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LEVEL FLOTATION COMPLIANCE GUIDELINE.(U)
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LEVEL FLOTATION COMPLIANCE GUIDELINE

American Boat and Yacht Council

U.S. Coast Guard Office of Boating Safety
Boating Technical Division
2100 2nd Street SW
Washington, D. C. 20590

January 1978
Final Report

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION

UNITED STATES COAST GUARD

WASHINGTON, D.C. 20590

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16. Abstract

The purpose of the level flotation regulations is to increase the visibility and survivability of individuals after a boating accident has occurred by requiring manufacturers to design certain boats less than 20 feet in length to float in an approximately level attitude when swamped, thus providing a platform from which the survivors can be rescued.

This Level Flotation Compliance Guideline contains explanatory and interpretative information, illustrations and diagrams to aid the average boatbuilder in complying with the level flotation regulations. This guideline does not dictate the methods a manufacturer must follow to comply with the regulations, but it is a guide to methods that, if they are followed, are acceptable to the Coast Guard as meeting the intent and purpose of the level flotation regulations.

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METRIC CONVERSION FACTORS

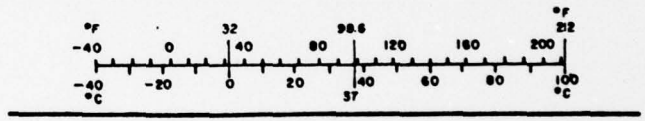
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
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^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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27 FEB 1978

FOREWORD

THIS LEVEL FLOTATION COMPLIANCE GUIDELINE WAS PREPARED BY THE AMERICAN BOAT AND YACHT COUNCIL (ABYC), A NON-PROFIT PUBLIC SERVICE ORGANIZATION, UNDER A U. S. COAST GUARD CONTRACT AWARDED TO ABYC PURSUANT TO THE AUTHORITY CONTAINED IN SECTION 25 OF THE FEDERAL BOAT SAFETY ACT OF 1971 (P. L. 92-75).

THIS GUIDELINE DOES NOT DICTATE THE METHODS A MANUFACTURER MUST FOLLOW TO COMPLY WITH THE REGULATIONS, BUT IT IS INTENDED TO BE USED AS A GUIDE TO METHODS WHICH, IF THEY ARE FOLLOWED, WILL BE ACCEPTABLE TO THE COAST GUARD AS MEETING THE INTENT AND PURPOSE OF THE REGULATIONS.

THE MEMBERS OF ABYC HAVE MADE EVERY EFFORT TO MAKE THIS GUIDELINE ACCURATE AND CONSISTENT WITH THE LEVEL FLOTATION REGULATIONS, AND THE COAST GUARD HAS REVIEWED IT FOR ANY INCONSISTENCIES. IN CASES WHERE IT APPEARS THAT A CONFLICT MAY EXIST, HOWEVER, USERS OF THIS GUIDELINE SHOULD ADHERE TO THE REQUIREMENTS OF THE REGULATIONS AND NOT THE SUGGESTED METHODS FOR COMPLIANCE DESCRIBED IN THIS GUIDELINE. ANY QUESTIONS SHOULD BE DIRECTED TO YOUR COAST GUARD DISTRICT BOATING STANDARDS OFFICE.

THE COAST GUARD WISHES TO THANK THE MEMBERS OF ABYC WHO CONTRIBUTED THEIR PERSONAL TIME TO THE DEVELOPMENT OF THIS COMPLIANCE GUIDELINE. THE GUIDELINE WILL AID SMALL VOLUME BOATBUILDERS WHO LACK LARGE ENGINEERING STAFFS AND EXTENSIVE TECHNICAL CAPABILITIES IN COMPLYING WITH THE REGULATIONS. THE RECREATIONAL BOATING PUBLIC WILL SOON REALIZE THE BENEFITS OF THE LEVEL FLOTATION REGULATIONS WHEN SWAMPED BOATS THAT ARE OUTBOARD POWERED OR MANUALLY PROPELLED FLOAT LEVEL.

D. F. LAUTH
Rear Admiral, U. S. Coast Guard
Chief, Office of Boating Safety

Dist: (SDL No. 106)
A: None
B: c(5); n(50)
C: None
D: None
E: s(2)
F: None

LEVEL FLOTATION COMPLIANCE GUIDELINE

LEVEL FLOTATION COMPLIANCE GUIDELINE

1.0 INTRODUCTION

To the date this was written, swamping and capsizing appear in 20 percent of the reported accidents and are implicated in 60 percent of the deaths in boating. No obvious changes in boat hull design would dramatically reduce the number of swampings and capsizings, but the seriousness of the accidents can be reduced and many fatalities can be avoided. The Coast Guard estimates that over 200 lives per year will be saved by requiring "Level Flotation" in certain boats.

The Coast Guard has been charged with saving lives on the water. They, and their advisory groups conducted careful research on boats and people who use them and concluded that a level, floating platform, capable of supporting a good measure of the weight normally aboard, even though that platform was partially submerged, is still the best, basic lifesaving tool.

"Level flotation" instills confidence in people to remain with the boat. With "basic flotation" only a portion of the hull may be exposed, and most times an area which is impossible to hang on to. A submerged boat which remains level will extend survival time, and through increased visibility, aid in search and rescue efforts. Level flotation for water craft is really nothing new. After all, wasn't that a feature of the very first log rafts?

Most small wooden boats have an inherent buoyancy, but those made of newer materials such as aluminum and fiberglass do not. In any boat, the use of flotation materials of the proper type, in correct quantities, suitably distributed, can create a level, floating platform that will support the passengers partially out of the water in the event of swamping.

Under the authority granted by the Federal Boat Safety Act of 1971 (PL 92-75) the Commandant, through the Office of Boating Safety, and with the concurrence of the National Boating Safety Advisory Council, initiated a regulation (33 CFR Part 183) on level flotation.

The far-reaching nature of this level flotation regulation makes it mandatory that you be familiar with the whole Boat Safety Act, particularly those sections containing the Definitions, Applicability, Prohibitions, Notification of Defects and Penalties, and all pertinent amendments. This knowledge is for the safety of the public and for your protection.

Compliance with the flotation regulation is the responsibility of the boat manufacturer. The U. S. Coast Guard will hire independent testing laboratories to make purchases of boats on the open market and to test them for compliance with all applicable standards. In the case of level flotation compliance, the purchased boat will be tested to determine precisely whether the proper amounts of flotation materials have been installed and correctly located. Flotation material properties will be checked at the same time.

If a test uncovers a non-compliance situation and the resultant follow-up reveals that other similar models are in the hands of consumers, the builder must notify all distributors, dealers and first purchasers of the deficient products. Compliance is the boat builders responsibility, not the duty of the vendor of the flotation material used.

So that you may know something of the extent of the responsibility, the builder is liable for all costs incurred to remedy the defect and is further subject to civil penalties of up to a $2,000 fine for each violation (a violation being considered one unit of the product not complying with one standard) and a maximum fine of $100,000 for any series of violations.

The wording of most legislation is prescribed by legal limitations and at best it makes for difficult reading. Where possible this guideline will step around the wording in the rule to help you comply with the flotation regulation. Different wording will be used, hints and suggestions will be made, not to circumvent the regulation, but to interpret it and offer alternatives and methods not permitted to be included in the original wording of the statute.

PAGES

Title 33—Navigation and Navigable Waters

CHAPTER I—COAST GUARD, DEPARTMENT OF TRANSPORTATION

[CGD 75-168]

PART 183—BOATS AND ASSOCIATED EQUIPMENT

Flotation Standards for Boats

AGENCY: Coast Guard, DOT.

ACTION: Final Rule.

SUMMARY: These amendments to the Coast Guard flotation standard are designed to increase the visibility and survivability of boaters following a boating accident, by requiring manufacturers to design certain boats less than 20 feet in length to float in an approximately level attitude when swamped, thus providing a platform from which the occupants can be rescued.

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EFFECTIVE DATE: This regulation is effective on August 1, 1978, however, manufacturers may voluntarily comply with the regulations at the time of this publication.

19

Subpart E—Flotation

1. By amending Subpart E by revising § 183.61 to read as follows:

§ 183.61 Applicability.

This subpart applies to monohull boats, the construction or assembly of which is begun after July 31, 1973, but before August 1, 1978, that are less than *20 feet in length, except monohull boats* that meet the requirements of Subparts F, G, or H of this Part, sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

19, 20, 21, 22

2. By adding new subparts F, G, and H to follow Subpart E and to read as follows:

Subpart F—Flotation Requirements for Inboard Boats, Inboard/Outdrive Boats, and Airboats

Sec.

19, 22

Subpart F—Flotation Requirements for Inboard Boats, Inboard/Outdrive Boats, and Airboats

§ 183.101 Applicability.

This subpart applies to monohull inboard boats, inboard/outdrive boats, and airboats less than 20 feet in length, the construction or assembly of which is begun after July 31, 1978, except sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

§ 183.105 Quantity of flotation required.

(a) Each boat must have enough flotation to keep any portion of the boat above the surface of the water when the

22, 43, 44, 45

boat has been submerged in calm, fresh water for at least 18 hours and loaded with—

(1) A weight that, when submerged, equals two-fifteenths of the persons capacity marked on the boat;

(2) A weight that, when submerged, equals 25 percent of the dead weight; and

(3) A weight in pounds that, when submerged, equals 62.4 times the volume in cubic feet of the two largest air chambers, if air chambers are used for flotation.

(b) For the purpose of this section, "dead weight" means the maximum weight capacity marked on the boat minus the persons capacity marked on the boat.

§ 183.110 Flotation materials and air chambers.

(a) As installed in a boat, flotation materials must withstand—

(1) The combined effects of contact with oil, oil products, or other liquids or compounds with which the material may be expected to come in contact during normal use; and

(2) The combined effects of exposure to sunlight, vibration, shock, and temperature variations expected during normal use.

(b) Air chambers used to meet the flotation requirements of this subpart must not be integral with the hull.

Subpart G—Flotation Requirements for Outboard Boats Rated for Engines of More Than 2 Horsepower

GENERAL

Subpart G—Flotation Requirements for Outboard Boats Rated for Engines of More Than 2 Horsepower

GENERAL

§ 183.201 Applicability.

(a) This subpart applies to monohull outboard boats that are—

(1) Less than 20 feet in length;

(2) Rated for outboard engines of more than 2 horsepower; and

(3) Constructed or assembled after July 31, 1978.

(b) This subpart does not apply to sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

§ 183.202 Flotation and certification requirements.

Each boat to which this subpart applies must be manufactured, constructed, or assembled to pass the stability and flotation tests prescribed in §§ 183.225 (a), 183.230(a), and 183.235(a).

22, 43, 44, 45

22, 43, 45

56, 57

22, 66

Section 4.0, 49–54

Section 5.0, 55 – 56

56, 57, 70

19, 20

65 – 84

§ 183.205 Passenger carrying area.

(a) For the purpose of this section a boat is level when it is supported on its keel at the two points shown in Figure 2.

(b) As used in this subpart, the term "passenger carrying area" means each area in a boat in which persons can sit in a normal sitting position or stand while the boat is in operation. Passenger carrying areas are illustrated in Figures 3 through 8.

(c) The length of the passenger carrying area is the distance along the centerline of the boat between two vertical lines, one at the forward end and one at the aft end of the passenger carrying area, when the boat is level as illustrated in Figures 3 and 4. For boats with a curved stem inside the passenger carrying area, the forward vertical line is where a line 45 degrees to the horizontal when the boat is level is tangent to the curve of the stem, as illustrated in Figure 5. For boats with cabins, the forward vertical line is where there is a minimum distance of two feet between the inside top of the cabin and the water line formed when the boat is swamped and loaded with weights under § 183.220 as illustrated in Figure 6.

(d) The breadth of each passenger carrying area is the distance between two vertical lines at the mid-length, excluding consoles, of the passenger carrying area when the boat is level as illustrated in Figures 7 and 8. For boats with round chines inside the passenger carrying area, the vertical line is where a transverse line 45 degrees to the horizontal is tangent to the arc of the chine, as illustrated in Figure 8.

§ 183.210 Reference areas.

(a) The forward reference area of a boat is the forward most 2 feet of the top surface of the hull or deck, as illustrated in Figure 9.

(b) The aft reference area of a boat is the aft most two feet of the top surface of the hull or deck, as illustrated in Figure 9.

§ 183.215 Reference depth.

Reference depth is the minimum distance between the upper most surface of the submerged reference area of a boat and the surface of the water measured at the centerline of the boat, as illustrated in Figure 10. If there is no deck surface at the centerline of the boat from which a measurement can be made, the reference depth is the average of two depth measurements made on opposite sides of, and at an equal distance from, the centerline of the boat.

§ 183.220 Preconditioning for tests.

A boat must meet the following conditions for at least 18 hours before the tests required by §§ 183.225, 183.230, and 183.235:

(a) Manufacturer supplied permanent appurtenances such as windshields and convertible tops must be installed on the boat.

(b) The boat must be loaded with a quantity of weight that, when sub-

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merged, is equal to the sum of the following:

(1) The sum of 50 percent of 550 pounds of the persons capacity marked on the boat and 12½ percent of the remainder of the persons capacity.

(2) Twenty-five percent of the result of the following calculation, but not less than zero: the maximum weight capacity marked on the boat; less the weight shown in Column 6 of Table 4 for maximum horsepower marked on the boat; less the persons capacity marked on the boat.

(c) The weights required by paragraph (b) of this section must be placed in the boat so that the center of gravity of each amount of weight required by paragraphs (b)(1) and (b)(2) of this section is within the shaded area illustrated in Figure 11. The location and dimensions of the shaded area are as follows:

(1) the shaded area is centered at the mid-length of the passenger carrying area and at the mid-breadth of the boat;

(2) the length of the shaded area, measured along the centerline of the boat, is equal to 40 percent of the length of the passenger carrying area of the boat; and

(3) the breadth of the shaded area, measured at the midlength of the passenger carrying area, is equal to 40 percent of the breadth of the passenger carrying area of the boat.

(d) Weight must be placed in the normal operating position of the motor and controls and the battery in lieu of this equipment. The required quantity of weight used for this purpose depends upon the maximum rated horsepower of the boat being tested and is specified in Columns 2 and 4 of Table 4 for the swamped weight of the motor and controls and for the submerged weight of the battery, respectively.

(e) Permanent fuel tanks must be filled with fuel and each external opening into the fuel tank must be sealed.

(f) The boat must be keel down in the water.

(g) The boat must be swamped, allowing water to flow between the inside and outside of the boat, either over the sides, through a hull opening, or both. Entrapped air in the flooded portion of the boat must be eliminated.

(h) Water must flood the two largest air chambers and all air chambers integral with the hull.

§ 183.222 Flotation material and air chambers.

(a) As installed in a boat, flotation materials must withstand—

(1) The combined effects of contact with oil, oil products, or other liquids or compounds with which the material may be expected to come in contact during normal use; and

(2) The combined effects of exposure to sunlight, vibration, shock, and temperature variations expected during normal use.

(b) Air chambers used to meet the flotation requirements of this subpart must not be integral with the hull.

20, 36

35, 37

35, 37

Figure 7.3, 71

Figure 7.3, 71

Figure 7.3, 71

Figure 7.5, 76

Table II, 47

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56, 70

Section 4.0, 49 – 54

56, 70

§ 183.225 Flotation test for persons capacity.

Flotation standard. When the conditions prescribed in § 183.220 are met, the boat must float in fresh, calm water as follows:

(a) The angle of heel does not exceed 10 degrees from the horizontal. — 77, 78

(b) Any point on either the forward or aft reference area is above the surface of the water. — 67, 76

(c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less. — 67, 76

§ 183.230 Stability test.

(a) *Flotation standard.* When the conditions prescribed in § 183.220 (a), (d) through (h) and paragraphs (b) and (c) of this section are met, the boat must float in fresh, calm water as follows:

(1) The angle of heel does not exceed 30 degrees from the horizontal. — 77, 78

(2) Any point on either the forward or aft reference area is above the surface of the water. — 67, 76

(3) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 12 inches or less. — 67, 76

(b) *Quantity of weight used.* Load the boat with a quantity of weight that, when submerged, is equal to the sum of the following:

(1) One-half of the quantity of weight required by § 183.220(b)(1). — 74

(2) The quantity of weight required by § 183.220(b)(2). — 34, 35

(c) *Placement of quantity of weight: starboard side.* Place the weight required by paragraph (b) of this section in the boat so that—

(1) The quantity of weight required by § 183.220(b)(2) is positioned in accordance with § 183.220(c); and

(2) One-half the quantity of weight required by § 183.220(b)(1) is uniformly distributed over a distance along the outboard perimeter of the starboard side of the passenger carrying area that is equal to at least 30 percent of the length of the passenger carrying area so that the center of gravity of the quantity of weight is located within the shaded area illustrated in Figure 12, the center of gravity of the amount of weight placed on the floor of the boat is at least 4 inches above the floor, and the center of gravity of the amount of weight placed on a seat is at least 4 inches above the seat. The location and dimensions of the shaded area are as follows: — 72, 76, 79

(i) The shaded area is centered at the mid-length of the passenger carrying area; — 79

(ii) The length of the shaded area is equal to 70 percent of the length of the passenger carrying area; and — 72

(iii) The breadth of the shaded area is 6 inches from— — 72

(A) For weights placed on the floor, the outboard perimeter of the passenger carrying area; and — 72

(B) For weights placed on a seat, a vertical line inside the passenger carrying area as illustrated in Figure 13.

(d) *Placement of quantity of weight: port side.* The quantity of weight required by paragraph (b)(1) of this section is placed along the port side of the passenger carrying area in accordance with the conditions prescribed in paragraph (c)(2) of this section.

§ 183.235 Level flotation test without weights for persons capacity.

When the conditions prescribed in § 183.220(a), (d) through (h) are met, the boat must float in fresh, calm water as follows:

(a) The angle of heel does not exceed 10 degrees from the horizontal.

(b) Any point on either the forward or aft reference area is above the surface of the water.

(c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less.

Subpart H—Flotation Requirements for Outboard Boats Rated for Engines of 2 Horsepower or Less

GENERAL

TESTS

Subpart H—Flotation Requirements for Outboard Boats Rated for Engines of 2 Horsepower or Less

GENERAL

§ 183.301 Applicability.

