapolations (using median years of education shown in Table II-19)

It would seem that operators who have taken a boating safety course are more likely to have over 100 hours of operating experience. However, about one-half of the boaters who have not taken a boating course are in the lower experience group and one-half are in the higher experience group.

Are operators who have a course less likely to be the initiators of loading-related accidents than operators who have had no course? The analysis of boaters according to these dimensions suggests that fewer operators who have taken formal boating instruction have loading-related accidents that are internally initiated (see Table II-21). In this analysis, internally initiated accidents are those when an operator actively influenced the accident. These included load shifting by the operator and a sudden maneuver executed by the operator. Externally initiated accidents are those initiators over which the operator had no direct control. These included load shifts externally initiated, waves, and wakes.

TABLE II-21. OPERATORS' FORMAL BOATING INSTRUCTION AND INTERNAL/EXTERNAL ACCIDENT INITIATORS

INITIATORS	COURSE	NO COURSE
Internal	7	40
External	14	50

( $\chi^2 = 14.27$ ,  $df = 1$ ,  $p \leq 0.05$ )

Chi Square analysis was statistically significant ( $\chi^2 = 14.27$ ,  $df = 1$ ,  $p \leq 0.05$ ). Again, as with the comparison of hours of boating experience, the boaters without formal instruction were distributed about evenly between internal and external initiations of the accident. Proportionately, more accidents were initiated externally for those boaters who had taken formal boating instruction. There is some support for a premise that boaters who have taken formal boating instruction may be different in some respects from the general boating population. Additional support would be required before this outcome can be specified as a result of the study.

### 2.3 Boating Safety Education and Loading-Related Accidents

One of the goals of this task was to compare boating educational programs with loading-related accident situations. How well do boating safety educational programs help an operator to cope with these situations? What types of behavior do boating educational programs stress that might prevent a loading-related accident? What boater behavior do they omit that is important?

To answer these questions, accident scenarios were selected from the loading-related accidents and the actions of the boaters involved were analyzed. The course texts consulted for this section were:

1. U. S. Coast Guard Auxiliary  
Text: Boating Skills and Seamanship (Ref. 7)
2. U. S. Power Squadron  
Text: Boating Course - Piloting, Seamanship, and Small Boat Handling (Ref. 8)  
Supplementary Text: Chapman's Piloting, Seamanship, and Small Boat Handling (Ref. 9)
3. Education for Safe Boating - Text used in high school courses in the Texas school system (Ref. 10)

It was not the intent of the authors of this report to deal comprehensively with evaluations of these texts. The material discussed is of an exemplary nature.

The accidents used for the scenarios were chosen on the basis of what kind of boat was involved, the conditions for the accident, and the nature of the accident itself. There are three scenarios for each boat and accident combination. The first comparison is the manual used by the Coast Guard Auxiliary; the second comparison is the supplementary text used by the Power Squadron. The text material is referred to only when the advice given is inconsistent with avoiding or recovering from the particular accident described. At the end of each scenario, an outline is presented of the accident related behavior on the part of persons involved.

A summary of the types of scenarios, the percentage of the accident type represented by each scenario, and the percentage of all loading-related accidents represented is given in Table II-22. The majority of the scenarios were chosen from those accidents which resulted in a capsizing since this type of accident comprised the largest number of loading-related accidents. These accidents also accounted for the highest number of the fatalities for the accidents studied.

TABLE II-22. SUMMARY OF ACCIDENT SCENARIOS BY ACCIDENT TYPE AND THE PERCENTAGE OF LOADING-RELATED ACCIDENTS

TYPE OF ACCIDENT (3 scenarios for each selected accident/ boat type combination)	PERCENTAGE OF ALL LOADING- RELATED ACCIDENTS	PERCENTAGE OF ALL ACCIDENTS BY ACCIDENT TYPE*	PERCENTAGE OF ALL FATALITIES
CAPSIZING:			
Lightweight Boats	20.31	47.32	18.24
Canoes	9.58	22.32	9.12
Other**	6.90	16.07	7.29
FALLS OVERBOARD:			
Runabout Boats	9.58	40.32	8.51
Lightweight Boats	6.90	29.03	5.47
Other	6.51	27.42	5.78
SWAMPING LEADING TO CAPSIZING:			
Lightweight Boats	12.64	55.93	14.29
Runabout Boats	5.36	23.73	6.08
SWAMPING:			
Lightweight Boats	3.83	35.71	5.17

\* Capsizing, falls overboard, swamping leading to capsizing, and swamping.

\*\* Dinghy, rowboat, heavy skiff, cabin motorboat, types coded as "other."

### 2.3.1 Accident Scenarios

The following scenarios were selected for evaluation based on the frequency with which the accident types occurred. See Table II-2 for the summary of accident frequencies (capsizings, swampings leading to capsizing, swampings, falls overboard).

#### LIGHTWEIGHT/CAPSIZINGS

The lightweight/capsizing combination of accidents accounted for the following percentages of loading-related accidents.

20.31% of all loading-related accidents

47.32% of all capsizing accidents

18.24% of all fatalities

1. Boat Data: Length - 12 ft (3.7 m)      This scenario is an example  
Beam - 47 in. (119.4 cm)      of the lightweight/capsizing accidents  
Depth - 16 in. (40.6 cm)      occurring under the listed conditions.

Weather/Water Conditions: Clear, good visibility  
Light wind  
Slight chop  
Air temperature - 55°F (12.78°C)  
Water temperature - 50°F (10°C)

#### Accident Scenario

Two men on a fishing trip; first outing for the passenger (unfamiliar with boat and boat operation). The passenger (158 lb (71.67 kg)) was seated amidships on a cushion; the operator (150 lb (68.04 kg)) was seated aft on a cushion. The two men were drift fishing. <sup>1</sup> The operator stood up to tend his line; he lost his balance, stepped on the gunwale, causing the boat to capsize. The two men were thrown into the water and were separated from the boat. The passenger made it back to the overturned boat and clung to it. The operator (a non-swimmer) treaded water for about one minute, then disappeared

#### Boating Safety Text

<sup>1</sup> ... , if you wanted to do some fishing it's possible that persons will stand up occasionally in the boat. (Standing up in a small boat is not especially dangerous if it is done carefully in calm water conditions, and if the boat is not too heavily laden.) By standing up you will change the center of gravity of the boat and, if the hull is being buffeted about appreciably, it could cause the boat to capsize, or for you to fall overboard.<sup>1</sup>

<sup>1</sup> Reference 7, page 2

below the surface. Neither cushion was used, due to the suddenness of the accident. The victim's body was recovered two hours later.

Accident Related Behavior

- 1) Operator stood up in small boat.
- 2) Operator was a non-swimmer. He was not wearing a PFD.

2. Boat Data: Length - 12 ft (3.7 m)  
Beam - 36 in. (91.4 cm)  
Depth - 14 in. (35.6 cm)

This scenario is an example  
of the lightweight/capsizing accidents  
occurring under the listed conditions.

Weather/Water Conditions: Cloudy, visibility five miles (8.05 kilometers)  
5-10 mph (8.05-16.09 kph) wind  
1-2 ft (.31-.61 m) seas  
Air temperature - 62°F (16.67°C)  
Water temperature - 54°F (12.22°C)

#### Accident Scenario

Two men left to go out on a lake and do some target practice with a service revolver. Neither had told anyone where they were going or what they intended to do. On the way to the lake they had stopped and had four beers each. The operator had over 500 hrs of experience; the passenger had less than 20 hrs. The two took the boat out about 500 yards (457.2 m) from shore in an isolated area. The passenger (the owner of the gun) was standing up shooting the gun when the operator stood up causing the boat to capsize. Both men were able to grab hold of the vests while in the water. Both tried to stay with the hull, but the passenger became fatigued after three hours, slipped off, and disappeared. The operator was able to stay with the boat and was picked up by a passing cabin cruiser four hours after the accident. The victim's body was recovered six days later.

#### Accident Related Behavior

- 1) Neither person told anyone where they were going or what they were going to do.
- 2) They drank before going out on the water.
- 3) The men were having target practice while standing in a small boat.
- 4) The operator stood up.

3. Boat Data: Length - 12 ft (3.7 m)  
Beam - 48 in. (121.9 cm)  
Depth - 19 in. (48.3 cm)

This scenario is an example of the lightweight/capsizing accidents occurring under the listed conditions.

Weather/Water Conditions: Clear, good visibility  
Light wind  
Strong current - turbulent water

#### Accident Scenario

Accident occurred in the area of a dam spillway. The dam was a four-bay gated structure - the two westerly gates were open about 12 in. (30.48 cm) and the two easterly gates were open about eight inches (20.32 cm) at the time of the accident. Two men launched their boat near the downstream end of the east shore riprap of the dam. They loaded fishing tackle and gear into the boat, started the motor, and proceeded upstream toward the spillway structure. As they neared the structure, the engine quit. The operator was seen pulling the motor cord several times, while the passenger was standing in a stooped position near the bow of the boat. The boat was turned broadside by the turbulent water and capsized, throwing both men into the water. Neither had a PFD on; both were good swimmers. The POB drifted downstream with the current surfacing about 30 yards (27.43 m) from the gates, only to disappear again before help could reach him. The operator remained struggling in the turbulence near the dam. Within approximately two minutes, both men had disappeared below the surface and were not seen alive again. The bodies were recovered 200 (182.88 m) and 300 (274.32) yards from the dam the next day.

#### Accident Related Behavior

- 1) Got too close to the spillway gates.
- 2) Passenger was standing up while in turbulent water.

## CANOE/CAPSIZINGS

The canoe/capsizings combination of accidents accounted for the following percentages of loading related accidents.