(a) This subpart applies to monohull boats that are—

(1) Less than 20 feet in length;

(2) Rated for manual propulsion or outboard engines of 2 horsepower or less; and

(3) Constructed or assembled after July 31, 1978.

(b) This subpart does not apply to sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

§ 183.302 Flotation requirements.

Each boat to which this subpart applies must be manufactured, constructed, or assembled to pass the stability and flotation tests prescribed in § 183.325(a), 183.330(a), and 183.335(a).

§ 183.305 Passenger carrying area.

(a) For the purpose of this section, a boat is level when it is supported on its keel at the two points shown in Figure 2.

(b) As used in this subpart, the term "passenger carrying area" means each area in a boat in which persons can sit in a normal sitting position or stand while the boat is in operation. Passenger carrying areas are illustrated in Figures 3 through 8.

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(c) The length of each passenger carrying area is the distance along the centerline of the boat between two vertical lines, one at the forward end and one at the aft end of the passenger carrying area, when the boat is level, as illustrated in Figures 3 and 4. For boats with a curved stem inside the passenger carrying area, the forward vertical line is where a line 45 degrees to the horizontal when the boat is level is tangent to the curve of the stem, as illustrated in Figure 5. For boats with cabins, the forward vertical line is where there is a minimum distance of two feet between the inside top of the cabin and the water line formed when the boat is swamped and loaded with weights under § 183.220 as illustrated in Figure 6.

(d) The breadth of the passenger carrying area is the distance between two vertical lines at the mid-length, excluding consoles, of the passenger carrying area when the boat is level as illustrated in Figures 7 and 8. For boats with round chines inside the passenger carrying area, the vertical line is where a transverse line 45 degrees to the horizontal is tangent to the arc of the chine, as illustrated in Figure 7.

§ 183.310 Reference areas.

(a) The forward reference area of a boat is the forward most 2 feet of the top surface of the hull or deck as illustrated in Figure 9.

(b) The aft reference area of a boat is the aft most two feet of the top surface of the hull or deck, as illustrated in Figure 9.

§ 183.315 *Reference depth.*

Reference depth is the minimum distance between the upper most surface of the submerged reference area of a boat and the surface of the water measured at the centerline of the boat, as illustrated in Figure 10. If there is no deck surface at the centerline of the boat from which a measurement can be made, the reference depth is the average of two depth measurements made on opposite sides of, and at an equal distance from, the centerline of the boat.

§ 183.320 Preconditioning for tests.

A boat must meet the following conditions for at least 18 hours before the tests required by §§ 183.325, 183.330, and 183.335:

(a) Manufacturer supplied permanent appurtenances such as windshields, and convertible tops must be installed on the boat.

(b) The boat must be loaded with a quantity of weight that, when submerged, is equal to the sum of the following:

(1) Two-fifteenths of the persons capacity marked on the boat.

(2) Twenty-five percent of the result of the following calculation, but not less than zero: the maximum weight capacity marked on the boat; less the weight shown in column 6 of Table 4 for the maximum horsepower marked on the boat; less the persons capacity marked on the boat.

(c) The weights required by paragraph (b) of this section are placed in the boat

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so that the center of gravity of each amount of weight required by subparagraphs (b)(1) and (b)(2) of this section is within the shaded area illustrated in Figure 11. The location and dimensions of the shaded area are as follows:

(1) the shaded area is centered at the mid-length of the passenger carrying area and at the mid-breadth of the boat;

(2) the length of the shaded area, measured along the centerline of the boat, is equal to 40 percent of the length of the passenger carrying area of the boat; and

(3) the breadth of the shaded area, measured at the mid-length of the passenger carrying area, is equal to 40 percent of the breadth of the passenger carrying area of the boat.

(d) Weight must be placed in the normal operating position of the motor and controls in lieu of this equipment. The quantity of weight used for this purpose depends upon the maximum rated horsepower of the boat being tested and is specified in Column 2 of Table 4 for the swamped weight of the motor and controls.

(e) Permanent fuel tanks must be filled with fuel and each external opening into the fuel tank must be sealed.

(f) The boat must be keel down in the water.

(g) The boat must be swamped, allowing water to flow between the inside and the outside of the boat, either over the sides, through a hull opening, or both. Entrapped air in the flooded portion of the boat must be eliminated.

§ 183.322 Flotation materials.

As installed in a boat, flotation materials must withstand—

(a) The combined effects of contact with oil, oil products, or other liquids or compounds with which the material may be expected to come in contact during normal use; and

(b) The combined effects of exposure to sunlight, vibration, shock, and temperature variations expected during normal use.

§ 183.325 Flotation test for persons capacity.

Flotation standard. When the conditions prescribed in § 183.320 are met, the boat must float in fresh, calm water as follows:

(a) The angle of heel does not exceed 10 degrees from the horizontal.

(b) Any point on either the forward or aft reference area is above the surface of the water.

(c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less.

§ 183.330 Stability test.

(a) *Flotation standard.* When the conditions prescribed in § 183.320(a), (d) through (g) and paragraphs (b) and (c) of this section are met, the boat must float in fresh, calm water as follows:

(1) The angle of heel does not exceed 30 degrees from the horizontal.

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Table II, 47

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Section 4.0, 49 – 54

77, 78

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77, 78

(2) Any point on either the forward or aft reference area is above the surface of the water.

(3) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 12 inches or less.

(b) *Quantity of weight used.* Load the boat with quantity of weight that, when submerged is equal to the sum of the following:

(1) One-half the quantity of weight required by § 183.320(b)(1).

(2) The quantity of weight required by § 183.320(b)(2).

(c) *Placement of quantity of weight starboard side.* Place the quantity of weight required by paragraph (b) of this section in the boat so that—

(1) The quantity of weight required by § 183.320(b)(2) is positioned in accordance with § 183.320(c); and

(2) One-half the quantity of weight required by § 183.320(b)(1) is uniformly distributed over a distance along the outboard perimeter of the starboard side of the passenger carrying area that is equal to at least 30 percent of the length of the passenger carrying area so that the center of gravity of the quantity of weight is located within the shaded area illustrated in Figure 12, the center of gravity of the amount of weight placed on the floor of the boat is at least 4 inches above the floor and the center of gravity of the amount of weight placed on a seat is at least 4 inches above the seat. The location and dimensions of the shaded area are as follows:

(i) The shaded area is centered at the mid-length of the passenger carrying area;

(ii) The length of the shaded area is equal to 70 percent of the length of the passenger carrying area; and

(iii) The breadth of the shaded area is 6 inches from—

(A) For weights placed on the floor, the outboard perimeter of the passenger carrying area; and

(B) For weights placed on a seat, a vertical line inside the passenger carrying area as illustrated in Figure 13.

(d) *Placement of quantity of weight: port side.* The quantity of weight required by paragraph (b)(1) of this section is placed along the port side of the passenger carrying area in accordance with the conditions prescribed in paragraph (c)(2) of this section.

§ 183.335 Level flotation test without weights for persons capacity.

When the conditions prescribed in § 183.320(a), (d) through (g) are met, the boat must float in fresh, calm water as follows:

(a) The angle of the heel does not exceed 10 degrees from the horizontal.

(b) Any point on either the forward or aft reference area is above the surface of the water.

(c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less.

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Weights (pounds) of Outboard Motor and Related Equipment for Various Boat Horsepower Ratings

Boat horsepower rating	Column No. 1	2	3	4	5	6
	Motor and control weight		Battery weight		Full portable fuel tank	
	Dry	Swamped	Dry	Submerged	weight	1+3+5
0.1 to 2	25	20	—	—	—	25
2.1 to 3.9	35	30	—	—	—	35
4.0 to 7	55	48	—	—	25	80
7.1 to 15	75	65	20	11	50	145
15.1 to 25	100	88	45	25	50	195
25.1 to 45	155	135	45	25	100	300
45.1 to 80	240	210	45	25	100	385
80.1 to 150	315	275	45	25	100	460
150.1 to 250	420	300	45	25	100	565
Transoms designed for twin motors						
50.1 to 90	310	270	90	50	100	500
90.1 to 160	480	420	90	50	100	670
160.1 to 300	630	550	90	50	100	820

PAGE 47

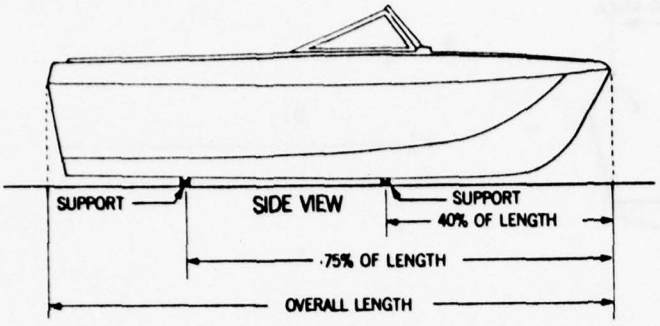

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FIGURE 1- LOCATION OF SUPPORTS FOR LEVEL BOAT

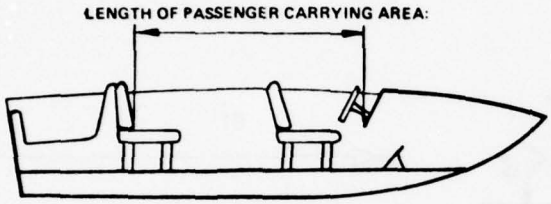

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FIGURE 2- BOAT WITH DECK

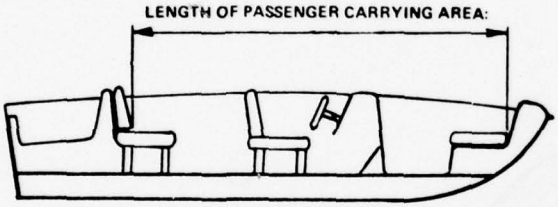

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FIGURE 3- BOAT WITH CENTER CONSOLE

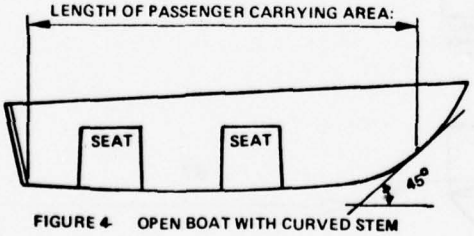

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FIGURE 4- OPEN BOAT WITH CURVED STEM

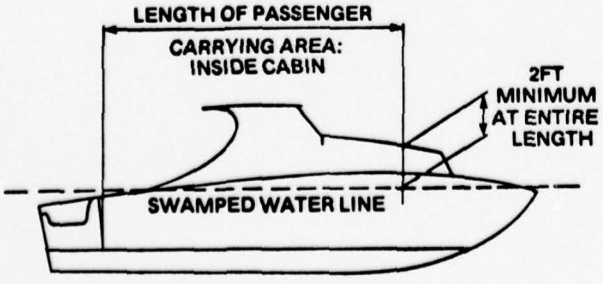

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FIGURE 6. BOAT WITH CABIN

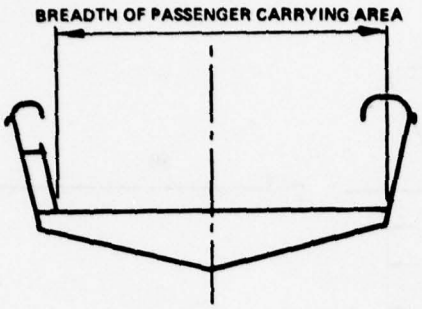

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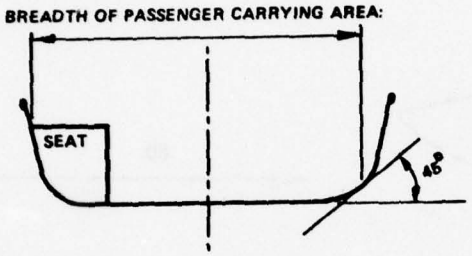
FIGURE 7



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FIG' 8 BOAT WITH ROUND CHINE

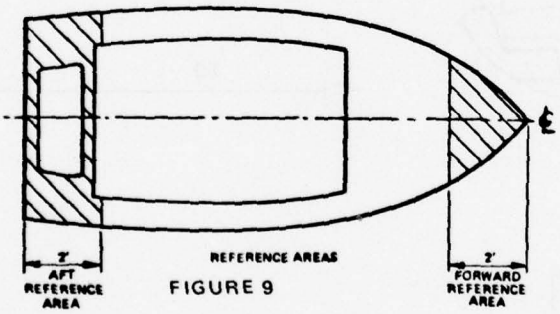

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FIGURE 9

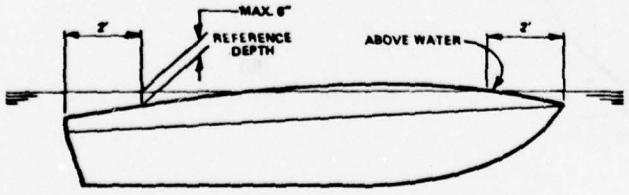

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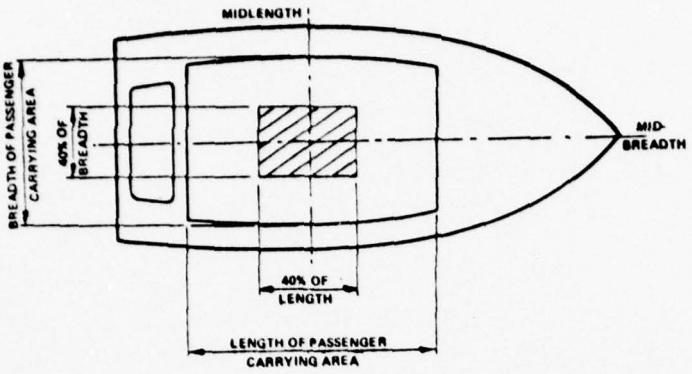
FIG.10 REFERENCE DEPTH

PASSENGER CARRYING AREA: LOCATION OF CENTER OF GRAVITY OF WEIGHTS

FIGURE 11



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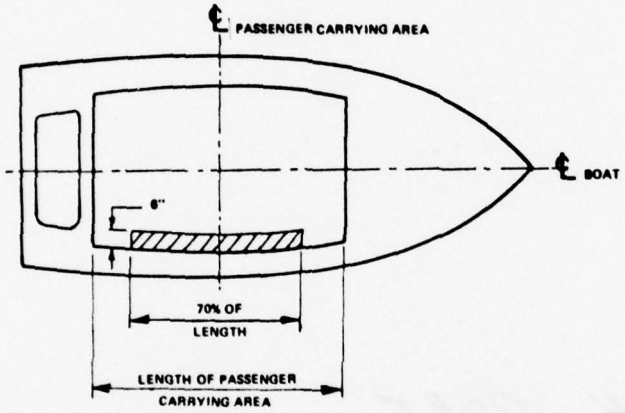

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FIG' 12 STABILITY TEST LOCATION OF CENTER OF GRAVITY OF WEIGHTS: STARBOARD SIDE

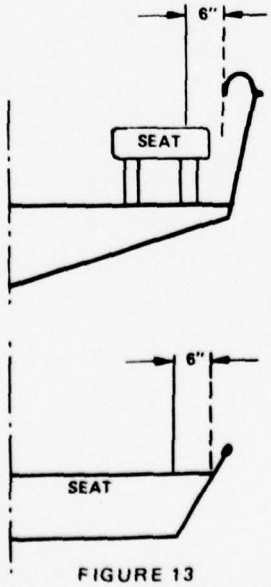

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FIGURE 13

LOCATION OF CENTER OF GRAVITY OF WEIGHTS ON SEATS

2.0 SUMMARY

Title 33 Code of Federal Regulations, Part 183, Subpart E contains the "basic" flotation requirements which apply to monohull boats, the construction or assembly of which was begun after July 31, 1973 but before August 1, 1978. It applies to boats which are less than 20 feet in length. It does not apply to sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

Effective August 1, 1978, Subparts, F, G, and H of Part 183 become regulation.

(1) Subpart F – Applies to Inboard Boats, Inboard/Outdrive boats and Airboats.
(2) Subpart G – Applies to Outboard Boats rated for engines of more than 2 horsepower.
(3) Subpart H – Applies to Outboard Boats rated for engines of 2 horsepower or less and boats for use with manual propulsion.

All boats must be monohull, less than 20 feet in length. It does not apply to sailboats, canoes, kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels and raceboats. These Subparts apply to boats constructed or assembled after July 31, 1978.

In the text the terms "motor" and "engine" are used interchangeably.

DEFINITIONS:

MONOHULL – Any vessel on which, when it is at rest and carries its maximum rated H.P. capacity and maximum weight capacity, the line of intersection of the water surface and the hull forms a single closed curve. For example, a catamaran, trimaran or pontoon boat is not a monohull boat.

RACEBOAT – Any vessel, which the United States Coast Guard has granted an exemption from applicable safety standards because it is manufactured solely for use in sanctioned racing events and is not intended for use as a recreational boat. Each race boat shall bear the label required by the United States Coast Guard Grant of Exemption which evidences these facts.

SAILBOAT – A boat designed or intended to use sail as the primary means of propulsion.

NOTE: In the event of a question of interpretation of these definitions, consult with the United States Coast Guard.

FLOTATION REQUIREMENTS

MONOHULL BOATS UNDER 20 FEET*

BOAT TYPE	1978 MODELS	SUBPART	EFFECTIVE WITH 1979 MODELS
Outboard–Over 2 horsepower	Basic	G	Level
Outboard–2 horsepower or Less AND Manually Propelled	Basic	H	Modified Level
Inboard and Inboard/Outdrive	Basic	F	Basic

**It does not apply to Sailboats, Canoes, Kayaks, Inflatables, Submersibles, Surface Effect Vessels, Amphibious Vessels and Raceboats.*

FOR OUTBOARD BOATS (SUBPART G)

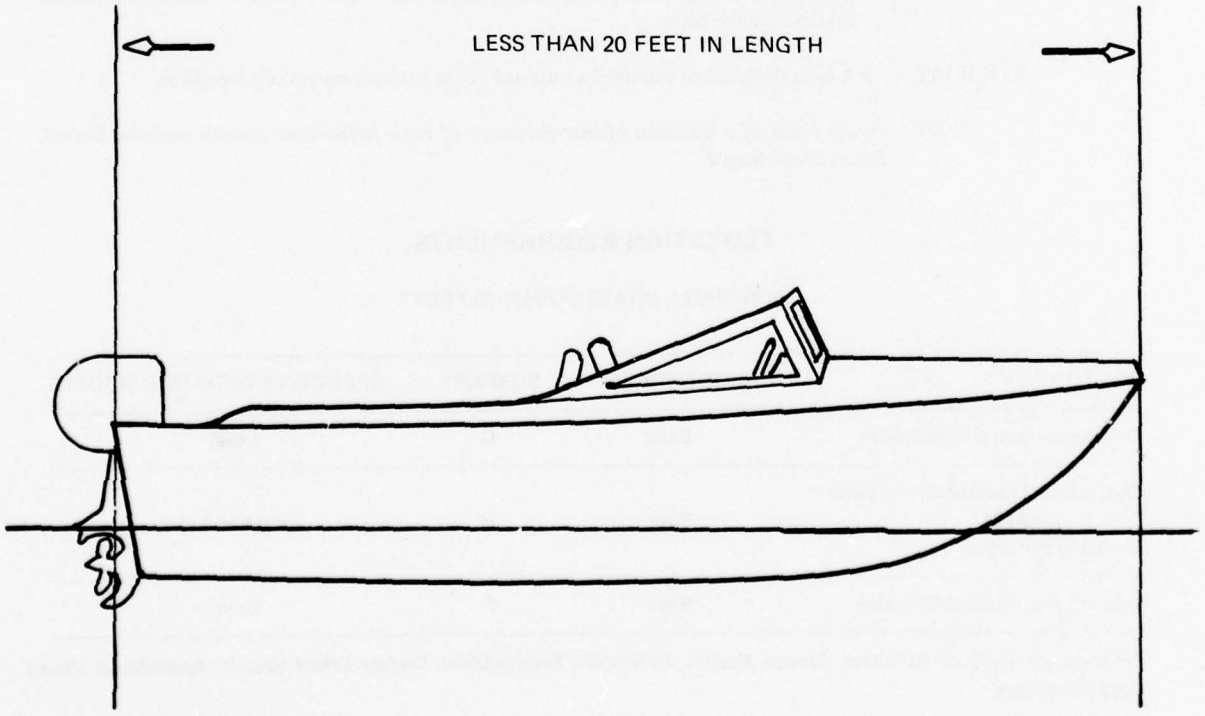
(1) Less than 20 feet in length
(2) Monohull
(3) Rated for engines of more than 2 horsepower
(4) Constructed or assembled after July 31, 1978

Level flotation is required, providing flotation for:

(a) the swamped boat
(b) the propulsion system
(c) 50 percent of the first 550 pounds of the persons capacity, and
(d) 12 1/2 percent of the remainder of the persons capacity weight
(e) 25 percent of the following:

the maximum weight capacity, MINUS–
the weight of the engine, battery, controls and full portable fuel tanks, MINUS–
the persons capacity.

(See Example page 43)



FOR OUTBOARD BOATS AND MANUALLY PROPELLED BOATS (SUBPART H)

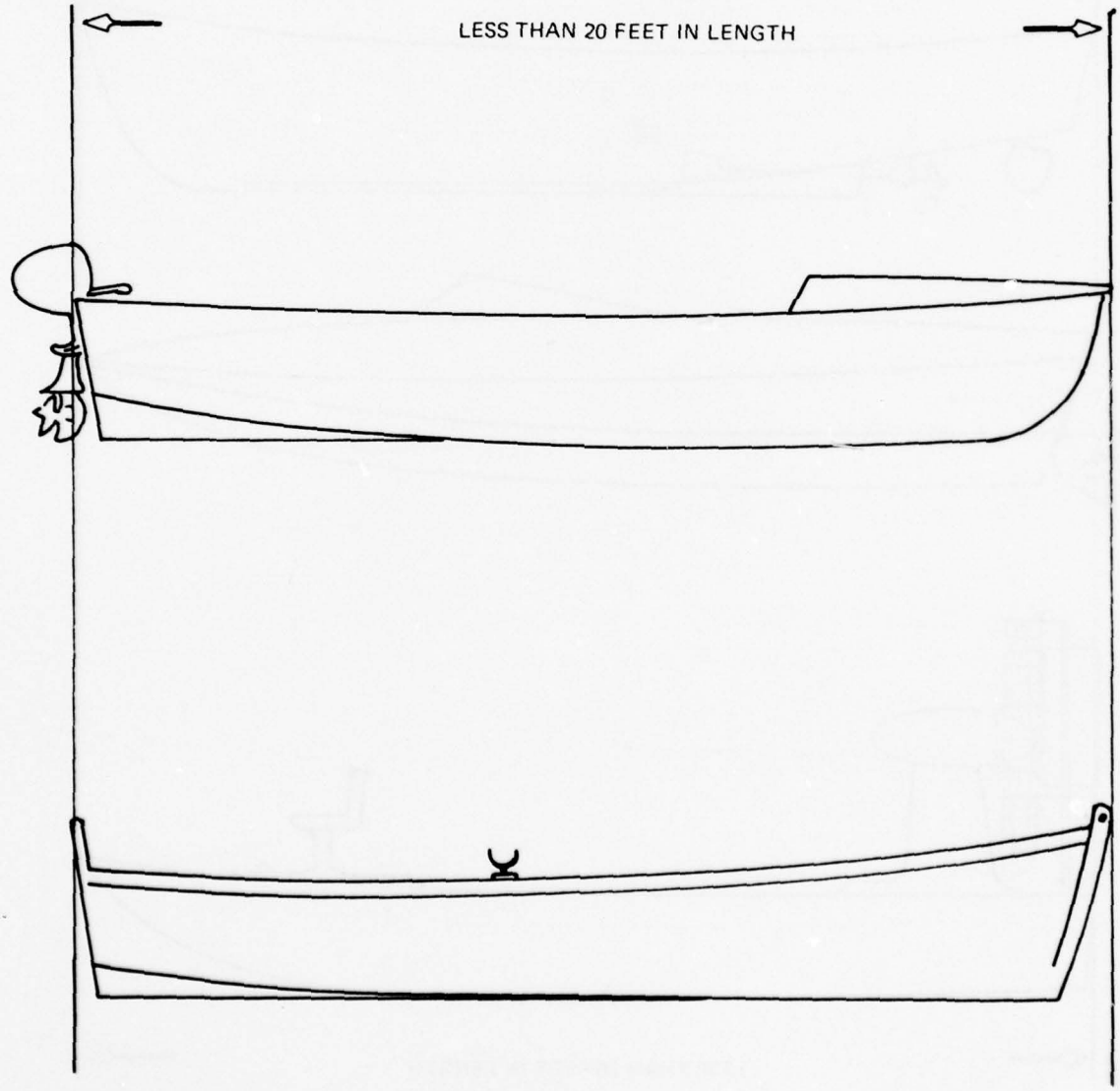
(1) Less than 20 feet in length
(2) Monohull
(3) If an outboard – rated for engines of 2 horsepower or less
(4) Constructed or assembled after July 31, 1978

Level flotation is required, providing flotation for:

(a) two-fifteenths (13 1/3 percent) of the persons capacity, PLUS –
(b) 25 percent of the result of the following:

the maximum weight capacity, MINUS –
the weight of the engine, controls, battery and portable fuel tank, MINUS –
the persons capacity.

(See Example pages 40 – 41)



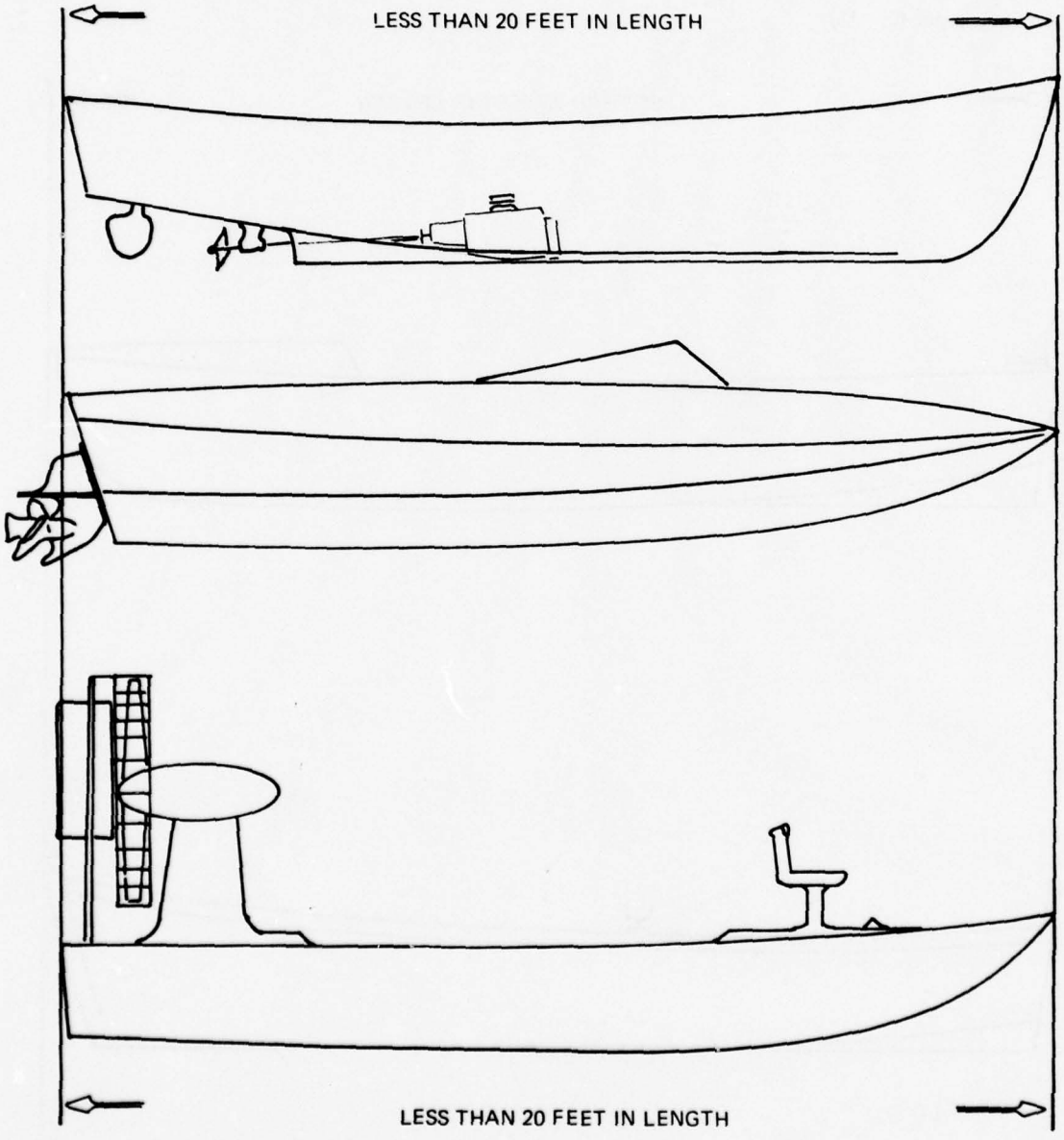
FOR INBOARD BOATS, INBOARD/OUTDRIVE BOATS, AND AIRBOATS (SUBPART F)

(1) Less than 20 feet in length
(2) Monohull
(3) Constructed or assembled after July 31, 1978

Basic flotation for:

(a) two-fifteenths (13 1/3 percent) of the persons capacity, AND –
(b) 25 percent of the dead weight
(Dead Weight is the maximum weight capacity MINUS the persons capacity).

(See Example page 34)



3.0 CALCULATIONS

The calculation methods which follow outline a system which can be used as a design criteria for most of the boats which must comply with the US Coast Guard test procedures for flotation. The calculation method provides for the recommended amount of flotation material which will be necessary to meet the standard. The calculations must be carefully done and the values inserted into the formulas must be accurate.

The distribution of the flotation material, if the guideline is followed, should provide the stability required.

Please be cautioned that the calculations will work for MOST boats, (we know of no case to date where they haven't) but it is conceivable that a special design or a departure from current design practices may not fit these methods. The calculations in these cases are a point of departure and actual flotation tests based on these basic methods will have to dictate the final quantity and distribution of the flotation material.

Manufacturer installed or supplied optional accessories for permanent installation must be considered in all combinations and the most severe conditions should be used in calculations and tests.

Unlike most options, fuel filled fuel tanks generally provide buoyancy during flotation tests and may affect stability test results.

It is acknowledged that the calculation method highly restricts the distribution of the flotation material. Depending upon the design of the particular boat, some variance in the distribution of the flotation material from the guideline may still meet the USCG test criteria, the calculations are aimed toward the safe side, but it is recommended that for design purposes the guide be followed as closely as possible.

Five formulas and examples follow. The first, second, third and fourth formulas indicate the quantity of flotation material necessary to maintain a LEVEL swamped attitude with the passenger load in a normal position and in accord with the boat's maximum weight capacity. The fifth formula covers BASIC flotation.

Sufficient stability is provided in the level flotation formulas to prevent a swamped boat from capsizing in calm water when the passenger load capacity is evenly distributed, or low in the boat at one side of the passenger carrying area. The formulas do not provide a self-righting capability should the craft capsize – nor do the regulations require it.

Boats provided with level flotation in accordance with these formulas should float near the sheer line if swamped. Selection of the sheer line as the approximate swamped waterline helps with the calculations. Since most boats are manufactured in units which divide at about the sheer line, it permits actual weighing of the above and below the swamped waterline parts of a boat, and these values are used in the formulas. (See Figure 3.10)

In concept, these calculations divide the boat's flotation into quantities necessary to:

(1) Support the swamped boat as equipped by the manufacturer.
(2) Support the propulsion system (including the outboard motor and batteries), and
(3) Support the required portion of the load capacity.

And, for level flotation, the flotation material must be so located or distributed in or on the boat that it supports the boat, the propulsion system and the passengers in a LEVEL attitude when swamped.

THE SWAMPED BOAT

The flotation material for the boat alone should be placed symmetrically about the balance point of the boat. The balance point may be found by placing the hull, when out of water, on a single roller, such as a small diameter pipe, and moving the boat until it balances on the single support point. This balance point may be anywhere between the boat's midlength and 1/3 of the boat length forward of the aft end of the boat. The flotation material which will support the swamped boat should be distributed equally forward and aft of the balance point. The same holds true for the distribution of the flotation material across the boat, generally with the fore and aft centerline acting as the transverse balance point. (See figures 3.1, 3.2, and 3.3.)

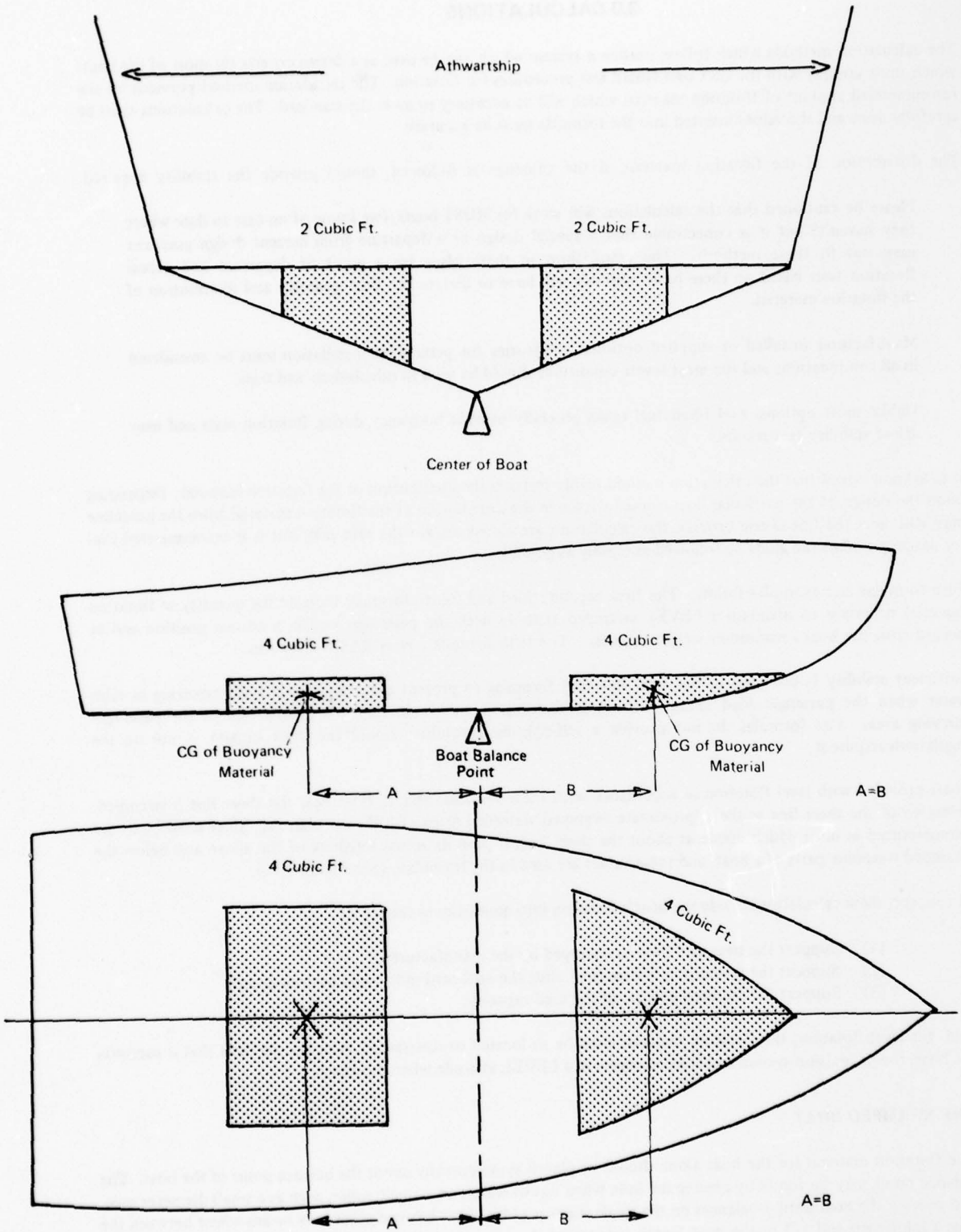
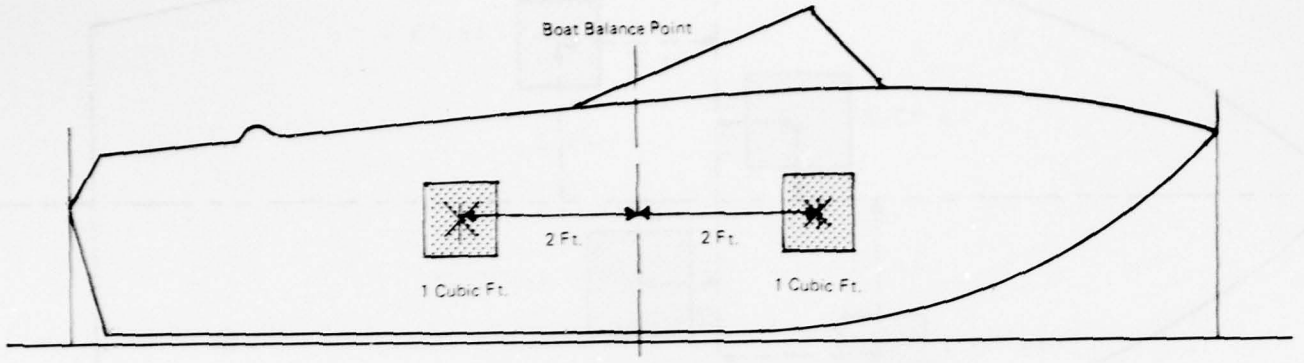