- 9.58% of all loading-related accidents
- 22.32% of all capsizing accidents
- 9.12% of all fatalities

1. Boat Type: Length - 17 ft (5.2 m)  
Beam - 30 in. (76.2 cm)  
Depth - 20 in. (50.8 cm)

This scenario is an example of the canoe/capsizing accidents occurring under the listed conditions.

Weather/Water Conditions: Clear, good visibility  
Light wind  
Strong current - rapids

### Accident Scenario

This accident involved one of five canoes on a fishing/exploring expedition. The canoe involved in this accident was in the middle with two canoes ahead of it and two canoes behind it. The intervals between the groups were such that they would be out of sight of each other in crooked sections of the river. The two men on the middle canoe ran into some rapids and were attempting to reach smoother water near the shore. In doing so, they angled the boat across the river; the boat broached and capsized due to the rough water caused by the rapids. Both men were thrown clear of the canoe. When they surfaced they were standing in waist deep water. They clung to the overturned boat, but decided to let go and wade ashore. One of the men reached under the boat and pulled out a "Mae West"-type life jacket and put it on. He tried to inflate it, but the CO<sub>2</sub> cartridge was inoperable. The other man did not get a jacket; thinking it unnecessary. The two men started to wade ashore, but about 25 yards (22.86 m) from shore ran into chest deep water. The man

without the jacket (victim) lost his footing due to the slick rocks and strong current and was swept away from the survivor (man with jacket). He went under and was not seen again. The survivor made it to shore and was picked up by the other group of two canoes at the rear. The victim's body was recovered the next day.

Accident Related Behavior

- 1) Placed the boat at such an angle that it was broadside to the current.
- 2) Let go of the boat to try and wade to shore.
- 3) One of the men did not put on a PFD.

2. Boat Type: Length - 17 ft (5.2 m)  
Beam - 34 in. (86.4 cm)  
Depth - 15 in. (38.1 cm)

This scenario is an example  
of the canoe/capsizing accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
No wind  
Rapids - strong current  
Water temperature - 38°F (3.33°C)

Accident Scenario

Two men out "shooting" rapids. In an attempt to return upstream, at a point halfway through the rapids, the strong current caught the bow of the canoe causing it to capsize. Both POB's hung onto the canoe, and drifted with the current. The canoe became submerged in a whirlpool and eddy area at which time one of the POB's (victim) slipped off the canoe and was carried downstream. Neither POB had a PFD on as there were none on board. The victim managed to catch hold of a rock, but was fatigued from the activity of shooting the rapids for two hours and numb from the cold water. Prior to disappearing from sight, he yelled to the other POB to push the canoe to him. Due to the rough, cold water and his fatigue, the survivor was unable to do anything for the victim. He hung onto the canoe until rescued by a witness on shore who picked him up in a motorboat. The victim's body was recovered two days later, about 150 yards (137.16 m) from the accident scene.

Accident Related Behavior

- 1) No PFD's on board the boat.

3. Boat Type: Length - 17 ft (5.2 m)  
Beam - 39 in. (99.1 cm)  
Depth - 17 in. (43.2 cm)

This scenario is an example  
of the canoe/capsizing accidents  
occurring under the listed conditions.

Weather Water Conditions:

Cloudy, good visibility  
Strong wind (15-25 mph)(24.14-40.23 kph)  
Storm conditions  
Rough water

#### Accident Scenario

Two young men were going on a camping trip; took a canoe and were paddling to a small island. The wind began to increase in velocity and the sky began to darken as the storm, forecasted for that day, started forming. The men were about 500 yards (457.2 m) from their destination when the wind and waves hit the canoe causing it to capsize. One of the POB's grabbed a cushion, the other POB (victim) in his panic was not able to grab the other cushion. The victim could not swim; the survivor tried to reach him, but was unable to do so because of the rough water. The victim disappeared within minutes after the accident. The survivor clung to the boat and cushion and swam to the island. He was picked up the next day by a passing boater.

#### Accident Related Behavior

- 1) Did not check the weather forecast before going out on water.
- 2) Non-swimmer not wearing PFD.

## OTHER/CAPSIZINGS \*

The other/capsizing combination of accidents accounted for the following percentages of loading-related accidents.

- 6.90% of all loading-related accidents
- 16.07% of all capsizing accidents
- 7.29% of all fatalities

1. Boat Type: Length - 21 ft (6.4 m)  
Beam - 90 in. (228.6 cm)  
Depth - 50 in. (127.0 cm)

This scenario is an example of the other/capsizing accidents occurring under the listed conditions.

Weather/Water Conditions: Clear, good visibility  
No wind  
Tide was rising

### Accident Scenario

Tide predictions for the accident area were: low tide of -1.3 ft (-0.39m) at 0740 hours and high tide of 7.2 ft (2.19 m) at 1552 hours. At 1115 hours (the time of the accident), the height of the tide was 2.5 ft (0.76 m) and the current was nearing maximum flood. In the accident area, when the tide is running it sets up rip tides and huge breakers run across the reef. Five people, three females and two males, departed at 0930 hours on a fishing trip. When they reached the fishing area, the operator throttled down to displacement speed so that they could fish. At 1115 hours, the male POB (Victim 1) warned the operator that they were drifting into turbulent waters. The operator moved to the helm and began a turn, even though Victim 1 warned him not to. Suddenly, a high wave (not previously seen by any of the occupants) appeared at the stern and capsized the boat end over end onto the starboard transom. At the time of the accident the people were in the following positions: operator was at the helm; Victim 1 and his wife were on the port side - Victim 1 aft and his wife forward next to

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\* The other/capsizing boat and accident combination included the following types of boats: dinghy, rowboat, heavy skiff, cabin motorboat, and the types coded as "other."

the cabin; Victim 2 (female) and the operator's wife were on the starboard side - Victim 2 forward just aft of the helm and the operator's wife near the stern. After the boat capsized, the operator and Victim 1's wife were under the boat fouled in fishing line, but were able to free themselves. Another large wave swept the people under briefly. The operator's wife was near the boat on the shore side and Victim 2 was on the same side lying face down, but further out. The survivor tried to reach her with three cushions. Meanwhile, the two under the boat came out on the other side of the boat. Victim 1 was on the same side further out and lying face down. The operator found three of the nine PFD's (one adult jacket, one child's jacket, and one cushion). He took the adult jacket; gave the cushion to Victim 1's wife. He and Victim 1's wife swam to Victim 1 and held him between them until rescued ten minutes after the accident occurred. Both victims were given mouth-to-mouth resuscitation, but to no avail; both were pronounced DOA at the hospital.

#### Accident Related Behavior

- 1) Inattentive as to where the boat was going.

2. Boat Type: Length - 25 ft (7.52 m)  
Beam - 108 in. (274.3 cm)  
Depth - 46 in. (116.8 cm)

This scenario is an example of the other/capsizing accidents occurring under the listed conditions.

Weather/Water Conditions:

Dark, fair visibility  
Light wind  
Choppy water - heavy surf

#### Accident Scenario

Six people, three adults and three children, left early in the morning for a day of fishing. They fished until dark and were returning to home port when they encountered dense fog. Radio contact was made with another boat which informed them that the fog had broken near Long Beach. The boat continued toward Alamitos Bay steering by compass. The boat was off the mouth of the Santa Ana River; the fog had broken, darkness had set in and the lights on shore were visible. The operator estimated his distance from shore to be one-half to three-quarters (0.81 km to 1.21 km) of a mile when the vessel was struck by a large, breaking swell and capsized. The occupants were thrown into the water and began making their way to the beach through a heavy surf. One of the POB's (A) was having difficulty holding his son (age 7) above the water. The operator swam over to them and held the son up. Another large swell broke over them and A disappeared. The operator and A's son made it to the beach safely. The other two children were helped to shore by the other adult. All but A made it to the beach. His body was recovered by search parties the next day. No PFD's were worn even though the boat was adequately equipped with them.

#### Accident Related Behavior

- 1) Operator should have been more careful while in the fog.
- 2) Operator should have had all the occupants including himself put PFD's on.

3. Boat Type: Length - 14 ft (4.27 m)  
Beam - 48 in. (121.9 cm)  
Depth - 14 in. (35.6 cm)

This scenario is an example  
of the other/capsizing accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Cloudy, poor visibility  
Light wind  
Calm water  
Air temperature - 70°F (21.11°C)  
Water temperature - 72°F (22.22°C)

Accident Scenario

Three men were fishing at anchor; one POB was forward; the operator was amidships; one POB was aft. For some reason the operator stood up, lost his balance, and caused the boat to capsize. The two POB's were thrown clear of the boat. They grabbed a cushion and began swimming the 25 yards (22.86 m) to shore sharing the cushion between them. Unknown to them, the operator had become entangled in fishing rods that either tired him out or hampered his swimming ability. (He was a good swimmer.) The other POB's, realizing that he was not following, turned to see him disappear beneath the surface of the water. The body was recovered three hours later by dragging operations.

Accident Related Behavior

- 1) Operator stood up in the boat.

## RUNABOUT/FALLS OVERBOARD

The runabout/falls overboard combination of accidents accounted for the following percentages of loading-related accidents.

- 9.58% of all loading-related accidents
- 40.32% of all falls overboard accidents
- 8.51% of all fatalities

1. Boat Type: Length - 14-1/2 ft (4.4 m)  
Beam - 60 in. (152.6 cm)

This scenario is an example of the runabout/falls overboard accidents occurring under the listed conditions.