FIGURE 3.1 PLACEMENT OF FLOTATION MATERIAL



Equal Quantities –
Equal Distance From
Boat Balance Point

Unequal Quantities –
Twice the Quantity – Half the Distance From
The Boat Balance Point

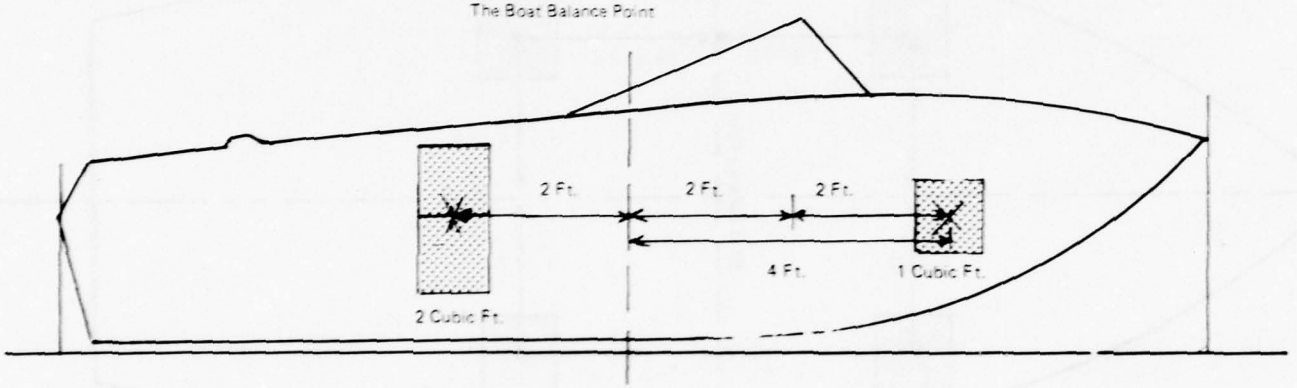
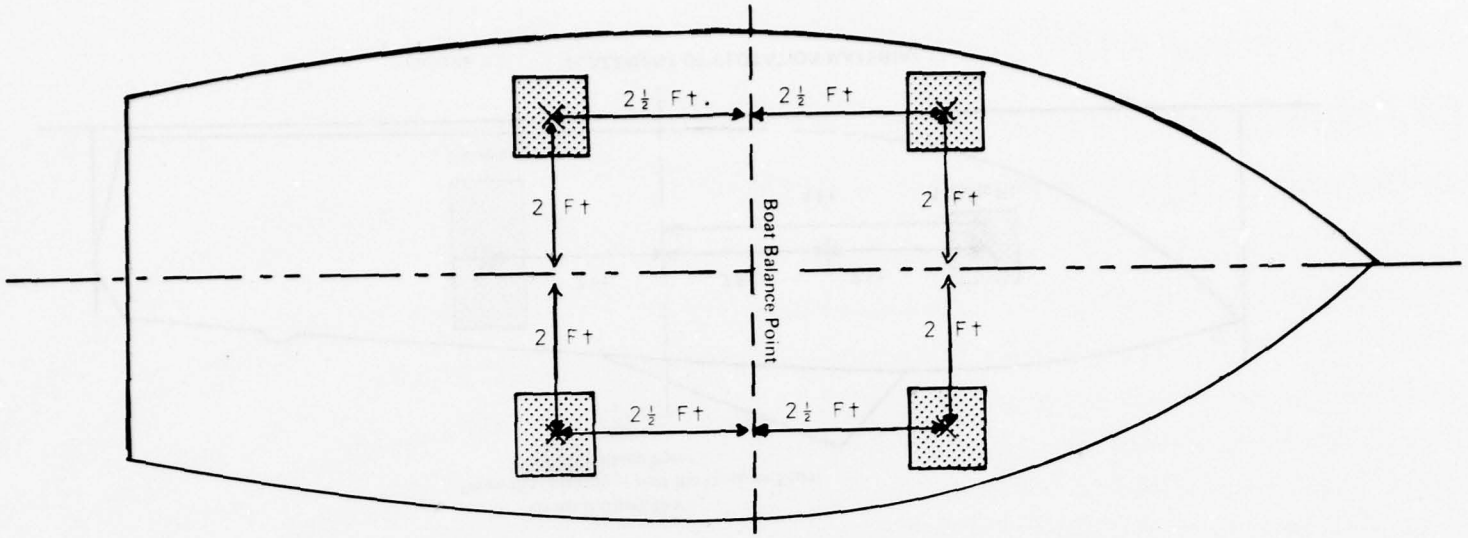


FIGURE 3.2 PLACEMENT OF FLOTATION MATERIAL



Depending upon Boat Weight Distribution Flotation Material
Must Supply Balanced Moments

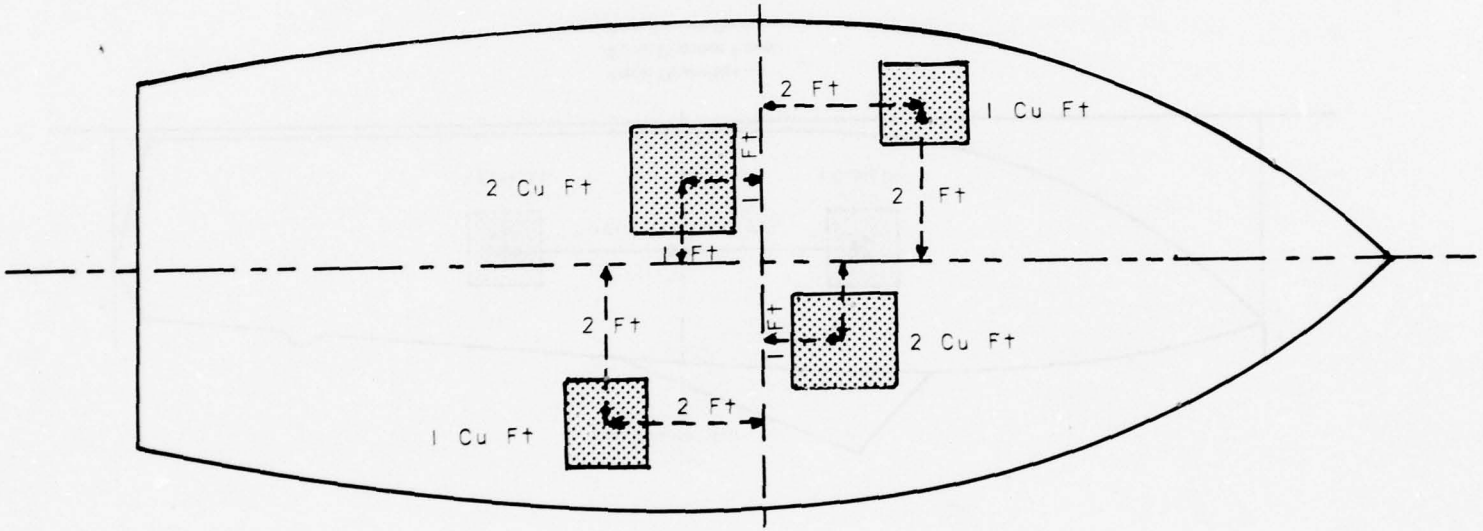


FIGURE 3.3 PLACEMENT OF FLOTATION MATERIAL

THE PROPULSION SYSTEM

The flotation material for the propulsion system should be located symmetrically about the system. With the engine aft, large amounts of flotation material will be needed near the stern to compensate. If a battery or batteries must be located off-center and they may be placed on either side of the boat, flotation material must be provided to compensate for the choice of either location. If a specific battery location is used in the calculations this location should be indicated or apparent on all boats. For boats 15 feet long or longer, large amounts of flotation material should be within 3 feet of the outside aft edge of the transom; for boats less than 15 feet in length this should be reduced to 30 inches. Flotation material located in these areas is primarily for the propulsion system, however, these areas may also be selected for locating flotation material for the boat and the load capacity. If so, remember the need for balancing flotation materials fore and aft each side of balance point.

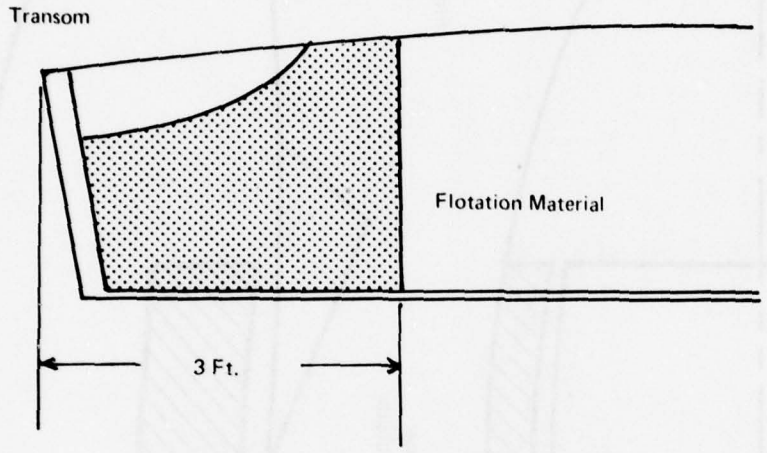
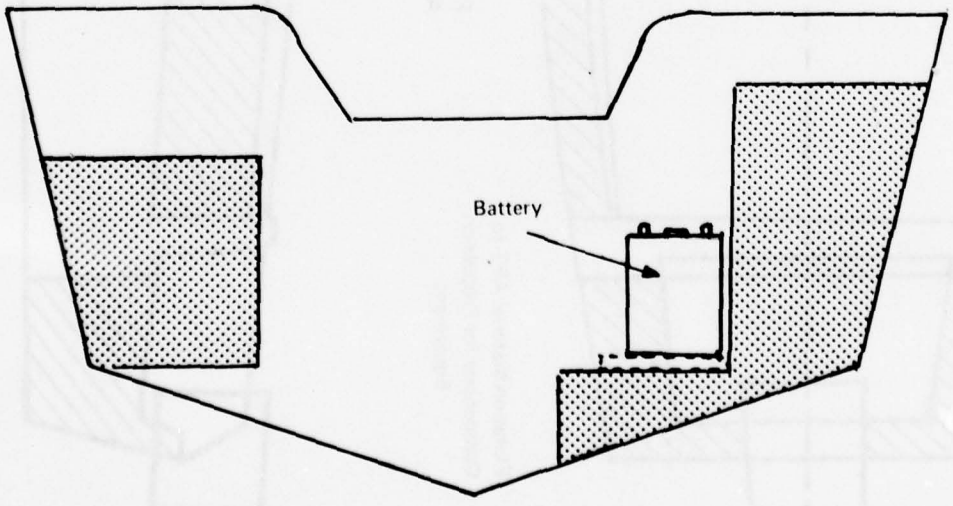


FIGURE 3.4 FLOTATION MATERIAL FOR PROPULSION SYSTEM



Foam Added Off-Center to Compensate for Off-Center Battery Weight

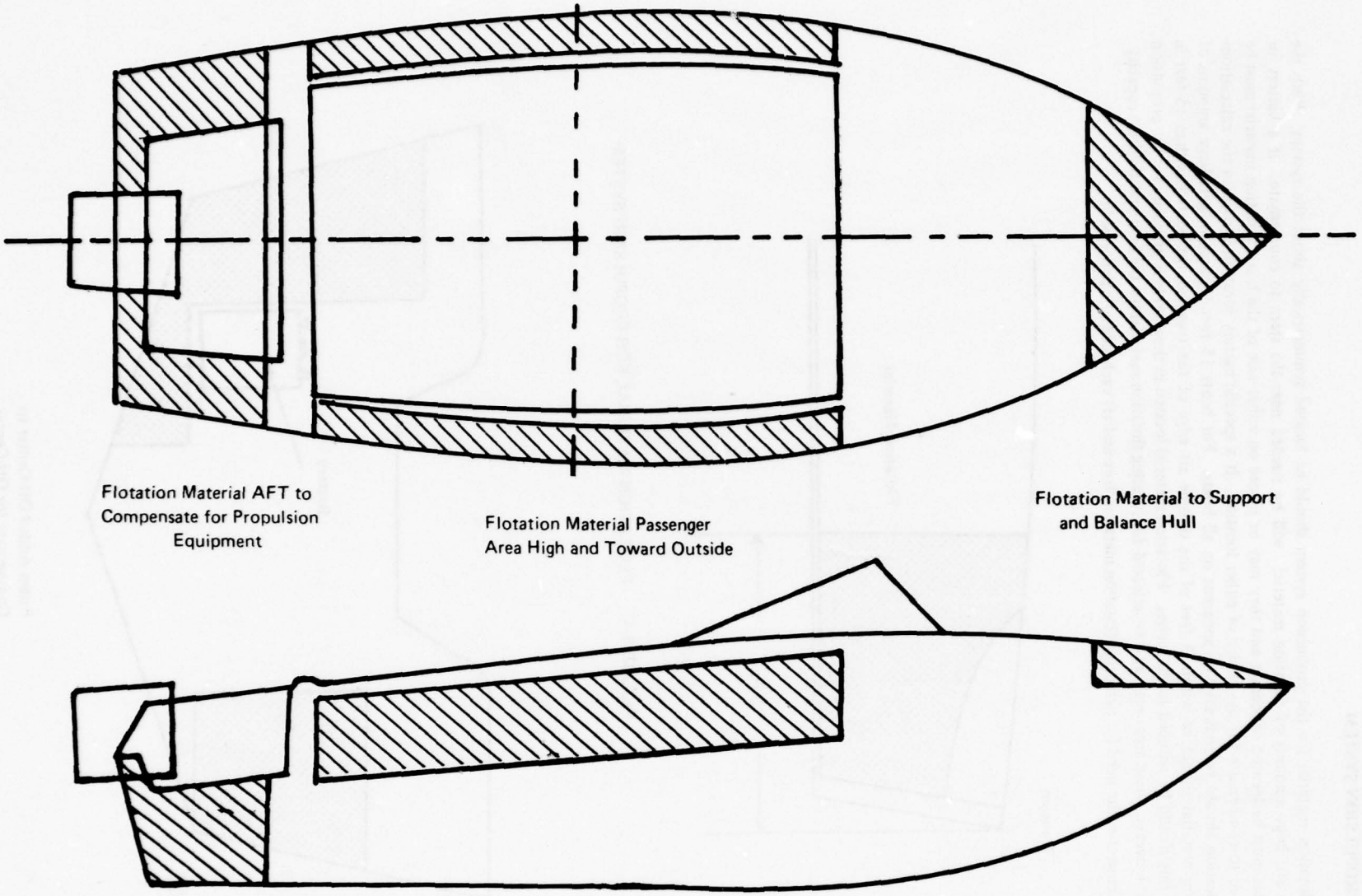
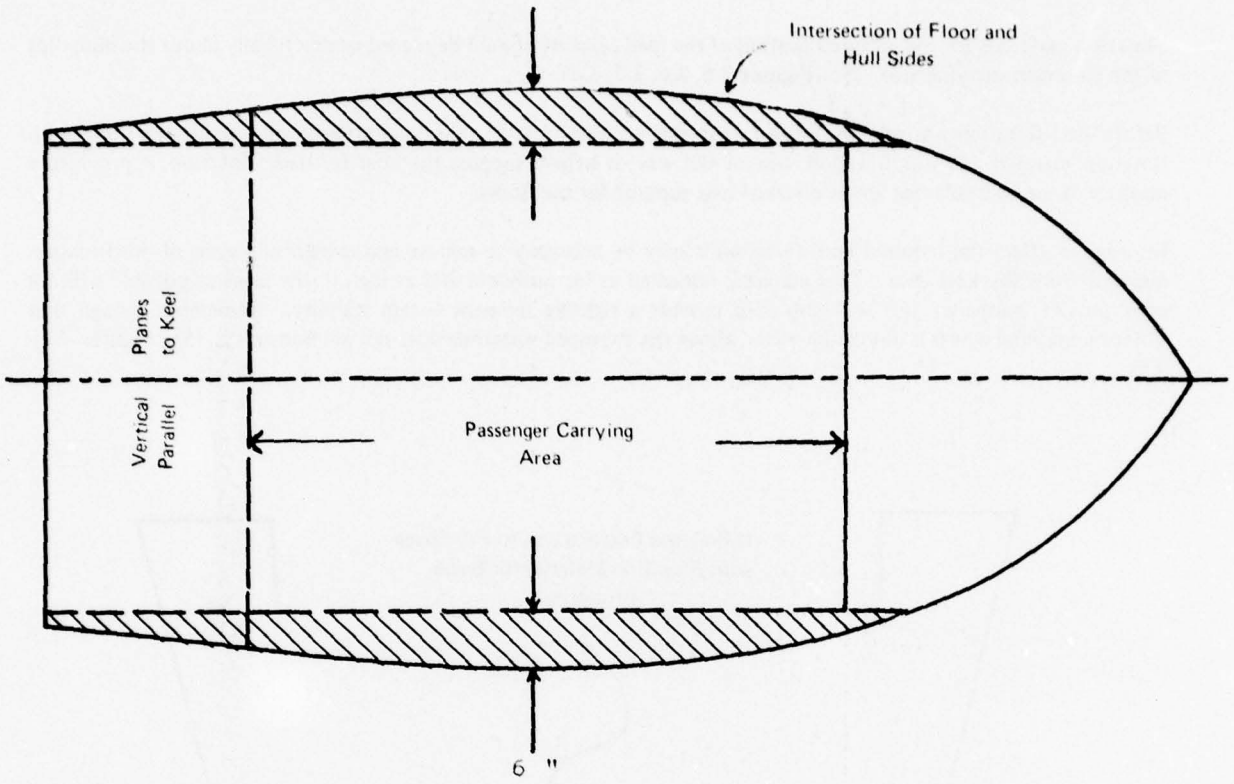
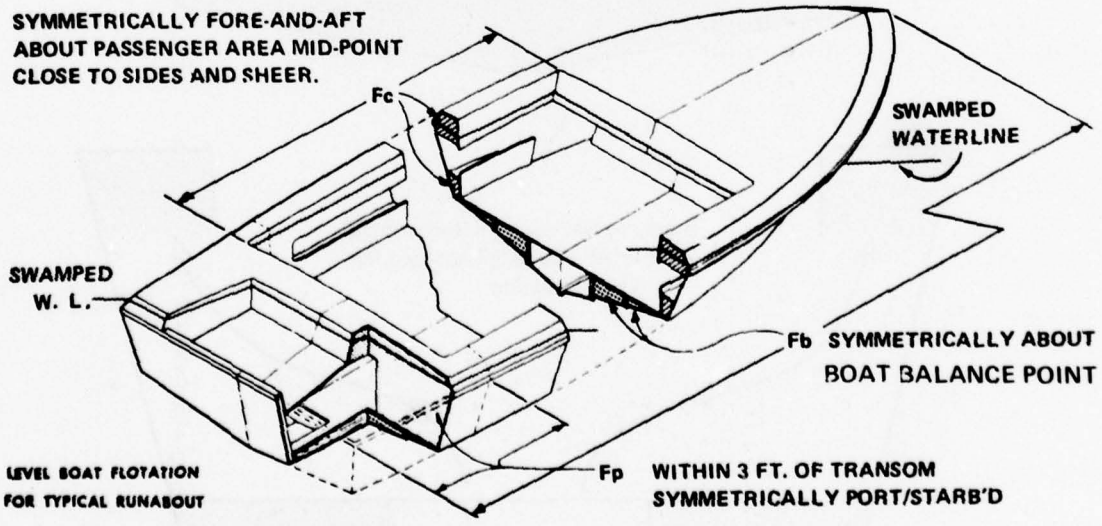