Weather/Water Conditions:

Overcast, visibility eight miles (12.87 km)  
10-20 mph (16.09-32.19 kph) wind  
Rough, three ft (.91 m) seas  
Air temperature - 52°F (11.11°C)  
Water temperature - 64°F (17.78°C)

### Accident Scenario

One adult male and his two children (son and daughter) departed at 0940 hrs for a fishing trip. They commenced drift fishing, but after about ten minutes the sea and wind conditions worsened. They decided to get underway and headed in a northwesterly direction toward protected waters. At about 1000 hrs the engine stalled and the boat began drifting in the trough while the operator worked on the engine. A large wave struck the boat, causing it to make a sudden, violent motion, throwing the girl out of her seat and into the water. The boat still without power began drifting away from the girl. The operator told his son to jump overboard and help his sister. The boy did so, but was unable to reach her. The operator finally managed to start the engine and pick up his son, who was exhausted and in danger of drowning. He attempted to maneuver the boat to his daughter, but the engine failed again. He then jumped overboard and held the girl up. The son tried to restart the engine, but couldn't.

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RECREATIONAL BOAT SAFE LOADING - OPERATOR STUDY.(U)  
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He kept the victims in sight for about ten minutes longer before they disappeared. There were PFD's available, but none were used. The boy was rescued by a passing boater at 1100 hrs. The operator's body was recovered two days later and the girl's body was recovered three days later.

#### Accident Related Behavior

- 1) Operator did not have the occupants (including himself) put PFD's on.
- 2) Operator had someone jump overboard without having a PFD on.
- 3) Operator jumped overboard without a PFD.

2. Boat Type: Length - 17 ft (5.2 m)  
Beam - 72 in. (182.9 cm)

This scenario is an example of the runabout/falls overboard accidents occurring under the listed conditions.

Weather/Water Conditions: Fair, good visibility  
Light wind  
Calm water

#### Accident Scenario

Five adults out cruising. One of the POB's (male) was standing at the stern when, for some reason, the boat took a slight turn to port. The POB at the stern lost his balance, lost his footing on the wet deck, and fell overboard. The operator immediately brought the boat dead in the water. Although there were ten PFD's (vests) on board, the operator (an excellent swimmer) dove overboard. He was not wearing a PFD nor did he take one with him. The POB (A) was approximately 20 ft (6.09 m) astern of the boat. The other people on board attempted to throw PFD's to the two men, but none got close enough for them to grab. When the operator (B) reached A he had already submerged, so B dove and brought him to the surface. A panicked, causing both men to submerge, but B managed to resurface along with A. B yelled to his wife to maneuver the boat alongside the two men, but before it got close enough the two men disappeared for the last time. One of the other men on board also dove into the water, but was not able to reach the victims. The bodies were recovered the next day.

#### Accident Related Behavior

- 1) Passenger standing while boat under power.
- 2) Operator stopped engine rather than putting it in idle.
- 3) Operator jumped overboard; did not take PFD with him nor did he wear one.
- 4) Passenger jumped overboard without taking a PFD or wearing a PFD.

3. Boat Type: Length - 19 ft (5.8 m)  
Beam - 87 in. (221.0 cm)  
Depth - 45 in. (114.3 cm)

This scenario is an example of the  
runabout/falls overboard accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Rain, fair visibility  
Slight wind  
Choppy water  
Water temperature - 57°F (13.89°C)

#### Accident Scenario

Three brothers took their boat to have a new engine installed. While waiting for this they bought two six packs of beer and began drinking. They then took the boat out to test the new engine. While cruising they finished what was left of the beer and decided to stop and have some more drinks. They pulled into a launch area where they stopped and stayed at two different places for about one hour each place. After this they decided to go home. One of the brothers was operating the boat and the other two were seated amidships facing aft. The youngest brother (A) got up and walked to the stern to urinate. While at the stern, he lost his balance and fell overboard. The other brother yelled to the operator that A had fallen over the side. The operator turned the boat back around, but when he got back to the spot where A had fallen in, there was nothing to be seen. Approximately five minutes had elapsed between the time A fell overboard and the boat came back. None of the men were wearing PFD's although there were four on board. The body was recovered about four hours later, but no autopsy was performed. Therefore, the victim's blood alcohol concentration (BAC) was unknown.

#### Accident Related Behavior

- 1) Drinking before going out on the boat and between stops.
- 2) Passenger standing up while boat underway.

## LIGHTWEIGHT/FALLS OVERBOARD

The lightweight/falls overboard combination of accidents accounted for the following percentages of loading-related accidents.

- 6.90% of all loading-related accidents
- 29.03% of all falls overboard accidents
- 5.47% of all fatalities

1. Boat Type: Length - 14 ft (4.3 m)  
Beam - 59 in. (149.9 cm)

This scenario is an example of the lightweight/falls overboard accidents occurring under the listed conditions.

Weather/Water Conditions: Clear, good visibility  
Light wind  
Calm water

### Accident Scenario

Two men left on a fishing trip, each in his own boat. They left their homes at 2300 hrs on 19 July and launched their boats at 0300 hrs on 20 July. They fished for about one hour, then pulled into a cove, anchored, and went to sleep in their boats. They awoke a few hours later, found it to be daylight, and began fishing in a shallow, grassy area. One of the men (B) indicated to the other (A) that he wanted to move to another location. A followed B. <sup>1</sup> After about ten minutes, B looked back to see A standing off balance. The boat turned sharply to the left throwing A overboard. Upon hitting the water, the stern ran over A and continued in a counterclockwise circle. B tried to reach A, but he was inside the boat's circular path. A was struck two more times as the boat continued its circular path and then disappeared. The victim was not wearing a PFD, but probably would not have survived even if he had had a PFD on. The operator's seat on the victim's boat was broken, but it was not known whether the damage occurred before or as he fell in. The body was recovered ten hours later.

### Boating Safety Text

<sup>1</sup> Standing up in a small boat is not especially dangerous if it is done carefully in calm water conditions, and if the boat is not too heavily laden. Don't stand up in a small boat without hanging on,....<sup>1</sup>

### Accident Related Behavior

- 1) Operator standing up while boat underway.

<sup>1</sup> Reference 7, page 2.

2. Boat Type: Length - 14 ft (4.3 m)  
Beam - 48 in. (121.9 cm)

This scenario is an example of the  
lightweight/falls overboard accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Clear, fair visibility  
Light wind  
Choppy water

#### Accident Scenario

Two men were returning home from setting trotlines for eight hours in a subsidiary of a river. As they turned into the main part of the river, there was some brush in front of them. The operator cut the boat to the right, but because of the speed at which he was going (20 mph)(32.19 kph), he lost control. Both men were thrown out of the boat into the water. One of the PFD's (jacket) on board was also thrown into the water. The two men held onto the jacket until the boat ran into the bushes and stopped approximately 50 yards (45.72 m) from the men. The operator turned loose of the jacket and started swimming towards the boat. After swimming about ten yards (9.14 m), he disappeared from sight. The other man was not able to help as he was a poor swimmer and fatigued from the day's activity. He held onto the jacket and dog paddled to the boat. He got the boat started and went to a nearby marina for help. Dragging operations were begun; the body of the operator was recovered a few hours later.

#### Accident Related Behavior

- 1) Operator made a sudden turn at high speed.
- 2) Should have throttled back before entering main part of river.
- 3) Operator released PFD and tried to swim to boat.

3. Boat Type: Length - 14 ft (4.27 m)  
Beam - 36 in. (91.44 cm)  
Depth - 24 in. (60.96 cm)

This scenario is an example of the lightweight/falls overboard accidents occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
Calm water  
10-15 mph (16.09-24.14 kph) wind  
Air temperature - 71°F (21.67°C)  
Water temperature - Unknown at scene, but at time of accident water temperature in Chesapeake Bay was 40°F (4.44°C)

Accident Scenario

On the 21st of March, two men departed from Dutch Gap to check the operation of the outboard motor which was recently overhauled. While cruising down the James River, they fished and adjusted the mixture to the motor. Approximately 5.5 miles (8.85 km) east of Dutch Gap, the operator turned the boat about and began their return trip up the James River. About one-half mile (.87 km) east of Dutch Gap, the operator turned the boat into a dredge cut for a rest stop. The operator took the boat out to run some more tests, while the other man watched from the bank. He completed two full turns and started a third while operating at three-quarters to full throttle. Immediately upon entering into the third turn at the mouth of the cut, he was thrown into the water. The victim kept his head above water for a full minute, then disappeared. He was not wearing a PFD, although there were three cushions on board beneath a seat. The other man ran along the bank of the river for about 20 minutes before the attention of a cabin cruiser was alerted. They picked him up, went back to the scene of the accident and conducted a surface search. The body was recovered on the 22nd of March in 20 ft (6.10 m) of water a short distance up river from the accident.

Accident Related Behavior

- 1) Operator making turns at high speed.
- 2) PFD's were not accessible to anyone on board because they were under a seat.

## OTHER/FALLS OVERBOARD

The other/falls overboard combination of accidents accounted for the following percentages of loading-related accidents.

- 6.51% of all loading-related accidents
- 27.42% of all falls overboard accidents
- 5.78% of all fatalities

1. Boat Type: Length - 19 ft (5.79 m)  
Beam - 72 in. (182.88 cm)  
Depth - 27 in. (68.58 cm)

This scenario is an example of the other/falls overboard accidents occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
15 mph (24.14 kph) wind  
3-5 ft (.91-1.52 m) seas  
Water was cold

### Accident Scenario

Five people (three adult males, one adult female, one teenage male) were out on a fishing trip. Three of the POB's (two adult males and one teenage male) were sitting on chairs fishing from the stern. The adult female POB was standing on the deck at the cabin entrance. The operator was seated at the wheel located amidships on the starboard side. The operator brought the boat about to starboard approximately three miles (4.83 km) from the west end of the island and was proceeding generally west-southwest at five knots. The boat was rolling moderately as it was broadside to the oncoming seas. At noon the boat broached hard to starboard approximately 150 yards (137.16 m) south of Santa Rosa Island. The three POB's fishing were thrown overboard over the starboard side. None were wearing PFD's. Two of the victims could not swim and one suffered from a serious heart condition. The operator shut the motor off, dove into the water to help the two non-swimmers. He took two PFD's with him, put them on the two victims, and began towing them to the beach. People on the beach

also came out to help. The POB (female) on board who had been thrown to the deck regained her footing and attempted to start the engine. She was unsuccessful and the boat drifted to shore. The other victim (one with heart condition) had disappeared immediately after falling into the water. The autopsy revealed that he had suffered a heart attack. The other two victims were given mouth-to-mouth resuscitation on the beach, but were pronounced DOA at the hospital.

#### Accident Related Behavior

- 1) Operator had boat broadside to the oncoming seas of 3-4 ft (0.91-1.22 m) high.
- 2) The non-swimmers and a person with a heart condition were not wearing PFD's.
- 3) Operator shut the motor off rather than putting it in idle.
- 4) Operator dove in without wearing a PFD, but did have PFD's with him.

2. Boat Type: Length - 14 ft (4.27 m)  
Rental boat

This scenario is an example  
of the other/falls overboard accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Cloudy, good visibility  
Strong wind  
Rough water

#### Accident Scenario

Three men proceeding home from a fishing trip when the engine quit. The operator stood up to start the engine (which had not been put in neutral). As the engine started, he fell overboard. One of the POB's held onto him for a short time. The combination of the operator's heavy clothing, the rough water, and the movement of the boat prevented the POB from saving him. The operator disappeared below the water. None of the cushions on board were used. The body was recovered the next day.

#### Accident Related Behavior

- 1) Operator standing up in boat while starting engine.
- 2) Did not put engine in neutral before starting.

3. Boat Type: Length - 15 ft (4.57 m)  
Beam - 66 in. (167.64 cm)  
Rental boat

This scenario is an example  
of the other/falls overboard accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
15-20 mph (24.14-32.19 kph) winds  
Slack water - 2 ft (0.61 m) seas  
Water temperature - 39°F (3.89°C)

#### Accident Scenario

Two men and their dogs were at anchor fishing. At 1615 hrs, the POB noticed that his dog was shivering, so they decided to take the dog back to shore. The POB stood up and began to weigh anchor. While doing so he fell overboard. The operator started the motor in order to pick up the victim, but the anchor line had fouled the prop and he was unable to reach the POB. The operator cut the anchor line, but the engine still would not start. He was going to row to the victim (POB), but one of the oarlocks was missing. The boat began to drift rapidly away from the victim. Before rescuers arrived, the victim disappeared from sight.

#### Accident Related Behavior

- 1) Passenger standing up while weighing anchor.
- 2) Boat inadequately equipped.

## LIGHTWEIGHT/SWAMPINGS LEADING TO CAPSIZING

Lightweight/swampings leading to capsizing combination of accidents accounted for the following percentages of loading-related accidents.

- 12.64% of all loading-related accidents
- 55.93% of all swamping leading to capsizing accidents
- 14.29% of all fatalities

1. Boat Type: Length - 14 ft (4.27 m)

Weather/Water Conditions:

This scenario is an example of the lightweight/  
swamping leading to capsizing accidents  
occurring under the listed conditions.

Clear, good visibility

Moderate wind

Choppy water - strong current

Water temperature - 38°F (3.33°C)

### Accident Scenario

Three men departed for a fishing trip on a river. When they reached a point in the river where they wanted to fish, they anchored the boat. The position of the anchor was adjacent to the shoals of the river. After anchoring, the combination of the river current, wind, and the turbulent eddy currents of the shoals caused the water to surge over the port side gunwale, swamping then capsizing the boat. The men were dumped into the water. Two of the men clung to the boat; the third man (victim) went into the shoals and drifted until he caught hold of a rock. When the boat capsized, the anchor lost its hold and the boat drifted downstream about 400 yards (365.76 m) before the anchor held again. The operator removed his outer clothing and swam to shore for help. The victim began calling to him to hurry and bring a rope. The other survivor

still clung to the boat. About 30 minutes elapsed before the operator returned with the rescue squad. The victim had disappeared and the other man was tiring and getting chilled by the cold water. He was starting to pass out when one of the rescue squad members put on a life jacket, took an inner tube, and swam out to the survivor reaching him just as he was beginning to lose his grip. The body of the victim was recovered the next morning.

#### Accident Related Behavior

- 1) Improper anchoring of boat.
- 2) No PFD's available.

2. Boat Type: Length - 14 ft (4.27 m)      This scenario is an example of the lightweight/  
Beam - 62 in. (157.48 cm)      swamping leading to capsizing accidents  
Depth - 23 in. (58.42 cm)      occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
Wind - 25 mph (40.23 kph)  
Rough water - 3-4 ft (0.91-1.22 m) seas - tide  
had just turned and was flooding  
Air temperature - 51°F (10.56°C)  
Water temperature - 54°F (12.22°C)

Accident Scenario

At 2230 hrs, three adult males launched their boat to go out on a fishing trip. The operator had been experiencing engine trouble prior to the accident. The engine itself was too large for the boat which was rated for a 40 hp motor and the operator had a 50 hp engine on it (weight - 150 lb (68.04 kg)). The operator (140 lb (63.50 kg) and one POB were forward at the starboard and port sides, respectively. The other POB (170 lbs)(77.11 kg) was seated in the rear. At 2300 hrs the engine failed and the operator went aft to check the engine. This put the total weight at the stern at 460 lbs (208.65 kg). While the two men were working on the engine, a wave broke over the stern swamping and subsequently capsizing the boat. The three men entered the water with no PFD's even though there were three cushions stored under the deck. The men, being good swimmers, decided to swim to an island approximately 1000 yards (914.40 m) away. One hour later the two survivors saw the operator (victim) disappear, but were too exhausted to help him. They continued on to the island where they were picked up the next day by a passing boater.

Accident Related Behavior

- 1) Owner/Operator had overpowered boat which meant that it was overloaded.
- 2) Had been experiencing engine trouble. Engine failed.
- 3) Load distribution was unbalanced.
- 4) PFD's not accessible - could not be used.

3. Boat Type: Length - 12 ft (3.66 m)  
Beam - 48 in. (121.92 cm)  
Depth - 18 in. (45.72 cm)

This scenario is an example of the lightweight/swamping leading to capsizing accidents occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
15-25 mph (24.14-40.23 kph) wind  
Rough water - 1 ft (0.30 m) seas  
Air temperature - 35°F (1.67°C) estimate  
Water temperature - 50°F (10°C)

Accident Scenario

Five men set out to go duck hunting; going to a duck blind. Because of the cold weather, all the men were heavily clothed. They had gone about half a mile (0.80 km) when water started coming over the bow. The boat swamped, then capsized about 75 yards (68.58 m) offshore in about 20 ft (6.1 m) of water. As the boat swamped, two of the POB's (both had been sitting on the port side) jumped into the water. The other three POB's stayed with the capsized boat. The three with the boat kicked off their hip boots and removed their outer clothing. The two swimming to shore (A and B) both managed to remove their hip boots. About 25 yards (22.86 m) from shore, A and B disappeared from sight. (They may have been able to stand up, but didn't.) One of the POB's on the boat swam to two cushions floating in the water which he and one other POB utilized to swim to shore. A man on shore helped them and then took his boat out and rescued the third POB. The two victims' bodies were recovered shortly after on the shore about 10 yards (9.14 m) from where they disappeared.

Accident Related Behavior

- 1) Boat was overloaded.
- 2) Operator took an overloaded boat out in hazardous weather/water conditions.
- 3) Two of the passengers tried to swim to shore; did not have PFD's on.

## RUNABOUT/SWAMPINGS LEADING TO CAPSIZING

The runabout/swamping leading to capsizing combination of accidents accounted for the following percentages of loading-related accidents.

- 5.36% of all loading-related accidents
- 23.73% of all swamping leading to capsizing accidents
- 6.08% of all fatalities

1. Boat Type: Length - 14 ft (4.27 m)      This scenario is an example of the runabout/  
Beam - 66 in. (167.64 cm)      swamping leading to capsizing accidents  
Depth 30 in. (76.2 cm)      occurring under the listed conditions.

### Weather/Water Conditions:

Cloudy skies  
25 mph (40.23 kph) wind  
Rough water - 1-2 ft (0.31-0.61 m) seas  
Air temperature - 60°F (15.56°C)  
Water temperature - 65°F (18.33°C)

### Accident Scenario

At 0700 hrs, three men departed for a fishing trip. After about 30 minutes out from shore, a cabin cruiser passed behind the boat at a distance of about 50 ft (15.24 m). The large wake of the cruiser combined with the 1-2 ft (0.31-0.61 m) seas swamped the boat which then capsized. All three men were thrown clear of the boat into the water. They all swam back to the overturned boat and clung to it until about 0900 hrs. All of the men were considered good swimmers. One of the POB's decided to swim to an island about 1000 yards (914.40 m) to the north. None of the men were wearing PFD's; there had been three cushions on board, but they were washed away. Shortly after the POB (victim) began to swim to the island, the other two people were picked up by a passing boater. They searched for the victim, but were unable to find him. His body was recovered the next day.

### Accident Related Behavior

- 1) One of the passengers tried to swim to shore; did not have a PFD.