FIGURE 3.5 FLOTATION MATERIAL PLACEMENT





Fb = The flotation material needed to support the swamped boat.
Fp = The flotation material needed to support the propulsion equipment.
Fc = The flotation material to support the live load

FIGURE 3.6 Flotation Material Placement

THE LOAD CAPACITY

Flotation materials for the required portion of the load capacity should be placed symmetrically about the midpoint of the passenger carrying area. (See Figures 3.5, 3.6, 3.7, 3.8)

Before level flotation was required it was a practice on many boats to fill those areas or voids under the floors with flotation material. It was flotation, out of the way, it helped support the boat for basic flotation, it provided a measure of sound deadening and it offered some support for the floors.

In order to effect the required level flotation it may be necessary to remove and redistribute some of this flotation material from the keel area. This material, relocated as far outboard and as high in the sides as possible will not only provide buoyancy but will also help provide a righting moment to aid stability. Remember though that flotation material which is out of the water, above the swamped waterline does not aid buoyancy. (See Figures 3.7, 3.8)

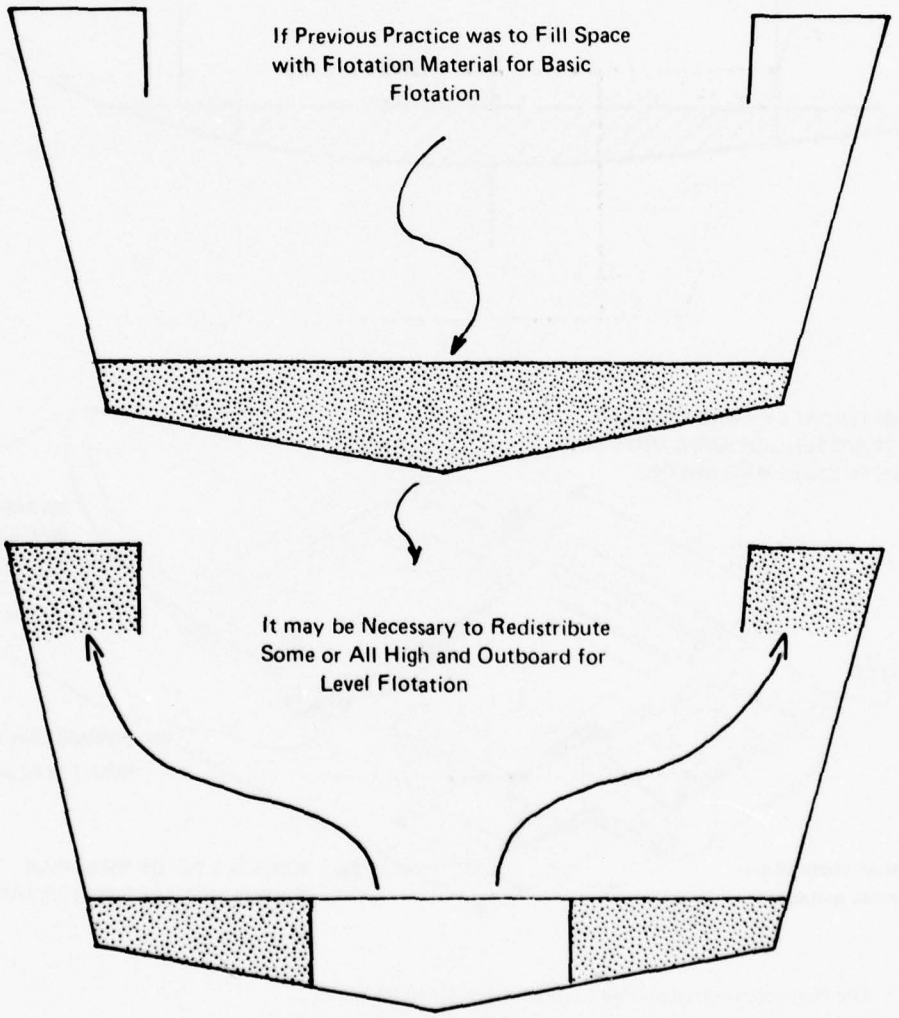
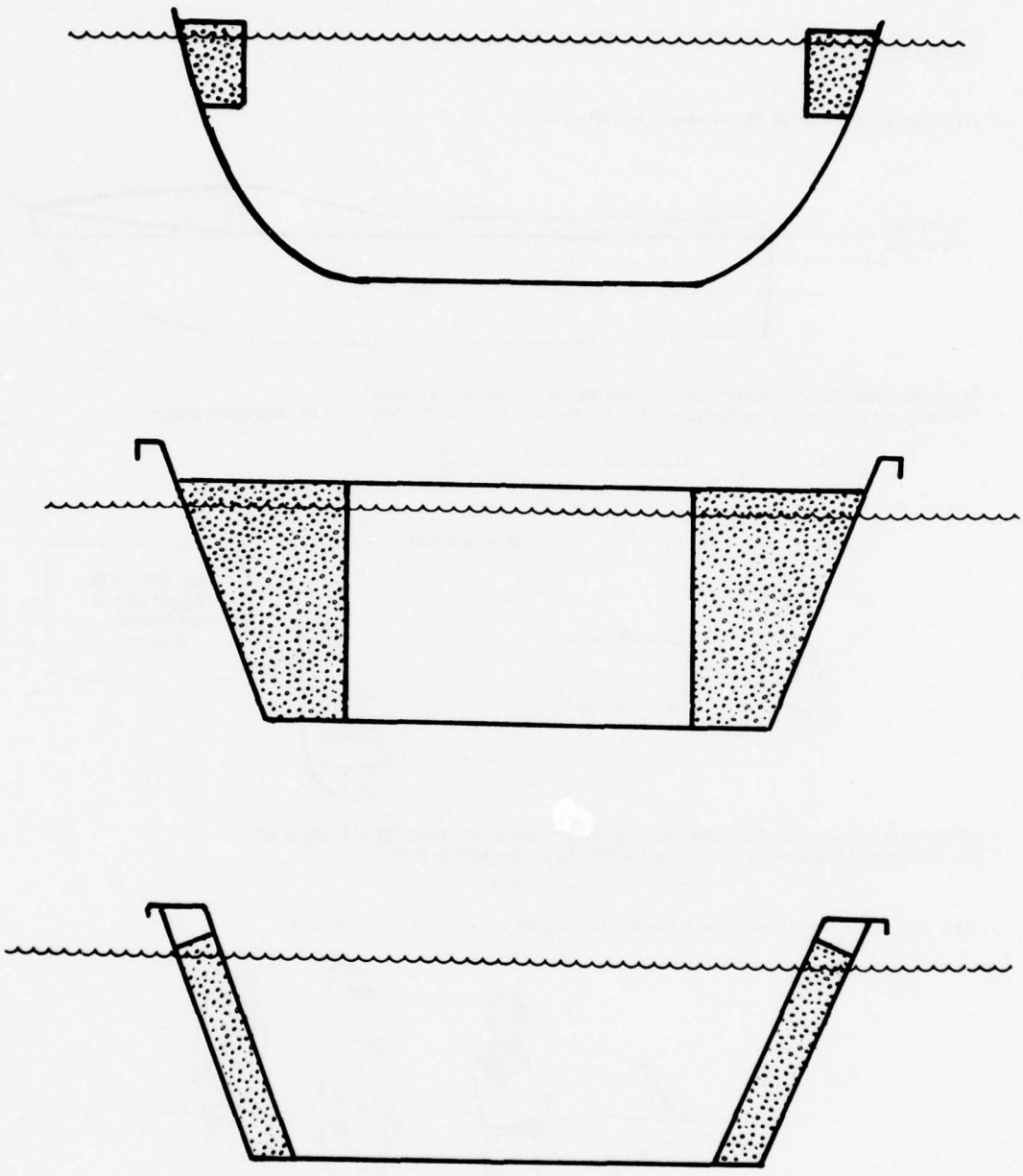


FIGURE 3.7



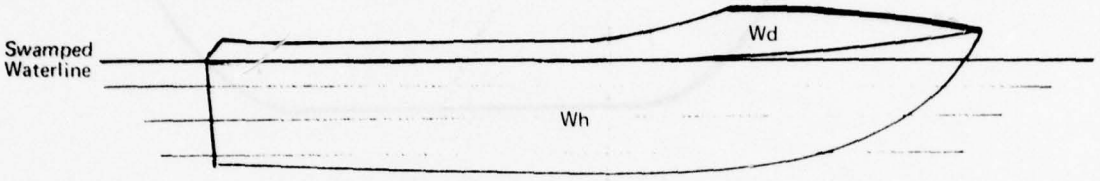
Placement of Passenger Support
Flotation Material

FIGURE 3.8

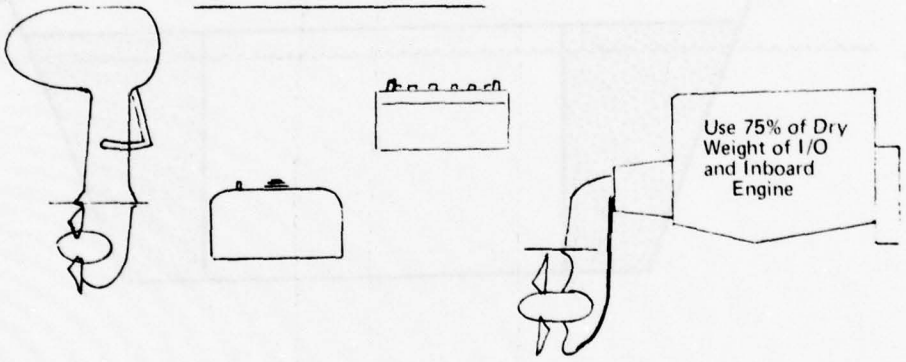
IN THE CALCULATIONS LETTERS REPRESENT ELEMENTS OF THE FORMULA:

Wd = Dry weight of deck (all above swamped waterline) including deck, windshield, hardware, factory accessories, etc.

Wh = DRY weight of hull (all below swamped waterline).

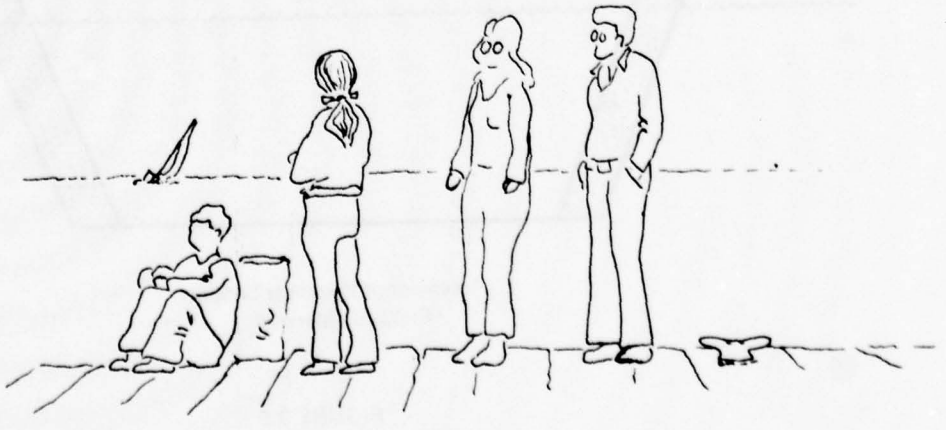


K = The conversion factors from Table 1, page **46** for different materials.
Fb = The amount of flotation material needed for the hull alone is derived from the elements above.



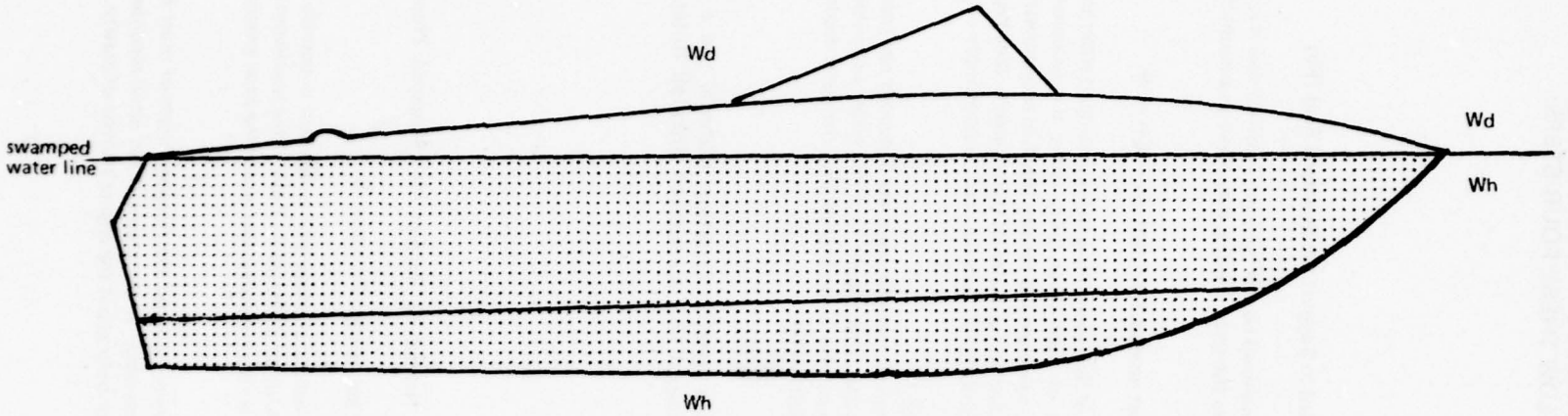
S = Weights for the propulsion system and equipment obtained from Table II, page **47**.
Fp = The amount of flotation material needed for the propulsion system.

Fc = The amount of flotation material needed to support a portion of the live load.



Fb + Fp + Fc = The total flotation needed, or "F".

FIGURE 3.9



NOTE: Reference is made in the calculations to "Wd" and "Wh". They are illustrated above.

FIGURE 3.10

TO CALCULATE THE FLOTATION REQUIRED FOR OUTBOARD BOATS WITH ENGINES OF MORE THAN 2 HORSEPOWER, FOLLOW THESE FOUR STEPS:

STEP 1

Determine the Flotation Material Needed to Support the Swamped Boat (Fb)

(Fb may be a negative number if the swamped boat is buoyant, in which case it is recommended that zero, (0), be substituted for a negative Fb to pass the tests. Testing may show an amount of flotation material up to Fb may possibly be removed in this case).

Formula: Flotation in cubic feet needed, $Fb = (Wh \times K + Wd) \div B$

Where:
- Wh = dry weight of hull (everything below swamped waterline).
- Wd = dry weight of deck (everything above the swamped waterline, including deck, windshield, hardware and factory supplied accessories).
- K = conversion factors for materials from Table I. (See Page 46)
- B = buoyancy of flotation material used, in pounds per cubic foot.*

Example of B:

For flotation material weighing 2 pounds per cubic foot, dry, the buoyancy is 62.4 pounds (the weight of fresh water per cubic foot) MINUS 2 pounds, or, 60.4 pounds per cubic foot MINUS the water absorption. Do not use the weight of sea (salt) water.

CAUTION:

In calculating the buoyancy of a specific flotation material use a figure obtained by actual test after 18 hours of submergence. This is required since all flotation testing requires an 18 hour pre-test submergence.

STEP 2

Determine the Flotation Material Needed to Support the Swamped Propulsion Equipment (Fp)

Formula: Flotation in cubic feet needed, $Fp = S \div B$

Where: S = swamped weight of propulsion equipment in pounds from Table II. (See Page 47)

For the value of S, locate in Table II the maximum horsepower capacity for which the boat is recommended and record the total swamped weight from the right-hand column.

NOTE: If the engine is stern mounted the flotation material must be distributed symmetrically as previously recommended. If the engine is not stern mounted, the flotation material should be located symmetrically about the engine's center of gravity.