2. Boat Type: Length - 14 ft (4.27 m)  
Beam - 70 in. (177.80 cm)  
Depth - 30 in. (76.2 cm)  
Homemade kit boat

This scenario is an example of the runabout/  
swamping leading to capsizing accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Partly cloudy, good visibility  
18-22 mph (28.97-35.41 kph) winds  
Very rough water  
Air temperature - 60°F (15.56°C)  
Water temperature - 46-52°F (7.78-11.11°C)  
Small craft warnings in effect

Accident Scenario

Three people (two adult males and one teenage male) departed at 1600 hrs to set lobster traps. At 1800 hrs the boat was anchored 500 yards (457.20 m) northwest of Newport Harbor Light. The operator was sitting forward at the steering station. The other two POB's were standing in the stern. Two weighted lobster traps were located in the midships section of the boat.

One of the POB's in the stern had begun to weigh anchor, and as he did so the low cut transom was pulled underwater. The teenager noticed the water entering over the transom and he quickly moved to a position forward at which time the boat capsized. All three were thrown into the water. The boat re-righted itself, but again capsized. No one was wearing a PFD, but the teenager was able to grab a jacket and put it on before the wind and tide swept it away. The boy and the POB stayed with the boat while the operator swam to and retrieved a gas can. He used this as flotation gear while attempting to swim to Newport Naval Base for help. He was seen by someone on shore at 1900 hrs; at 1930 hrs he was taken from the water in a state of shock. Shortly after the operator left, the boy left the boat and the other POB and attempted to swim to a nearby island. He was carried by wind and tide

to another island where he was seen by a boater. He was taken from the water in a state of shock at 2017 hrs. A search for the victim was conducted over the next two days. His body was recovered 26 days after the accident. According to the autopsy, he was in the water three hours prior to death.

Accident Related Behavior

- 1) Boat was unbalanced.
- 2) Boat anchored improperly.
- 3) Passenger made sudden movement which caused a load shift.
- 4) Operator did not check the weather forecast before departure.
- 5) People tried to swim to shore.

3. Boat Type: Length - 14 ft (4.27 m)      This scenario is an example of the runabout/  
Beam - 66 in. (167.64 cm)      swamping leading to capsizing accidents  
Depth - 36 in. (91.44 cm)      occurring under the listed conditions.  
Homemade boat

Weather/Water Conditions:

Clear, visibility 20 miles (32.19 km)  
12-18 mph (19.31-28.97 kph) winds  
Very rough - 3-5 ft (0.91-1.52 m) seas  
Air temperature - 70° F (21.11° C)  
Water temperature - 64° F (17.78° C)

Accident Scenario

Four people, one adult and three children, and one dog, launched the boat at 0800 hrs to go fishing. They began fishing at 0900 hrs. At 0945 hrs while fishing it was noticed that the seas were increasing in height so the operator decided to return to the launch area. This meant that the boat would be headed directly into the seas. The operator proceeded at half speed, because at less speed the motor would die as it had once or twice. The three children sat in the forward area at first, but the operator had all the children in the stern area. This put the weight in the stern at about 560 lbs (254.01 kg) with only about 270 lbs (122.47 kg) in the forward area. At 1200 hrs the engine died and the boat began taking on water. The children tried to bail with their hands, but the boat swamped then capsized. All the occupants clung to the boat. One of the POB's made the statement that next time they would pay attention to the forecast. One and one-half hours later one of the children panicked. He put on a cushion with the pad on his back. The other people tried to help him put it on properly, but he fought off all help. He subsequently floated away, face down in the water. One of the children was given a PFD and told to swim to shore (time between 1400 and 1500 hrs). She was picked up about one hour later by a passing boater. When she left, the bow was the only part of the

boat above the water. A search was conducted. The first victim was found still floating face down seven hours after the accident. The other two victims were found the next day at two different locations. Neither one had on a PFD.

Accident Related Behavior

- 1) Improper weight distribution.
- 2) Did not pay attention to weather forecast.
- 3) No one was wearing a PFD.
- 4) No bailing device on board.

## LIGHTWEIGHT/SWAMPINGS

The lightweight/swamping combination of accidents accounted for the following percentages of loading-related accidents.

- 3.83% of all loading-related accidents
- 35.71% of all swamping accidents
- 5.17% of all fatalities

1. Boat Type: Length - 11 ft (3.35 m)  
Beam - 48 in. (121.92 cm)

This scenario is an example of the lightweight/swamping accidents occurring under the listed conditions.

Weather/Water Conditions:

Cloudy, fair visibility  
20-30 mph (32.19-48.28 kph) winds  
3-4 ft (0.91-1.22 m) seas  
Air temperature - 40-50°F (4.44-10.00°C)

### Accident Scenario

Three adult males out on a duck hunting trip. The area in the river where the accident occurred was known for having shallows with numerous low, mud islands dividing the river into several branches ranging from 100 to 500 yards (91.44 to 457.20 m) wide. The hunting was poor, so the men started back towards the launch area late in the evening. The tide had started to flood and the wind was picking up which caused the water to be rough. The boat, due to its overloaded condition, began taking on water. A large wave struck the boat from the stern, killing the engine and swamping the boat. The men entered the chest deep water holding onto the gunwales. The men were not able to dump the water out of the boat, so they turned the boat over so that it would float in a capsized position and they could hold onto it more easily. The incoming tide carried them into deeper water, so one of the POB's (A) decided to remove his hip boots and try to swim to shore 200 yards (182.88 m) away. The operator tried to remove the engine in order to make the boat more level. This was unsuccessful. About 50 yards (45.72 m) from the boat, A disappeared from sight. Shortly after,

the two survivors felt the bottom. They made their way to a small, mud island where they spent the night and were picked up the next morning. A's body was recovered 150 yards (137.16 m) from the scene of the accident the next day.

#### Accident Related Behavior

- 1) Boat was overloaded.
- 2) Passenger tried to swim to shore
- 3) No PFD's on board the boat.

2. Boat Type: Length - 12 ft (3.66 m)  
Beam - 42 in. (106.68 cm)  
Depth - 12 in. (30.48 cm)

This scenario is an example of the  
lightweight/swamping accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility

No wind

5-6 mph (8.05-9.66 kph) current

Air temperature - 80°F (26.67°C)

Water temperature - 70°F (22.11°C)

### Accident Scenario

Three adult males out on a fishing trip were drifting downstream with the motor running in neutral. The operator was at the stern facing aft, one POB was seated at the bow, and one POB was seated in the middle. The maximum capacity for the boat was 320 lbs (145.15 kg). The POB in the center (A) stood up and moved to the bow of the boat and sat down next to the POB (B) in the bow. A weighed 300 lbs (136.08 kg) and B weighed 150 lbs (68.04 kg) which put 450 lbs (204.12 kg) in the bow of the boat making the load distribution uneven. This load shift allowed the swirling water to enter the boat over the bow swamping the boat. A told B and the operator (C) to swim to shore. The two jumped into the water and began to swim the 75 ft (22.86 m) to shore. A stayed with the boat as it continued to sink. There were no PFDs on board at the time. About halfway to shore, C developed a severe cramp in his leg. He looked around for assistance and saw B struggle and disappear. At this time, A jumped into the water to try and help B, but disappeared immediately. C was able to make it to shore safely.

### Accident Related Behavior

- 1) Boat was overloaded.
- 2) Shift in weight by a passenger caused the boat to be unbalanced.
- 3) Two of the people tried to swim to shore.
- 4) There were no PFD's on board.

3. Boat Type: Length - 14 ft (4.27 m)  
Beam - 42 in. (106.68 cm)  
Homemade boat

This scenario is an example of the  
lightweight/swamping accidents  
occurring under the listed conditions.

Weather/Water Conditions:

Clear, good visibility  
Light wind  
Calm water

#### Accident Scenario

Seven persons, two adult males and five children, launched a 14 ft (4.27 m) boat into a river with the intention of fishing. The operator headed the boat upstream, but wakes from other boats passing by at slow speeds caused the small boat to rock uncomfortably. The operator decided to turn the small boat into the wakes, but the motor could not maintain a heading and was caught by the ebbing currents. The operator decided to turn around and head downstream until the other boats passed. Because of the overloaded condition (computed maximum number of people is three) of the boat, there was only four inches (10.16 cm) of freeboard at the stern. When the operator headed the boat downstream, the wakes from the other boats centered and swamped the boat. All of the people were in the water. One of the victims (six year old boy) disappeared immediately. There were no PFD's on board the boat. One of the adult males went to the aid of his son (five year old) and swam safely to shore. The other two victims (ages 9 and 11) began drifting with the current. Their father (operator) began to swim between his two sons. He told his oldest to dog paddle to shore, while he helped his other son who was struggling, face submerged. The oldest son panicked, swam back to his father and held on to his shoulder. This caused the father to be submerged, at which time he lost his grip on both sons who disappeared. The father made it to shore safely.

Accident Related Behavior

- 1) Boat was overloaded.
- 2) Operator headed the boat downstream with the waves at the stern.
- 3) No PFD's on board.
- 4) Tried to swim to shore rather than staying with boat.

### 2.3.2 Discussion of Course Texts

This discussion concerns texts used for the Coast Guard Auxiliary and the U. S. Power Squadron courses. It is not intended to reflect on the quality of the texts or on the courses offered by the organizations. Further, only major references to the accident related behavior discussed in the texts were included. It should be noted that both organizations concerned may have additional materials dealing with these problem areas.

The texts do discuss many of the problems associated with the scenarios, but in many cases they do not emphasize the exact causes of the accidents. Advice on PFD usage seems somewhat conservative in that it goes only as far as the PFD regulations (stating that PFDs should be accessible). For example, non-swimmers should wear a PFD while the boat is underway, but in one accident scenario the boat was drifting and so the victim (a non-swimmer) did not wear a PFD. It would seem appropriate to emphasize more PFD wear — for swimmers as well as non-swimmers, for adults as well as children, and for men as well as women. In some instances, the recommendation of the text actually tended to reinforce the accident related behavior; i.e., don't wear your PFD unless things get really bad.

What do the boating education materials say about movement and standing up in a boat? Since the Coast Guard Auxiliary sponsored the majority of courses taken (27.3%), their manual will be used for examples.

According to the Coast Guard Auxiliary manual (Reference 7, page 2):

"Standing up in a small boat is not especially dangerous if it is done carefully in calm water conditions, and if the boat is not too heavily laden. By standing up you will change the center of gravity of the boat, and if the hull is being buffeted about appreciably, it could cause the boat to capsize, or for you to fall overboard."

What is the advice given about weather? The Auxiliary manual states, "...weather should be taken seriously. Get the latest report before you depart, and keep informed while you are out." The majority of the advice is given for large boats, but some of it can be applied to those boats under 16 ft (4.9 m). Advice on hazardous water is not covered except as it pertains to weather. The manual is concerned mainly with operation in coastal waters.

According to the manual, overloading is one of the principal causes of loading-related accidents. The discussion on weight carrying capability has several statements which refer to or have implications for these types of accidents. For example:

"Many boats today have a capacity plate, generally on the instrument panel, where it can be easily seen, ..."\*

According to Subtask 1 of this report, the estimated percentage of boats in the population with capacity plates is approximately 74% of the total boat population. During a telephone survey of nighttime collision victims (results in MacNeill "Capacity Plate Effectiveness: Pleasure Boats," Reference 11), it was found that only 66% of the capacity plates were installed in a legitimate location; only 18% of these installations were on the instrument panel.

What is the effectiveness of capacity plates in preventing overloading-related accidents? According to Subtask 1 there was not a statistically significant difference between boats with and without capacity plates involved in loading-related accidents.

Addressing capsizing accidents, "Practical Hints for Safe Boating," the Auxiliary manual advises:

"It's best not to talk about capsizing since this may frighten your crew, but you should have your plans clearly in mind in the unlikely event that this might happen. Your boat will most likely remain afloat and you should see to it that nobody attempts to swim for shore. Remember, the chance of being located by a search plane or boat are far greater if all hands stay with the boat and hang on."

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\* Reference 7, page 2

The advice does not prepare the crew for an accident. The implication is that the operator, and only the operator, should know the emergency plans in case of a capsizing. It seems feasible that most persons can be prepared for emergency situations in a positive manner.

In boating education courses, information could be added on the handling of boats and the operating procedures for rivers and lakes. Courses presently emphasize the operation of larger boats. Since the U.S. Coast Guard has predicted an increase in the number of small boats in the future (Reference 12), the courses could be adapted to the newer trend. In addition, a high number of smaller boats were involved in loading-related accidents in this study. Educational programs can justifiably emphasize small boat operation.

In general, all of the courses deal with some of the loading-related accident problems. The courses often refer to courtesy and etiquette. If instructional materials could be made to treat the accident problem areas in-depth, and could be presented to enough boaters, the accident and fatality rate might be reduced.

### 3.0 CONCLUSIONS AND RECOMMENDATIONS

The goals of this study were to:

- identify causes of loading-related accidents, conditions associated with an accident, and characteristics of the accident victims and their boats,
- identify areas where educational programs could have helped to prevent the accidents, including those human operator responses which are repeatedly involved in loading-related accidents; and,
- identify areas where two of the current educational program texts deal with loading-related accident causes.

There appear to be many causes of loading-related accidents. In terms of the persons involved, the primary observations were:

- the population of operators in loading-related accidents may be different from the population of operators in the Nationwide Boating Survey in terms of age and boating experience. There were various differences in the age distributions of the accident operators and they tended to be less experienced.
- operators in loading-related accidents were no more likely to have had a boating safety course than other operators. However, there was evidence that operators who have had a course may be somewhat different from other operators with respect to hours on the water and whether or not the accident was initiated by the operators (internally initiated inside the boat). These questions seem to warrant further research.

There was certain accident related behavior on the part of the accident victims which occurred repeatedly in the accidents. These include the following:

- standing up in a small craft for any of several reasons, such as to work on or start a motor, to urinate, to move or change positions,
- leaning over the side,
- executing a sudden maneuver with the boat, or
- deciding to boat in hazardous weather or water.

The educational program materials were compared with loading-related accident scenarios. The comparisons indicated that the educational programs did deal generally with some of the accident causes. There was justification to include more specific treatment of some of the accident problem areas discussed.

Some suggestions for educational programs are:

- more emphasis on content for small boats.
- a sharing of emphasis for boating in inland as well as in coastal waters including weather conditions.
- more safety instruction concerning operator behavior that often leads to accidents
- more safety instruction aimed at improving the probability of survival given the occurrence of an accident (relating to discussions of accident types and emergency procedures, wearing of PFDs, etc.).
- the major effort of boater educational programs would seem to be better directed at smaller boats and their operators. It was noted that loading-related accidents frequently involved small boats (under 16 ft (4.9 m)).

Further research seems to be needed in boating safety instruction. Wyle Laboratories recently proposed two projects related to education addressing loading-related accidents. One of these projects reviews educational objectives and methods applicable for boating safety instruction. The goal of the project is to determine how available educational resources can be more effectively utilized, and to suggest ways in which educational techniques and media can be applied to boating safety education. The project includes the development and testing of model educational programs.

The second project proposed by Wyle will begin to explore a program for education applied specifically to loading-related accidents. This project includes a review of accident causes and recovery problem areas. Each area will be evaluated in terms of importance (number of lives lost) and its amenability to educational solution. The project will further identify the target populations, the media alternatives, message content, and the methods of presentation for each problem area.

Further research in the area of human response characteristics during an accident is also needed. For example, in-depth investigations could be conducted in order to determine when boaters can recognize potential accident situations before the accident actually occurs. It would seem particularly valuable to know if there are differences for these kinds of recognitions for those operators who have taken a boating safety course and those operators who have not taken a course. Such comparisons may indicate additional areas for improvement in all educational programs.

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SUBTASK III -  
OPERATOR CHARACTERISTICS OF A SPECIFIC LINE OF SMALL CRAFT

1.0 INTRODUCTORY SUMMARY

A particular line of small craft appear to have an impressive loading-related safety record. In 1974 there were no reports of loading-related accident involving these boats. Is this particular line of small craft safer than other boats of similar design? Or do they appeal to a more safety conscious population? This study attempts to answer the second question.

This subtask is concerned with determining if there are any characteristics of the operators of this particular line of small craft that could be responsible for the safety record. This study should not be taken as an endorsement or criticism of any trade, manufacturers' names, or products. Any manufacturers' names that appear herein are solely used because they are considered essential to the object of this report.

Boston Whaler operators (obtained from warranty card files) and operators of other boats (obtained from the Nationwide Boating Survey (Reference 1)) were interviewed by telephone. The areas of concern were their:

- general boating knowledge,
- boating experience,
- awareness of safe boating practices, and
- knowledge concerning capacity information and what it means.

The answers obtained from the two groups were compared to determine if there were any differences with regard to the areas of concern. The differences were used to specify those areas where Boston Whaler operators may possess attitudes that were responsible for the supposed safety record.

According to the data there are differences between Boston Whaler operators and other boat operators. The attitudes of Boston Whaler operators indicate an unusual awareness of safety and knowledge concerning boats and boating.

## 2.0 DATA ACQUISITION AND RESULTS

The Boating information on Boston Whaler (BW) operators and Nationwide Boating Survey (NBS) operators was obtained by telephone interviews conducted over a six week period. The telephone numbers of BW owners were selected randomly from the warranty card files of the Boston Whaler Company. The telephone numbers of NBS owners were selected randomly from the Nationwide Boating Survey. The requirements of the survey were: 1) the person must still own a boat, and 2) the boat must have been used in the last two years. The second requirement was used because the questionnaire had to do with usage of the boat. It was felt that if the operator had not used his boat for two years, then he would not remember the details needed for the survey.

From the interviews, data were obtained from 100 BW operators and 100 NBS operators. The interviews contained questions which provided information about the boat operator, his boating knowledge, and his awareness of safe boating practices. See Appendix III-A for the compilation of remaining questions and Appendix I-A for the complete questionnaire.

Upon completion of the interviews, the relevant data were extracted and tabulated. The first series of questions concerned the boat operator and his background. The data are shown in Table III-1.

TABLE III-1. BOAT OPERATORS BY AGE, INSTRUCTION, EXPERIENCE, AND TOTAL NUMBER OF BOATS OWNED \*

Background	BW Operators	NBS Operators
Age of Operator		
Mean	42 yrs	45 yrs
Median	44 yrs	44 yrs
Formal Boating Instruction		
Yes	40%	18%
No	60%	82%
Experience		
Under 20 Hrs	2%	5%
20 to 100 Hrs	13%	19%
101 to 500 Hrs	27%	41%
501 Hrs or Over	58%	35%
Boats Owned		
Mean Number	5	3

\* Experience is defined as the total number of boat operating hours; number of boats owned includes all boats owned during the person's life.

Data from seven pertinent questions concerning the operators' knowledge of safe boating practices and capacity information were collected and tabulated, as follows:

(1) Are you aware that your boat has a capacity limit?

<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
Yes	99%	93%
No	1%	7%

(2) Does your boat have capacity information such as a label or plate on it?

<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
Yes	97%	67%
No	2%	28%
Don't Know	1%	5%

(3) Do you know what information is given on the capacity plate? \*

<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
Yes	84.5%	78%
No	15.5%	22%

\* This percentage is based on the number of "yes" answers to No. 2 above.