STEP 3

Determine the Flotation Material Needed to Support the Live Load (Fc)

Formula: Flotation in cubic feet needed, Fc = [.5 (persons' capacity up to 550 pounds) + .125 (remaining persons' capacity in pounds) + .25 (C MINUS persons' capacity)] ÷ B

(See Note 1 and 2)

Where: C = boat's maximum weight capacity in pounds MINUS the total dry weight of the propulsion system from Table II.

(See Note 3)

NOTE: (1) If the number is a negative, use zero.

(2) Use the persons' capacity and maximum weight capacity as shown, or will be shown on boat's capacity plate.

(3) If permanent tanks are used, replace the portable tank weight with 6 pounds times the gallon capacity of the permanent tank.

This flotation material shall be distributed symmetrically on both sides, and fore and aft of the passenger carrying area midpoint. It should be brought up as close to the swamped waterline as possible. If above the waterline it will not contribute to the LEVEL buoyancy, but will contribute to a righting effect as it submerges during a stability test. It should be located outside a vertical plane which is parallel to the keel, and within 6 inches of the hull sides at the widest point on the floor line. (See Figures 3.6, 3.8)

STEP 4

Determine the Total Flotation Material Needed (F)

Formula: Fb (Step 1) + Fp (Step 2) + Fc (Step 3) = F (in cubic feet)

WORKING THROUGH A TYPICAL EXAMPLE;
EXAMPLE 1: OUTBOARD BOAT -- ENGINE MORE THAN 2 HORSEPOWER

Assume a 17 foot fiberglass runabout rated on the capacity plate for 135 horsepower, maximum persons' capacity 1040 pounds, maximum weight capacity 1600 pounds.

STEP 1

FLOTATION FOR SWAMPED BOAT ALONE

Wh = dry hull weight (from swamped waterline down) 500 pounds of fiberglass + 220 pounds of fir plywood. In this case other materials are negligible. *(See Note)

Wd = dry weight of deck AND its hardware = 185 pounds.

K = conversion factors for fiberglass and plywood (from Table I) for materials which will be below the water's surface; 0.33 for fiberglass; –0.81 for fir plywood. (A negative number --- indicated by the minus sign – means that the material normally floats and is lighter than water.)

B = buoyancy of flotation material = 60.4 pounds per cubic foot.

Formula: Fb = (Wh x K + Wd) ÷ B
Fb = [(500 pounds x 0.33) + (220 pounds x –0.81) + 185] ÷ 60.4
Fb = [(165) + (–178.2) + 185] ÷ 60.4
Fb = 172 ÷ 60.4 = 2.84 cubic feet (rounded up to 2.9 cubic feet)

In this case, 2.9 cubic feet of flotation material that will support 60.4 pounds per cubic foot will be needed to support the hull alone of this submerged (to the sheerline) boat.

*NOTE: *In this example Wh is made up of two factors:*

$Wh = Wh_1 \times K_1 + Wh_2 \times K_2$

$Wh_1 = 500 \times 0.33 = 165$ *for fiberglass*

$Wh_2 = 220 \times -0.81 = -178$ *for plywood*

Remember that the conversion factors are only applied to those materials which will be submerged, they convert dry weight to submerged weight.

STEP 2

FLOTATION FOR THE PROPULSION SYSTEM

S = swamped weight in pounds of the propulsion system (from Table II) 135 horsepower, outboard, controls and battery.

S = 300 pounds.

Formula: Fp = S ÷ B
Fp = 300 ÷ 60.4
Fp = 4.96 cubic feet (round up to 5.0 cubic feet)

In this example, 5.0 cubic feet of flotation material which will support 60.4 pounds per cubic foot will be needed to support the propulsion system including the battery and controls.

STEP 3

FLOTATION MATERIAL FOR THE LIVE LOAD

Formula: Fc = [.5 (persons' capacity up to 550 pounds) + .125 (remaining persons' capacity) + .25 (C MINUS persons' capacity)] ÷ B

Persons' Capacity = 550 pounds + 490 pounds = 1040 pounds.
Maximum Weight Capacity = 1600 pounds.

C = 1600 – 460 (dry weight of propulsion equipment from Table II) = 1140 pounds

Fc = [.5 (550 pounds) + .125 (490 pounds) + .25 (1140 – 1040)] ÷ 60.4
Fc = (275 + 61.25 + 25) ÷ 60.4
Fc = 5.98 cubic feet (round up to 6.0 cubic feet)

In this example, 6.0 cubic feet of flotation material, that will support 60.4 pounds per cubic foot, will be needed to support the required amount of the persons' capacity.

STEP 4

TOTAL FLOTATION MATERIAL REQUIRED

Formula: F = Fb + Fp + Fc
F = 2.9 + 5.0 + 6.0
F = 13.9 cubic feet of flotation material (that will support 60.4 pounds per cubic foot)

WORKING THROUGH A TYPICAL EXAMPLE;
EXAMPLE 2: OUTBOARD BOAT – ENGINE MORE THAN 2 HORSEPOWER, PERMANENT FUEL TANK

Assume a 17 foot fiberglass runabout rated for 135 horsepower on the capacity plate, permanent aluminum fuel tank of 25 gallons capacity, weight of tank 24 pounds. Maximum persons' capacity 1020 pounds, maximum weight capacity 1550 pounds.

STEP 1

FLOTATION FOR SWAMPED BOAT ALONE

Wh = dry hull weight (from swamped waterline down) 500 pounds of fiberglass + 220 pounds of fir plywood.
Wd = dry weight of deck and its hardware = 185 pounds
We = dry weight of hardware, controls, empty fuel tank and accessories that will be submerged. In this case the only weight to be used will be the 24 pounds fuel tank.
K = conversion factors from Table I; 0.33 for fiberglass, –0.81 for fir plywood and 0.63 for aluminum
B = buoyancy of flotation material = 60.4 pounds per cubic foot.

Formula: Fb = (Wh x K + We x K + Wd) ÷ B
Fb = [(500 pounds x 0.33) + (220 pounds x –0.81) + (24 x 0.63) + 185] ÷ 60.4
Fb = [(165) + (–178.2) + 15.1 + 185] ÷ 60.4
Fb = 187 ÷ 60.4
Fb = 3.096 = 3.1 cubic feet (rounded up)

STEP 2

FLOTATION FOR THE PROPULSION SYSTEM

Formula: Fp = S ÷ B

Where: S = swamped weight of propulsion equipment in pounds from Table II.
(For the value of S, locate in Table II (See Page 47) the maximum horsepower capacity for which the boat is recommended and record the total swamped weight from the right-hand column.)

For a 135 horsepower motor, 300 pounds.

Fp = 300 ÷ 60.4
Fp = 4.96 cubic feet (round up to 5.0 cubic feet)

STEP 3

FLOTATION MATERIAL FOR THE LIVE LOAD

Formula: Fc = [.5 (persons' capacity up to 550 pounds) + .125 (remaining persons' capacity) + .25 (C MINUS persons' capacity)] ÷ B

Persons' Capacity = 550 pounds + 470 pounds = 1020 pounds.
Maximum Weight Capacity = 1550 pounds.

C = boat's maximum weight capacity in pounds MINUS the total dry weight of the propulsion system from Table II (See Page 47), MINUS 6 pounds times the gallon capacity of the built-in tank.

so: C = 1550 - 540 pounds (dry weight of 135 horsepower motor and battery and (25) times 6 pounds). The weight of the fuel here replaces the weight of the portable fuel tank and its fuel in Table II. (See Page 47)

C = 1040 pounds
Fc = [.5 (550) + .125 (470) + .25 (1040 – 1020)] ÷ 60.4
Fc = (275 + 58.75 + 5) ÷ 60.4
Fc = 5.6 cubic feet

STEP 4

TOTAL FLOTATION MATERIAL REQUIRED

Formula: F = Fb + Fp + Fc
F = 3.1 + 5.0 + 5.6
F = 13.7 cubic feet

TO CALCULATE THE FLOTATION REQUIRED FOR OUTBOARD BOATS WITH ENGINES OF 2 HORSEPOWER OR LESS, FOLLOW THESE FOUR STEPS:

STEP 1

Determine the Flotation Material Needed to Support the Swamped Boat (Fb)

Formula: Flotation in cubic feet needed, Fb = (Wh x K + Wd) ÷ B
(See Page 32 for definition of terms)

STEP 2

Determine the Flotation Material Needed to Support the Swamped Propulsion Equipment (Fp)

Formula: Flotation in cubic feet needed, Fp = S ÷ B
(See Page 32 for definition of terms)

STEP 3

Determine the Flotation Material Needed to Support the Live Load (Fc)

NOTE: Steps 1, 2 and 4 will be the same in this example as they are in Example 1, but Step 3 will be different since the requirements for flotation for the live load are different. Flotation for two-fifteenths (13.33 percent or .133 of the live load is required for boats in this category).

Formula: Flotation needed Fc = [.133 (persons' capacity marked on the boat) + .25 (maximum weight capacity marked on the boat MINUS 20 pounds. [The weight of the submerged 2 horsepower engine from Table II] MINUS the persons' capacity marked on the boat)] ÷ B

STEP 4

Determine the Total Flotation Material Needed (F)

Formula: Flotation needed (F) = Fb + Fp + Fc

WORKING THROUGH A TYPICAL EXAMPLE;
EXAMPLE 3: OUTBOARD BOAT WITH ENGINE OF 2 HORSEPOWER OR LESS

Assume an aluminum dinghy rated for a 2 horsepower engine; maximum persons' capacity of 275 pounds, maximum weight capacity of 300 pounds. For this example we assume no deck.

STEP 1

FLOTATION FOR THE SWAMPED BOAT ALONE

Wh = dry weight of hull = 85 pounds (80 pounds aluminum, 5 pounds of fir plywood)
Wd = dry weight of deck = 0
K = conversion factors for aluminum = 0.63, fir plywood = −0.81
B = buoyancy of flotation material = 60.4 pounds per cubic foot

Formula: Fb = (Wh x K) ÷ B
Fb = [80 (0.63) + 5 (−0.81)] ÷ 60.4
Fb = [50.9 − 4.0] ÷ 60.4
Fb = 0.896 cubic feet (round up to 0.9 cubic feet)

STEP 2

FLOTATION FOR THE PROPULSION SYSTEM

Formula: Fp = S ÷ B
Fp = 20 (engine weight) ÷ 60.4
Fp = 0.33 cubic feet (round up to 0.4 cubic feet)

Where: S = swamped weight of 2 horsepower or less engine

STEP 3

FLOTATION MATERIAL FOR THE LIVE LOAD

Formula: Fc = [.133 (persons' capacity) + .25 (maximum weight capacity − 25 (engine weight) − persons' capacity)] ÷ B
Fc = [.133 (275) + .25 (300 − 20 − 275)] ÷ 60.4
Fc = [36.58 + .25 (5)] ÷ 60.4
Fc = [36.58 + 1.25] ÷ 60.4
Fc = 0.63 cubic feet (round up to 0.7 cubic feet)

STEP 4

TOTAL FLOTATION MATERIAL REQUIRED

Formula: Total Flotation Material (F) = Fb + Fp + Fc
F = 0.9 + 0.4 + 0.7
F = 2.0 cubic feet

The flotation material must be distributed as follows:

0.9 cubic feet symmetrically about the balance point of the boat; 0.4 cubic feet within 30 inches of the transom, symmetrically divided on either side, and; 0.7 cubic feet symmetrically divided with respect to both sides and the midpoint of the passenger carrying area, as close to the gunwales as possible without being located above the swamped waterline.

WORKING THROUGH A TYPICAL EXAMPLE;
EXAMPLE 4: MANUALLY PROPELLED BOAT

Assume that you want to determine the flotation material necessary for the same dinghy in Example 3, BUT, for manual propulsion ONLY. Maximum persons' capacity 275 pounds, maximum weight capacity 300 pounds. Compared to Example 3, Step 1 is the same, Step 2 is omitted (no engine) and there is one change in Step 3; therefore Step 4 adds two factors instead of three.

STEP 1

FLOTATION FOR SWAMPED BOAT ALONE

$$Fb = (Wh \times K) \div B$$
$$Fb = [80\ (0.63) + 5\ (-0.81)] \div 60.4$$
$$Fb = 0.896 \text{ cubic feet (round up to 0.9 cubic feet)}$$

STEP 2

FLOTATION FOR PROPULSION (STEP OMITTED)

STEP 3

FLOTATION MATERIAL FOR LIVE LOAD

$$Fc = [.133\ (\text{persons' capacity}) + .25\ (\text{maximum weight capacity MINUS the persons' capacity})] \div B^*$$
$$Fc = [.133\ (275) + .25\ (300 - 275)] \div 60.4$$
$$Fc = [36.58 + 6.25] \div 60.4$$
$$Fc = 0.7 \text{ cubic feet}$$

**There is no engine, therefore the "minus 20 pounds" is omitted.*

STEP 4

TOTAL FLOTATION MATERIAL REQUIRED

$$\text{TOTAL FLOTATION } F = 0.9 + 0.7$$
$$F = 1.6 \text{ cubic feet}$$

BASIC FLOTATION

Basic flotation, providing for 13 1/3 percent (2/15) of the maximum persons' capacity plus 25 percent of the dead weight, (dead weight = maximum weight capacity MINUS the persons' capacity) is mandatory for all monohull boats which are:

(1) Less than 20 feet in length
(2) Have inboard, inboard/outdrive propulsion, or are airboats
(3) Are constructed or assembled after July 31, 1978

The following calculations provide for the amount of basic flotation material which will be necessary to meet the test criteria. Calculate accurately, using correct values.

The law does not require inboard and inboard/outdrive powered boats or airboats to have a level attitude or stability when swamped.

TO CALCULATE THE BASIC FLOTATION REQUIRED FOR INBOARDS, INBOARD/OUTDRIVES AND AIRBOATS FOLLOW THESE STEPS:

STEP 1

Determine the Flotation Needed to Support the Swamped Boat (Fb)

Formula: $Fb = (Wh \times K_1 + Wd \times K_2 + .69\ We) \div B$

Where:
- Wh = dry weight of hull (everything below swamped waterline)
- Wd = dry weight of deck and superstructure
- We = dry weight of factory installed equipment, hardware and accessories, including permanent, empty fuel tank
- K_1 and K_2 = conversion factors for materials (Table 1) (See Page 46).

STEP 2

Determine the Flotation Material Needed to Support the Swamped Propulsion Equipment (Fp)

NOTE: Tests conducted with actual engines and other parts of boat propulsion systems have determined that a best estimate of the quantity of flotation material needed to support the swamped equipment is about 75 percent of its installed dry weight. Therefore that figure is used in these calculations.

Formula: $Fp = (G) \div B$

Where:
- G = 75 percent of the installed weight of the engine, drive and battery (inboard), or the engine, outdrive and battery of an inboard/outdrive, in pounds to the nearest whole number.
- B = buoyancy of flotation material in pounds per cubic feet.

STEP 3

Determine the Flotation Material Needed to Support the Live Load (Fc)

Formula: $Fc = [.133\ (\text{persons' capacity} + .25\ (\text{C MINUS the persons' capacity})] \div B$

Where:
- C = the maximum weight capacity MINUS the fuel weight
- Fuel Weight = 6 pounds/gallons times the tank capacity in gallons

STEP 4

Determine the Total Flotation Required

Formula: F = Fb + Fp + Fc

WORKING THROUGH A TYPICAL EXAMPLE;
EXAMPLE 5: INBOARD/OUTDRIVE POWERED, FIBERGLASS BOAT

Assume an inboard/outdrive powered fiberglass boat with a maximum persons' capacity of 1200 pounds and a maximum weight capacity of 1400 pounds. Fuel capacity of 30 gallons, V8 engine AND outdrive 900 pounds, battery, 45 pounds.

STEP 1

FLOTATION FOR SWAMPED BOAT ALONE

Wh = dry weight of hull:
820 pounds fiberglass including plastic upholstery; 220 pounds of fir plywood
Wd = dry weight of deck:
150 pounds (120 pounds fiberglass, 30 pounds of fir plywood)
We = dry weight of hardware, controls, empty fuel tank and accessories: 100 pounds
(an average conversion factor for these miscellaneous weights is .69)
K = conversion factor for fiberglass = 0.33; for fir plywood — 0.81
B = 60.4 pounds/cubic foot

Formula: [(Wh x K) + (Wd x K) + .69 We] ÷ B = Fb
Fb = [600 (0.33) + 220 (−0.81) + 120 (0.33) + 30 (−0.81) + .69 (100)] ÷ 60.4
Fb = [198 − 178.2 + 39.6 − 24.3 + 69] ÷ 60.4
Fb = 2.36 (round up to 2.4 cubic feet)

STEP 2

FLOTATION FOR THE PROPULSION SYSTEM

Fp = [.75 (weight of engine and outdrive, 900 pounds, battery, 45 pounds)] ÷ B
Fp = [.75 (900 + 45)] ÷ 60.4
Fp = 11.7 cubic feet

STEP 3

FLOTATION MATERIAL FOR THE LIVE LOAD

Formula: Fc = [.133 (persons' capacity) + .25 (C MINUS persons' capacity)] ÷ B
C = weight capacity (1400) – 6 pounds/gallons times gallons (30)
Fc = [.133 (1200) + .25 (1400 – (6 x 30) – 1200)] ÷ 60.4
Fc = [159.6 + 5] ÷ 60.4
Fc = 2.7 cubic feet

STEP 4

TOTAL FLOTATION MATERIAL REQUIRED

Formula: F = Fb + Fp + Fc
F = 2.4 + 11.7 + 2.7
F = 16.8 cubic feet

NOTE: In Step 3, a larger fuel capacity could result in a value for C, or [.25 (C MINUS persons' capacity)] that is less than zero. Values less than zero must not be used in this part of the calculation. Use zero

Basic flotation is intended to keep any portion of the boat above the surface of the water when the boat is filled with water and loaded with those weights specified in the formula.

It is not required that the boat float level or upright but the intention is that they have that quantity of flotation material which will keep the boat from sinking when it is filled with water, and passengers are clinging to it.