What is the capacity limit given for:

- 1) Persons \_\_\_\_\_ (This may be given in number of people or poundage)
- 2) Horsepower \_\_\_\_\_
- 3) Persons, motor and gear maximum capacity \_\_\_\_\_

If an operator was not able to give at least one detailed answer on the capacity limit for persons, horsepower, or maximum capacity, his answer to Question (3) was tabulated as a "No."

(4) What does capacity information mean to you?

	<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
a)	Weight or people boat can carry	40%	53%
b)	Comment about capacity being safety feature	50%	31%
c)	Don't know	10%	16%

(5) Have you ever loaded your boat beyond its capacity limit?

<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
Yes	6%	10%
No	94%	90%

(6) Social pressure question: This was a two-part question - when asked, "How would you react if you discovered that you had more potential passengers for an outing than the capacity limit of your boat?", boat owners replied:

	<u>Response</u>	<u>BW Operators</u>	<u>NBS Operators</u>
a)	Wouldn't overload, make more than one trip, leave someone behind, or not go	94%	95%
b)	Depend on water conditions	6%	5%

The second part of the question was asked of those who answered that it would depend on the water conditions. The boater was placed in a hypothetical situation (see Appendix I-A, Question 18) where a party of eight plus gear (fishing and skiing) and food must be put in one boat rather than divided between two boats, as planned. All respondents replied that they would not take all the people at once. This, of course, contradicted what they had already said.

The social pressure example above illustrates one of the major concerns in collecting data via interviews: biases due to the social desirability or undesirability of the available answers. In the social pressure example, the subjects who had answered that their actions would depend upon water conditions contradicted that answer (to an extent) when placed in a similar situation by the next question. Another example of this problem is the set of responses to the automobile safety question (see Appendix III-A). All 200 subjects stated that they had not had an automobile accident in the last five years. That's a total of 1,000 man years of driving without an accident. Assuming 75 million drivers and 50,000 deaths on the highway per year, there is a traffic fatality for every 1,500 man years of driving. Obviously, the result of no accidents in 1,000 man years of driving appears suspect. In the present study, an attempt was made to minimize these sources of bias. However, the results to certain questions should be interpreted with caution.

### 3.0 ANALYSIS OF BOATER CHARACTERISTICS

To determine if there are characteristics peculiar to BW operators that are responsible for the presumed safety record of the Boston Whaler line of boats, their answers to certain questions were compared to the answers of NBS operators. These questions concerned the following areas:

- General boating knowledge
- Boating experience
- Awareness of safe boating practices
- Knowledge concerning capacity information and what it means.

The differences in the two sets of answers were used to specify the areas where BW operators possess attitudes which might be responsible for that line of boats apparently having a good safety record. The questions concerned only the operator and not the boat directly.

The first area studied was general boating knowledge. Two interrelated assumptions are made: 1) there is a direct correlation between taking a boating safety course and boating knowledge; and 2) there is a direct correlation between the number of boats owned and boating knowledge. Therefore, operators will generally be more knowledgeable about boats if they have taken a boating safety course and/or own (owned) several boats. The data for this area were obtained from the answers to the following questions:

- Have you ever taken a boating safety course?
- Is this the first boat that you have owned?
- If "no" to second question, how many boats have you owned prior to the one you have now?

Forty percent of the BW operators had taken a boating safety course, while only 18% of the NBS operators had taken a course, as shown below:

### SAFETY COURSE

	BW Operators	NBS Operators	
Safety Course	40 (29)	18 (29)	58
No Course	60 (71)	82 (71)	142
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 10.71$ ,  $df = 1$ ,  $p < 0.005$ ) indicates that Boston Whaler operators are significantly more likely to have taken a boating safety course than other boat operators.

Of the BW operators, 20 percent were first-time boat owners, while 32 percent of the NBS operators were first-time boat owners. A  $\chi^2$  test was run to determine if there was any statistical difference; the computations follow:

### FIRST-TIME BOAT OWNERS

	BW Operators	NBS Operators	
First Boat Owned	20 (26)	32 (26)	52
Not First Boat Owned	80 (74)	68 (74)	148
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 3.14$ ,  $df = 1$ ,  $0.05 < p < 0.10$ ) indicates a marginally significant difference, in the direction that BW operators are less likely to be first-time owners. This result is marginal, but the next comparison adds to its meaning.

The median number of boats ever owned by Boston Whaler operators is 3.59. The median number of boats owned by NBS operators is 2.78. The median for the two groups combined is 3.11. A  $\chi^2$  test was run to determine the association between BW operators and number of boats owned.

### NUMBER OF BOATS OWNED

	BW Operators	NBS Operators	
Above Median	51 (42.5)	34 (42.5)	85
Below Median	49 (57.5)	66 (57.5)	115
	100	100	200

Median for 200 scores = 3.11

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 5.24$ ,  $df_1$ ,  $p < 0.025$ ) indicates that there is a significant difference between the two groups. Boston Whaler operators are more likely to have owned more than three boats.

The mean number of boats ever owned by BW operators is 4.99. For NBS operators, the mean number of boats ever owned is 3.22. Figure III-1 shows the overall breakdown of the number of all boats owned by BW and NBS operators. As can be seen from the figure, more BW operators (N=33) have owned six or more boats than NBS operators (N=16).

The data indicates that BW operators are more likely to take a boating safety course and to have owned more boats than NBS operators. The data suggest that BW operators might have more general boating knowledge than NBS operators, because they've owned more boats and taken more courses.

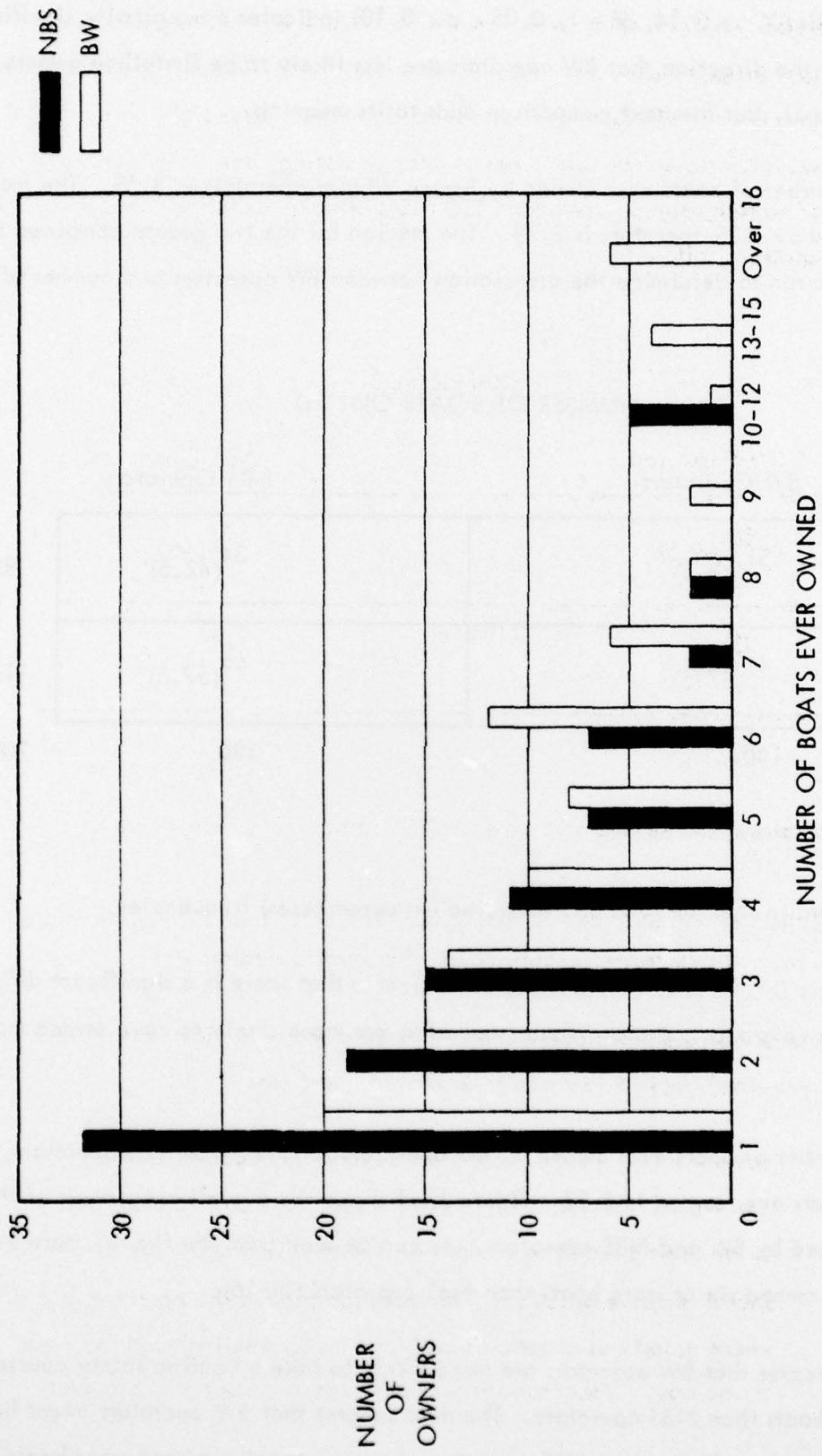


Figure III-1. Comparison of Boats Owned

The next area discussed is boating experience. For this report boating experience is defined as the total number of boat operating hours. Further, an "experienced" operator is defined as an operator with more than 500 hours of boat operating time. Fifty-eight percent of the BW operators interviewed had more than 500 hours of boat operating time. Thirty-five percent of the NBS operators interviewed had more than 500 hours of boat operating time. A  $\chi^2$  test was run; the computations follow:

EXPERIENCE

	BW Operators	NBS Operators	
Over 500 hrs	58 (46.5)	35 (46.5)	93
Less than 500 hrs	42 (53.5)	65 (53.5)	107
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 9.73$ ,  $df = 1$ ,  $p < 0.005$ ) indicates that BW operators are significantly more likely to be "experienced" than NBS operators.