TABLE I

FACTORS FOR CONVERTING VARIOUS BOAT MATERIALS FROM DRY TO SUBMERGED WEIGHT

MATERIAL	SPECIFIC GRAVITY	FACTOR	POUNDS/CUBIC FOOT
Lead	11.38	0.91	710
Copper	8.91	0.89	556
Monel Metal	8.91	0.89	556
Bronze	8.88	0.89	554
Nickel	8.61	0.88	537
Brass	8.56	0.88	534
Stainless Steel (rolled)	8.00	0.88	500
Steel	7.85	0.88	490
Cast Iron	7.08	0.86	442
Zinc-Cast Alloy	6.63	0.85	414
Aluminum	2.73	0.63	170
Glass	2.60	0.62	162
Ferro-Cement	2.40	0.58	150
Rubber	1.51	0.34	94
Fiberglass	1.50	0.33	94
Kevlar	1.30	0.24	81
Plexiglass-Lucite	1.20	0.17	75
Linoleum*	1.17	0.15	72
A.B.S.	1.12	0.11	70
Teak	0.99	–0.01	62
Oak-White	0.85	–0.18	53
Oil-Diesel	0.85	–0.18	53
Gasoline	0.73	–0.37	45
Oak	0.63	–0.56	39
Blandex	0.58	–0.70	36
Mahogany-Philippine	0.58	–0.72	36
Mahogany-Honduras	0.56	–0.78	35
Ash	0.56	–0.78	35
Yellow Pine	0.55	–0.81	34
Fir Plywood	0.55	–0.81	34
Mahogany Plywood	0.54	–0.83	34
Royalex	0.50	–0.95	31
Mahogany-African	0.51	–0.96	32
Fir	0.51	–0.96	32
Cedar-Port Orford	0.48	–1.08	30
Pine-White	0.42	–1.38	26
Cedar-White	0.33	–1.95	21
Cork	0.24	–3.17	15
Balsa-End Grain	0.16	–5.24	10

$$FACTOR = \frac{sp.\ gr. - 1}{sp.\ gr.}$$

Weight of Water-Fresh, at 39°F = *62.4 pounds/cubic foot*
Specific Gravity of Water-Fresh, at 39°F = *1.0*
One gallon of water = *0.1337 cubic foot or 231.03 cubic inches*
One gallon of Water-Fresh = *8.34 pounds*
One cubic foot of water = *7.48 gallons*
Head of one foot of water = $\frac{62.4}{144}$ = *0.433 p.s.i.*

**1.5 pounds/square foot for 1/4 inch thick linoleum*

TABLE II

WEIGHTS OF OUTBOARD MOTOR AND
RELATED EQUIPMENT FOR VARIOUS BOAT HORSEPOWER RATINGS

BOAT HORSEPOWER RATING	MOTOR AND CONTROL WEIGHT	BATTERY WEIGHT	PORTABLE TANK WEIGHT	TOTAL WEIGHT	SWAMPED WEIGHT(S)
0.1 - 2.0	25	---	---	25	20
2.1 - 3.9	35	---	---	35	30
4.0 - 7.0	55	---	25	80	48
7.1 - 15.0	75	20	50	145	76
15.1 - 25.0	100	45	50	195	113
25.1 - 45.0	155	45	100	300	160
45.1 - 80.0	280	45	100	425	235
80.1 - 150.0	345	45	100	490	300
150.1 - 250.0	446	45	100	591	395
TRANSOMS DESIGNED FOR TWIN MOTORS:					
50.0 - 90.0	310	90	100	500	320
90.1 - 160.0	480	90	100	670	470
160.1 - 300.0	630	90	100	820	600
300.1 - 500.0	840	90	100	1030	790

4.0 FLOTATION MATERIAL REQUIREMENTS

Section 183.110 of the Rule called for, among other things, flotation material that must withstand:

(1) The combined effects of contact with oil, oil products, or other liquids or compounds with which the material may be expected to come in contact during normal use; and
(2) The combined effects of exposure to sunlight, vibration, shock, and temperature variations expected during normal use.

What oils? What liquids or compounds? What temperatures, vibration or shock? The Coast Guard has clarified the issue by writing standards for flotation materials which are based upon performance characteristics of the materials, characteristics which can be tested by submitting the material to specific tests.

There are now different performance specifications for flotation materials based upon *their location in a boat; the* degree of performance dependent on the degree of exposure to detrimental agents.

In these flotation material requirements you will find the terms "static floating position" or "unloaded static floating position". These are different from previous references to "level" in this and other standards. Level, when applied to a boat is the attitude of a boat when supported by two supports of equal thickness, located 40 percent and 75 percent of the hull's length back from the bow with the two supports resting on a horizontal surface. (See Page 69)

The static floating position is one which an unloaded boat will take while floating in calm, fresh water. In this case, the static float plane will be the waterline as marked while the boat is in this static floating position.

The term "unloaded boat" means that the boat shall contain all permanently installed items such as, but not limited to, the engine or engines, batteries, seats, fuel to the designed capacity of permanent tanks, engine oil, railings, fishing towers, etc. The "unloaded boat" shall not contain such items as, live loads, portable fuel tanks, paddles, PFD's, tool kits, flags, portable lights or other loose gear. If the boat has a fish well it should be empty as should a fresh water tank and a holding tank.

With the unloaded boat floating in calm water, the waterline, "A B" on Figure 4.2 establishes the other lines called for in the flotation material performance standards; the 4 inch and 12 inch levels. Either may, by coincidence, fall at this waterline, but they most likely won't. They will parallel this waterline, with the lowest point of the measurement starting at the lowest spot where water may accumulate within the boat in an unloaded static floating position.

Under the flotation material requirements we have outlined six possible conditions which may exist that will place requirements of performance on a material. *They follow:*

INSTALLATION CONDITION 1:

A. (1) If the flotation material is enclosed or encased in an enclosure that will resist seeping or leaking *one-quarter ounce of fresh water per hour when the enclosure is submerged to a depth of 12 inches; then –

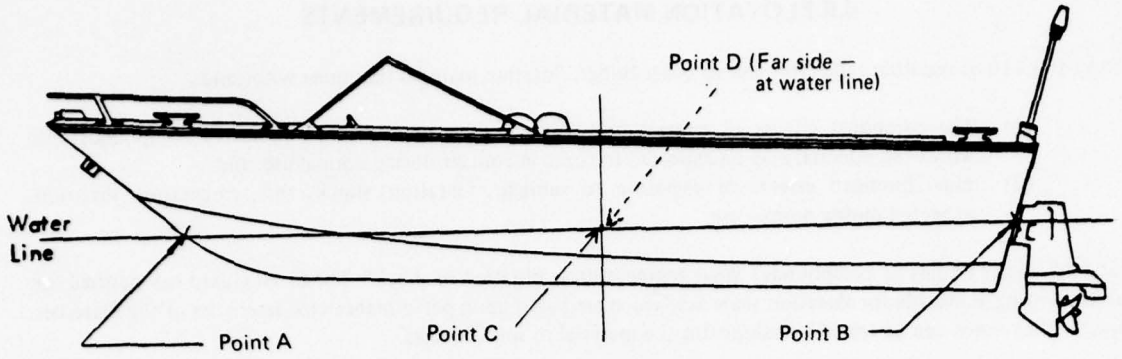
*(*one-quarter fluid ounce = 1/2 tablespoon)*

Flotation Material Requirement

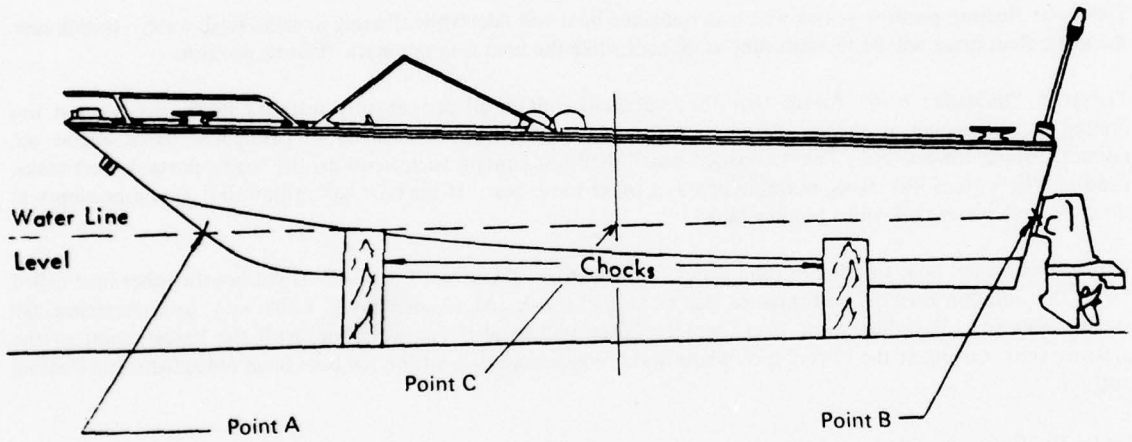
(2) any flotation material may be used anywhere in the boat. (See Figure 4.3)

INSTALLATION CONDITION 2:

B. (1) If the flotation material is NOT enclosed or encased, or,
(2) if the flotation material is enclosed or encased so that MORE than one-quarter fluid ounce of fresh water will seep or leak into the enclosure when submerged to a depth of 12 inches, and,



Point A is exactly at the waterline at the Bow; Point B, exactly at the intersection of the waterline and the centerline of the transom. Points C and D are at the waterline amidship, at either side. If the boat is mounted in chocks this line should be horizontal.



The term "Static Floating Position" is used in the flotation regulations. It is the attitude in which a boat floats in calm water, with fuel tanks filled to rated capacity, but with no person or item of portable equipment aboard.

The boat should include all factory supplied equipment options, BUT NOT portable gear such as: flags, searchlight, movable cushions, mattresses, portable fire extinguishers, lines, fenders, chairs, tables, anchors, chains or PFD's.

If the boat has a water tank, holding or live bait well they should be empty.

This establishes a standard condition, an attitude not related to freeboard or other safety considerations, which can be used as a basis for testing certain criteria of the regulations.

FIGURE 4.1 STATIC FLOATING POSITION

(3) if the flotation material is installed in an engine compartment less than 12 inches above the lowest point where liquid can collect in that compartment when the boat is in its static floating position (See Figure 4.1 for static floating position) (See Figures 4.2 and 4.3 for illustration of 12 inch line), then –

Flotation Material Requirement

(4) the flotation material must not be reduced in volume by more than 5 percent after being immersed in any of the following liquids for 30 days at 29°C: *

a. Reference Fuel B ASTM D-471
b. No. 2 Reference Oil of ASTM D-471
c. A 5 percent solution of trisodium phosphate in water.

INSTALLATION CONDITION 3:

C. (1) If the flotation material is installed outside the engine compartment (this includes inside the hull of outboard boats), and,

(2) if the flotation material is less than 4 inches above the lowest point where liquid can collect when the boat is in its static floating position (See Figures 4.1 and 4.3), then –

Flotation Material Requirement

(3) the flotation material must not reduce in volume by more than 5 percent after being immersed in any of the following liquids for 24 hours at 29°C: *

a. Reference Fuel B ASTM D-471
b. No. 2 Reference Oil of ASTM D-471
c. A 5 percent solution of trisodium phosphate in water.

INSTALLATION CONDITION 4:

D. (1) If the flotation material is installed in the engine compartment, and,

(2) the flotation material is more than 12 inches above the lowest point where liquid can collect in that compartment when the boat is in its static floating position (See Figures 4.1 and 4.3) then –

Flotation Material Requirement

(3) the flotation material must not reduce in volume by more than 5 percent after being immersed in a fully saturated gasoline vapor atmosphere for 30 days at 38°C.

INSTALLATION CONDITION 5:

E. (1) Flotation material used in a manually propelled boat, or,

(2) flotation material installed outside the engine compartment and more than 4 inches above the lowest point where liquid can collect when the boat is in its static floating position, then –

Flotation Material Requirement

(3) the flotation material does not have to be gasoline, oil, gasoline vapor or trisodium phosphate solution resistant. (See Figure 4.3)

* *NOTE: The change in volume, and this buoyancy, can be measured with ASTM D-2842.*

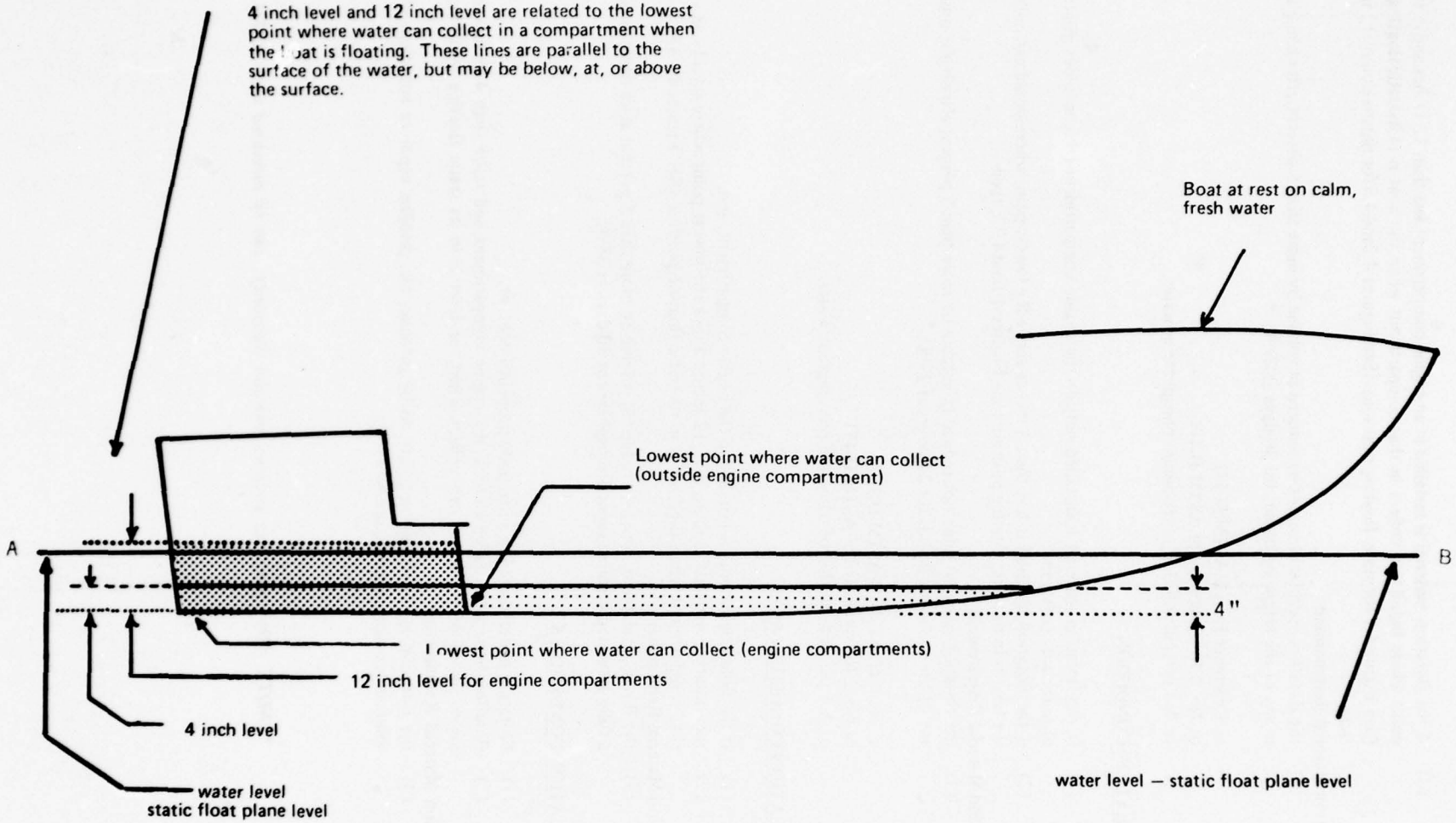

4 inch level and 12 inch level are related to the lowest point where water can collect in a compartment when the boat is floating. These lines are parallel to the surface of the water, but may be below, at, or above the surface.
Boat at rest on calm, fresh water
Lowest point where water can collect (outside engine compartment)
A
B
4"
Lowest point where water can collect (engine compartments)
12 inch level for engine compartments
4 inch level
water level
static float plane level
water level – static float plane level

FIGURE 4.2

If the flotation material is enclosed or encased and meets CONDITION 1:
Any flotation material may be used, anywhere.