Awareness of safe boating practices is the next area discussed. This was determined on the basis of the operators' answers to three interrelated questions:

- Have you ever loaded your boat beyond its capacity limit?
- How would you react if you discovered that you had more potential passengers for an outing than the capacity limit of your boat?
- Social pressure question: This question placed the operator in a situation where a party of eight plus gear (fishing and skiing) and food must be put in one boat rather than divided between two boats, as planned.

Ninety-four percent of the BW operators said they had never overloaded their boats. Ninety percent of the NBS operators said they had never overloaded their boats.

### LOAD LIMIT

	BW Operators	NBS Operators	
Yes	6 (8)	10 (8)	16
No	94 (92)	90 (92)	184
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 0.61$ ,  $df = 1$ ,  $p < 0.30$ ) indicates that one cannot conclude that BW operators are more or less likely to overload their boats than NBS operators.

The next questions asked for the operators' reaction to potential overloading situations. The first question determined the operators' reaction to an outing situation in which there are more potential passengers than the allowable capacity limit of the boat. Ninety-three percent of the BW operators answered that they would not overload their boats. Of the NBS operators, 95% answered that they would not overload their boats. Since the difference is so slight, a  $\chi^2$  test was not run because there would be no statistically significant difference between the two groups. This means that neither group is more or less likely to admit they would overload their boats.

The second question was asked of those operators who answered that it would "depend on the water conditions" or "didn't know." When these operators were placed in the hypothetical situation (see Page I-A-5), all answered that they would make more than one trip (not overload their boat). It is interesting that the question never mentioned water conditions, but did state that the distance to be travelled would be 16 miles (25.7 km). The distance travelled may have been a factor which could have biased the operators' responses.

The next area concerns capacity plates and the operators' awareness of the plate. Several questions concerning the plates and information were asked such as:

- Are you aware that your boat has a capacity limit?
- Does your boat have capacity information such as a label or plate on it?
- Do you know what information is given on the capacity plate?
- What does capacity information mean to you?

If BW operators are more aware of capacity limits and information, it may account for the fact that few Boston Whaler boats are involved in overloading-related accidents (i.e., capsizings, swampings, floodings, and falls overboard).

Ninety-nine percent of the BW operators were aware that their boat had a capacity limit, while 93% of the NBS operators were aware of that fact. A  $\chi^2$  test was run to determine if this difference is significant.

#### CAPACITY LIMIT

	BW Operators	NBS Operators	
Yes	99 (96)	93 (96)	192
No	1 (4)	7 (4)	8
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 3.26$ ,  $df = 1$ ,  $0.05 < p < 0.10$ ) indicates that there is a marginally statistically significant difference between the two groups. According to the analysis, BW operators may be more aware that a boat has a capacity limit than the NBS operators.

The next question concerned the operators' awareness of whether their boat had a capacity label. Ninety-seven percent of the BW operators answered that their boat had a capacity label. Sixty-seven percent of the NBS operators answered that their boat had a capacity plate. All of the Boston Whaler boats should have had capacity labels; while 71 of the other boats should have had capacity labels according to the year and manufacturer. This suggests that three of the BW operators and at least four of the NBS operators did not know that their boats had capacity labels. These data provide no basis from which to conclude that there is any difference in awareness of capacity labels for BW and NBS operators.

The answers tabulated for the fourth capacity question was determined on the basis of the operators' answers to two parts:

- Do you know what information is given on the capacity plate?
- What is the capacity limit given for:
  - 1) Persons
  - 2) Horsepower
  - 3) Persons, motor and gear maximum capacity

If an operator was not able to give at least one detailed answer on the second part, the answer was tabulated as a "No" for the entire question.

Eighty-two (84.5%) of the BW operators knew what the label said, while 52 (78%) of the NBS operators knew what it said. Are BW operators significantly more aware of capacity label information?

### CAPACITY PLATE INFORMATION

	BW Operators	NBS Operators	
Yes	82 (79.26)	52 (54.74)	134
No	15 (17.74)	15 (12.26)	30
	97	67	164

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 0.85$ ,  $df = 1$ ,  $p > 0.20$ ) does not support the conclusion that BW operators are more aware of what their labels say than NBS operators.

The last capacity question concerned the meaning of capacity information to the operators. Since capacity limits are set for purposes of safety, the number of answers which contained comments about capacity being a safety feature was tabulated. Fifty percent of the BW operators said the label was a safety feature, while 31% of the NBS operators said it was a safety feature. Are BW operators significantly more likely to have the attitude that capacity information is a safety feature than NBS operators?

### CAPACITY AS A SAFETY FEATURE

	BW Operators	NBS Operators	
Safety	50 (40.5)	31 (40.5)	81
Other	50 (59.5)	69 (59.5)	119
	100	100	200

Each cell contains the observed and expected (in parentheses) frequencies.

The  $\chi^2$  analysis ( $\chi^2 = 6.72$ ,  $df = 1$ ,  $p < 0.01$ ) indicates that BW operators are more likely to regard the capacity label as a safety feature.

The data tends to support the statement that the awareness of capacity limits and information could account for BW's safety record with regard to overloading-related accidents. Two of the four  $\chi^2$  tests showed a significant difference between the groups. The two tests indicated that BW operators are more likely to know that their boat has a capacity limit, and that the capacity limit is a safety feature.

## 4.0 DISCUSSION

What makes a safety conscious boat operator? The areas used to define safety consciousness in the present study were:

- General boating knowledge
- Boating experience
- Awareness of safe boating practices
- Knowledge concerning capacity information and what it means

Are Boston Whaler operators more safety conscious? The present data indicates that they have: 1) more boating knowledge (under the assumptions outlined on page III-6); 2) more boat operating experience; and 3) a greater awareness that their boat has a capacity and that it is a safety feature.

More specifically, the characteristics of Boston Whaler operators that make them different are:

- A greater number of BW operators have taken a boating safety course.
- BW operators have owned more boats.
- BW operators are more experienced.
- BW operators are more aware that their boat has a capacity limit.
- BW operators are more aware of the fact that capacity is a safety feature.

The more a boat is used, the more knowledge and experience may be acquired by the operator. Since BW operators have more boat operating experience, they may therefore have more knowledge of the boats and boating procedures.

Another of the important differences about BW operators is that more of them were aware that the capacity limits of boats are a safety feature. This is especially important because the safety record of the Boston Whaler boats is in the area of loading-related accidents. Few of this line of small craft are involved in accidents such as capsizings, swampings, or floodings.

The question arises, why do Boston Whaler operators possess certain safety-related characteristics that are different from owners of boats of similar size? This research effort was directed towards determining if a difference exists. Further research may explore the reasons for the differences. Perhaps the Boston Whaler marketing program that has stressed safety and quality for the past decade has been effective in that those who are attracted to the Boston Whaler boats are attracted because of safety reasons as opposed to performance, aesthetics, etc. Or perhaps the fact that Boston Whaler was the first to market this type of boat and that it is more expensive than any of its imitators carries the image of a status symbol which makes it a desirable addition to the "Yachtsman's" collection of boats.

Another factor may be the characteristics peculiar to the people in the New England area. The largest concentration of Boston Whaler owners are from the New England area with a background steeped in seafaring and boating. The area abounds with boating-oriented facilities and activities: yacht clubs, marinas, schools, and community clubs, offering courses in sailing and power boating to all who are interested.

The interviewer's impressions of Boston Whaler operators were that they were a different type of boater from the NBS people. The various impressions were that Boston Whaler operators are:

- more cooperative
- more articulate - possibly higher education level
- monied - many in professional fields (doctors, lawyers), executives, own their own business
- more confident in Boston Whaler than other owners are in their boats.

## 5.0 CONCLUSIONS

Boston Whaler operators are different from other boat operators. According to the data, their attitudes indicate an unusual awareness of safety and knowledge about boats when compared to NBS owners of boats 20 feet (6.1 m) and under.

These conclusions apply to the owner/operator only - consideration of the boat's physical parameters was not within the scope of the work reported herein.

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APPENDIX III-A

COMPILATION OF REMAINING QUESTIONS

1.	Length of boat.		
		BW	NBS
	Mean	14'	15'
	Mode	13'	14'
2.	Age of boat.		
		BW	NBS
	Mean	1.92 years	7.49 years
	Mode	2.00 years	6.00 years
3.	Were these the same type of boat that you now own?		
		BW	NBS
	Yes	33.7% (27)	42.6% (29)
	No	66.3% (53)	57.4% (39)
4.	What type engine do you have on your boat?		
		BW	NBS
	Outboard		
	Single	99%	95%
	Twin	1%	2%
	Manual		3%
5.	What is the total horsepower of the boat?		
		BW	NBS
	Mean	54 hp	36 hp
	Mode	40 hp	10 hp
6.	What material(s) is your boat hull made of?		
		BW	NBS
	Fiberglass	100%	40%
	Aluminum		48%
	Wood		12%

APPENDIX III-B

$\chi^2$  STATISTICS

The  $\chi^2$  statistics used in the third subtask were computed via the Yates correction for  $\chi^2$  with one degree of freedom. If the data are tabled as shown below, then  $\chi^2$  is computed according to,

$$\chi^2 = \frac{N (|ad - bc| - N/2)^2}{(a+b)(c+d)(a+c)(b+d)} \quad \text{with one degree of freedom}$$

a	b	a+b
c	d	c+d

a+c

b+d

N = a+b+c+d