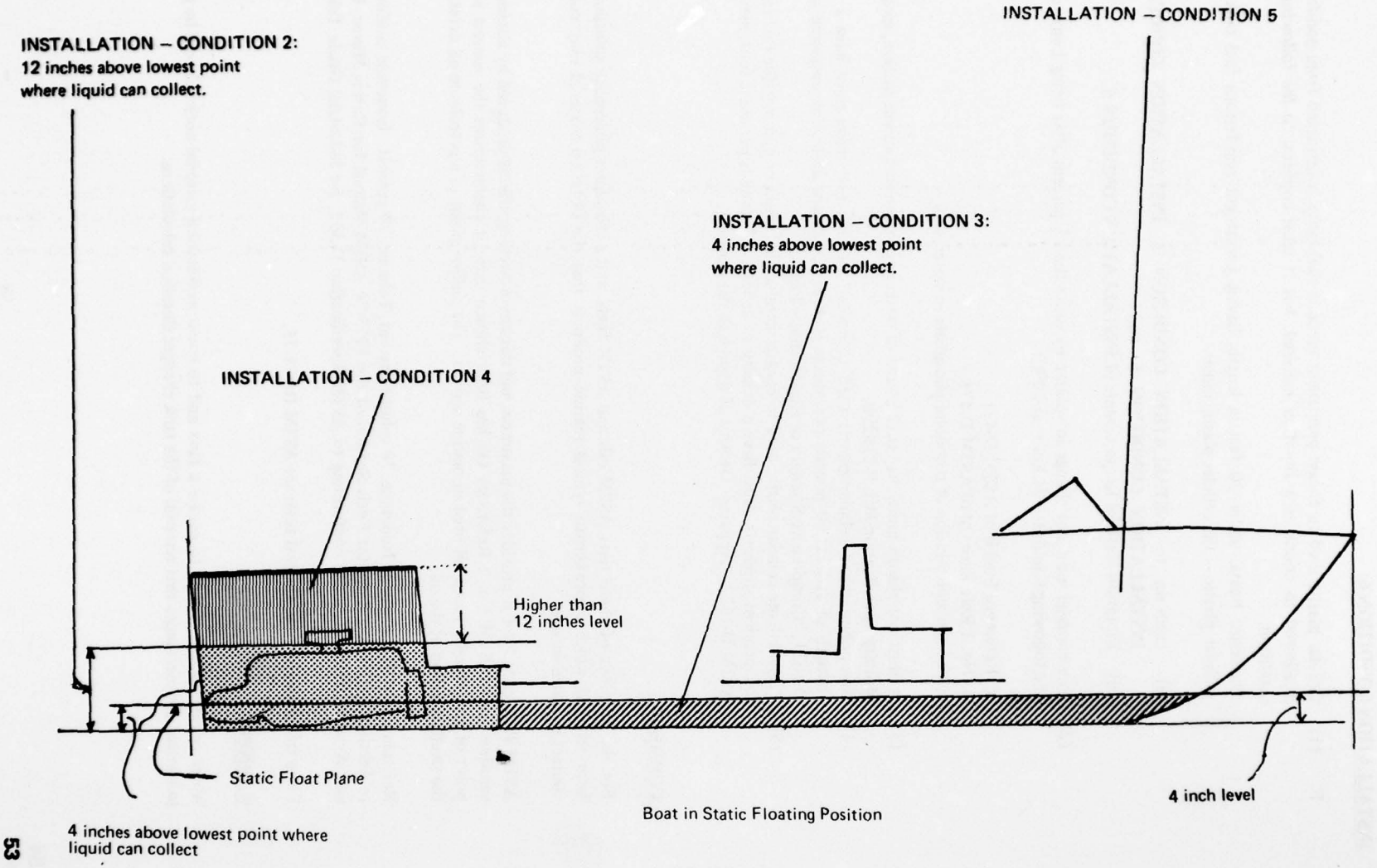


FIGURE 4.3

INSTALLATION CONDITION 6:

F. (1) Cellular plastic used to encase permanent metallic fuel tanks constructed from non-ferrous alloys is allowed to count as a flotation material, but it must conform to the following applicable condition:

Outboard boats, under 20 feet in length, having permanent non-ferrous fuel tanks encased in cellular plastic — the cellular plastic must:

(i) conform to **INSTALLATION CONDITION 1, INSTALLATION CONDITION 3,** or **INSTALLATION CONDITION 5,** and ,
(ii) Flotation Material Requirements of **INSTALLATION CONDITION 6**.

(2) The material must not change in volume by more than 5 percent after being immersed in any of the following liquids for 24 hours at 29°C:

a. Reference Fuel B of ASTM D-471
b. No. 2 Reference Oil of ASTM D-471
c. A 5 percent solution of trisodium phosphate in water; and,

(3) it must not absorb more than 0.12 pound of water per square foot of cut surface, measured under Military Specification MIL P-21929B.

(4) Non-polyurethane cellular plastic used to encase metallic fuel tanks must have a compressive strength of at least 60 pounds per square inch at 10 percent deflection measured under ASTM D-1621, "Compressive Strength of Rigid Cellular Plastics".

(5) Polyurethane cellular plastic used to encase metallic fuel tanks or non-metallic fuel tanks without independent supports, must have a density of at least 3.2 pounds per cubic foot, measured under ASTM D-1622, "Apparent Density of Rigid Cellular Plastics".

COMMENT

For the purposes of these tests ASTM oils and ASTM fuels, and a trisodium phosphate solution have been selected which approximate typical marine products that the flotation material may come in contact in actual service.

ASTM Reference Fuel B provides the maximum and minimum swelling effects produced by commercial gasolines, and ASTM No. 2 Reference Oil has been chosen since it characterizes the nearest aniline point of a petroleum based oil used in marine service. The aniline point of a petroleum oil determines the swelling action of the oil.

Reference Fuel B consists of Isooctane, 70 volume percent, Toluene, 30 percent. Isooctane conforming to Section Annex A 2.8, Motor Fuels Section of the 1973-74 ASTM Manual for Rating Motor, Diesel and Aviation Fuels; Toluene conforming to ASTM Specification D-362, for Industrial Grade Toluene.

For a full explanation of the test fuels see ASTM D-471-75.

WARNING

Where cellular plastic is used to encase a tank and to count as flotation material notice should be given to owners and mechanics that removal of the tank changes flotation calculations.

5.0 FLOTATION MATERIALS

This section contains general information about various materials which can be used to achieve the required flotation; their characteristics, performance specifications and testing standards.

TYPES OF MATERIALS:

A. **FOAMS (cellular plastics)** – must meet current Coast Guard requirements which are based upon the performance characteristics for use in specific locations in a boat.

(1) **FOAMED POLYSTYRENE** – Is a commonly used and possibly the lowest cost flotation material. It is produced from expandable beads (pop corn) or extruded in the form of billets or boards. The common trade name is "Styrofoam". In its more common forms it is readily dissolved in gasoline and it is highly flammable. However, several companies offer special compounds of polystyrene foam that are solvent resistant and self-extinguishing. The major objections to foamed polystyrene are that it cannot be foamed in place or produced in the boat builder's plant.

(2) **POLYURETHANE FOAM** – Another widely used buoyancy material. It is usually foamed in place or molded into shapes before installation. It is also available in slabs and billets. Polyurethane foam is normally highly resistant to gasoline and oil in the higher density ranges of 4.0 pounds per cubic foot and over, and it is still considered very resistant to gasoline and oil in the lower densities (1.5 to 2 pounds per cubic foot). Polyurethane foam is flammable but can be made so that it is self-extinguishing.

(3) **UNICELLULAR POLYETHYLENE FOAM** – Solvent-resistant, tough and flexible. Although combustible, it is classified as slow burning. It is available in sheets and molded shapes. Two trade names are "Ethafoam" and "Plastazote". Black materials usually have greater resistance to solar degradation.

(4) **POLYVINYL CHLORIDE** – "PVC" in its foam form is used as a core material in fiberglass sandwich construction in the same manner as balsa wood. "PVC" foam is incombustible and it doesn't rot. While non-burning, it does melt.

(5) **OTHER FOAMS** – There are other forms of foam available that can meet the requirements as a flotation material and in their resistance to the test liquids. Two are acrylonitrile-butadiene-styrene (ABS) and foamed epoxy resin. There is also a foamed glass on the market which has been used in lifeboats and liferafts. Though resistant to most solvents and non-burning — it crumbles easily.

(6) **FACTORS TO CONSIDER WHEN SELECTING PLASTIC FOAM:**
(Not in order of importance)

When choosing a foam, consideration should be given to:

a. Adhesion
b. Density and buoyancy
c. Durability (aging qualities)
d. Fire resistance
e. Friability (brittleness, crumble)
f. Fuel, vapor and chemical resistance
g. Impact resistance
h. Resiliency (recovery of shape)
i. Resistance to vibration and fatigue
j. Water absorption
k. Workability and safety during installation
l. Resistance to solar degradation

TABLE I

SELECTED PLASTIC FOAM TYPES AND CHARACTERISTICS

TYPE	DENSITY LB/FT³	GASOLINE RESISTANCE	WATER ABSORPTION BY WEIGHT
Extruded Polystyrene (Styrofoam)	1.8 to 4.3	Poor	Nil
Expanded Bead Polystyrene	1.0 to 5.0	Poor	< 2%
Styrene Acrylonitrile (KPF 324)	1.0 to 2.0	Fair	< 0.1%
Extruded Polyethylene (Ethafoam)	2.0 to 9.0	Slight Swelling	< 0.5%
Polyurethane (Pour in place or slab)	1.5 to 10+	Good	< 0.1% (short term) (See Note 2)
Polyvinyl Chloride (PVC)	2.0 to 6.0	Good	Nil
ABS (Royalex)	30	Good	Nil
Epoxy	2.0 to 20	Good	< 0.1%

NOTES: *(1) The symbol "<" means "less than".*

(2) Over a long period polyurethane foam with a density of less than 2 pounds per cubic foot may absorb a significant amount of water.

POSSIBLE PROBLEMS

All materials used to comply with flotation requirements should be examined in their relationship to creating additional hazards aboard boats. Some lower density foams have difficulty due to excessive water absorption, some have a tendency to shrink with age, and some foams are quite friable and cannot stand impact and vibration.

Some materials may soften and run or melt when placed near heat such as that radiated from an engine's exhaust system. This may cause drops or clumps of the material to fall on the heated surface which might be sufficiently hot to ignite them.

The field of plastics, including plastic foams which are or could be used for flotation material is growing rapidly and much is being done to improve the physical properties and applications. We urge the boat builder to keep a constant check with his material supplier for new technical information.

B. **WOOD** – Wood, including balsa wood and cork when used in a boat, provide flotation. Of greatly varying densities and water absorption qualities, they have widely different flotation values. Balsa wood is frequently used as a structural core material in fiberglass boat construction, and as such can provide a significant amount of positive buoyancy, however, balsa must -- and cork can be sealed or enclosed in plastic to retain their flotation factors. Due to the variations in resin absorption, buoyancy values should be checked or verified as finally installed.

C. **AIR CHAMBERS** – Air chambers may be used to achieve flotation, HOWEVER, there are some basic requirements and exceptions. In outboard boats rated for engines of more than 2 horsepower and in inboard boats, inboard/outdrive's and airboats, the air chamber may not be integral with the hull; and for the tests the two largest air chambers and all integral air chambers must be completely flooded with water before undergoing the tests. Integral air chambers may be used in boats rated for 2 horsepower engines and less, and manually propelled boats.

The air chamber material must be capable of withstanding the same solvent resistance tests as other flotation materials and it must pass the required 18 hour submergence preconditioning before undergoing the flotation test. Air chambers should be designed so that moisture and condensation can be drained out periodically. Usually air chambers are provided with drainage holes with a closure device to accomplish this.

6.0 INSTALLATION

Three flotation systems are outlined here:

A. AIR FLOTATION CHAMBERS

(1) Integral Air Chambers
(2) Non-integral Air Chambers

B. PLASTIC FOAM BLOCKS AND FORMS

pre-molded, or
cut to shape from billets

C. LIQUID MIX, plastic foam prepared in-plant, and either:

poured in place, or
sprayed in place, or
poured or sprayed in molds

A. AIR FLOTATION CHAMBERS:

Integral Air Chambers

(1) Integral air chambers are permitted to count as flotation only in outboards rated for 2 horsepower motors and less, and in manually propelled boats.

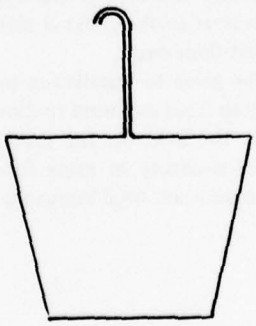
Air flotation chambers that are integral with the hull, (a chamber with one or more surfaces formed by the boat hull skin):

a. should maintain their integrity under pre-test conditioning and under flotation test conditions. They should not leak when subjected to an internal air pressure test and should not allow the ingress of water when submerged, minimally, to a depth equal to that required in the flotation test.

What pressure might be used for an internal air pressure test? Submerging an air chamber 30 inches below the surface of the water subjects it to a pressure of about 1 pound per square inch, and this is probably a good place to start. Don't attempt to subject the air chamber to a much higher pressure, it takes very little to destroy most chambers, and this could be a destructive test. Soapy water solution or other leak detection methods such as sonic amplifiers can be used to locate any leaks.

b. Provision should be made for venting pressure differentials in the tank due to temperature change. This excessive pressure can rupture the chamber and render it ineffective for flotation. One method of venting the chamber consists of a tube of metal or plastic, attached to the top of the chamber and formed into a loop to create an air lock. This air lock or trap prevents water from entering the chamber when it is submerged.

EXAMPLE:



c. Have a drain plug at the low point of the chamber for periodic checks for water and for draining. You should consider having a captive-type plug that cannot be totally removed and lost. It is also a very good idea to place a warning near the drain as a reminder to replace the plug after checking.

d. Much forethought must be given to the location and installation of air chambers, the adjacent hardware and other boat elements such as thwarts, so as to preclude the possibility of puncturing or drilling holes through them. A final pressure test after complete boat assembly should be made to expose any leak.

Non-integral Air Chambers

(2) Air chambers that are not integral with the hull must meet all the provisions for integral air chambers, EXCEPT, if the chambers are small air bottles or containers. These containers are usually blow molded plastic and neither a pressure vent or drain need be provided. They must maintain their integrity under flotation test pre-conditioning and during the test. Again, care must be taken to avoid puncture of the chambers during boat construction.

Nothing in the regulations prohibits the presence of integral air chambers in outboard boats rated for motors of over 2 horsepower, BUT they must not be considered as flotation and for the purpose of the flotation test they MUST be flooded as MUST the two largest non-integral air chambers.

That also means that if the boat only has two NON-integral air chambers (an outboard boat propelled by a motor of more than 2 horsepower), both chambers must be flooded.

B. **PLASTIC FOAM BLOCKS AND FORMS:**

If foam blocks and forms, pre-molded, or cut to shape from billets before installation, are used:

(1) some method must be employed to assure that each boat gets the correct flotation in the correct location. Molded shapes, cavity size and markings are examples.

(2) E.P.S. (Expanded Polystyrene) foam should not come in contact with uncured polyester resin or fumes.

(3) foam blocks can be:

a. bonded in with FRP (except E.P.S. foam)
b. fastened mechanically with metal or plastic straps
c. encased or entrapped in boxes, under floors, under thwarts, etc.
d. attached by a suitable adhesive.

NOTE: All methods should secure the foam so that no movement in any direction occurs that will effect the flotation test. Normally, flotation material is secured to resist falling DOWN, but when the boat is submerged the material exerts a substantial force upward toward the waters surface, and it should be secured to avoid the possibility that it will come loose and float away.

(4) consideration should be given to installation in a manner that will prevent damage from occupant contact and deterioration from exposure to direct sunlight.

(5) the space provided in the boat for the installation of foam blocks and forms should be large enough to prevent the necessity of using force during installation that will deform the shape, thereby lowering its volume and total buoyancy.

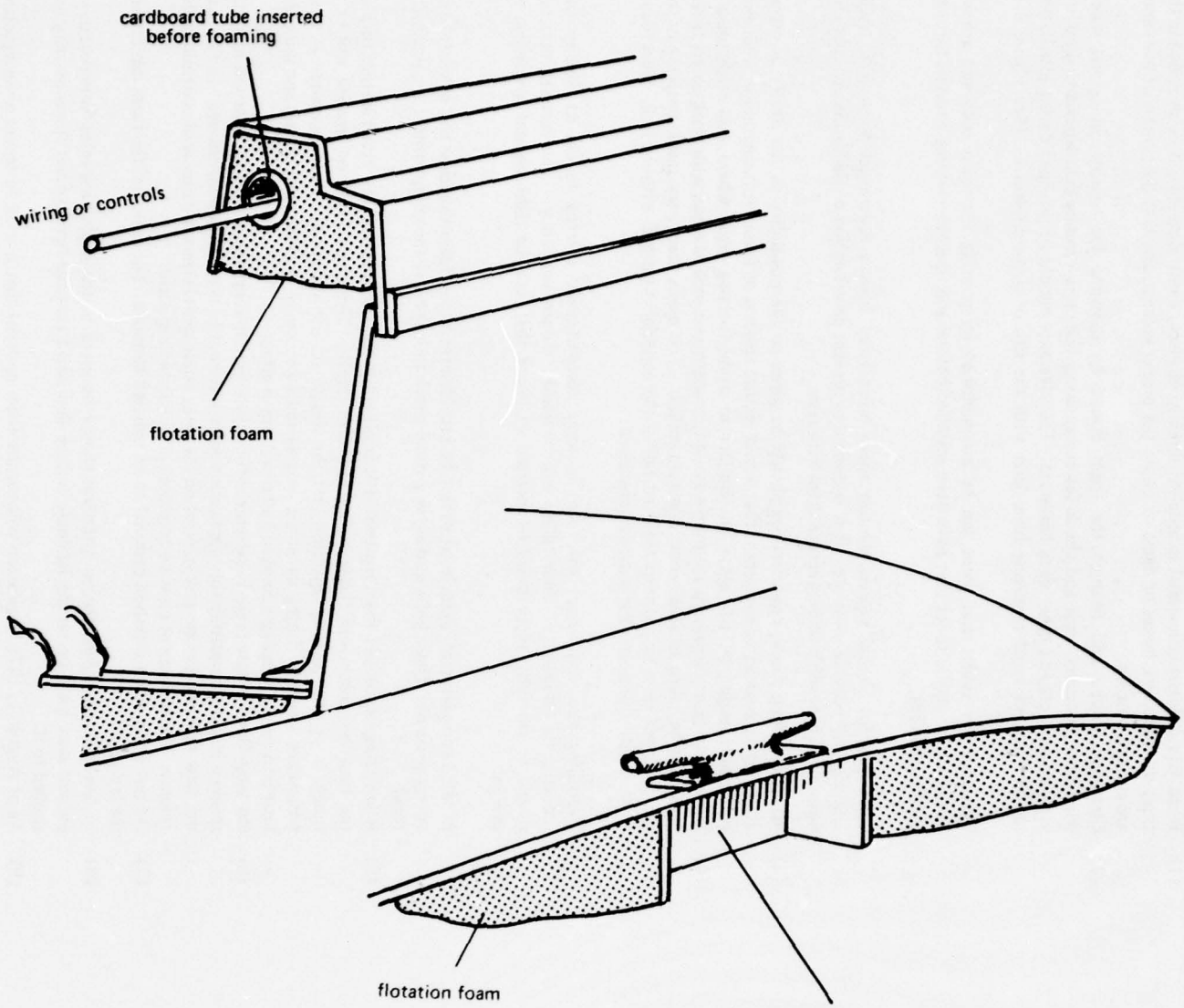

cardboard tube inserted
before foaming
wiring or controls
flotation foam
flotation foam
box or dam to keep area under hardware clear
of foam to allow access for fastening

FIGURE 6.1

C. **LIQUID MIX: poured in place, sprayed in place, or poured or sprayed in molds**

(1) When liquid flotation material is installed directly in place, constraints should be provided in the form of bulkheads, boxes or dams to insure the proper volume, and that the centers of buoyancy are correctly placed.

(2) Clearance around and through the foam should be provided for routing cables and wires, windshield fasteners, cleat and chock fasteners, railing fasteners, running light wires and supports, ventilation ducts and other deck hardware. This clearance should be provided during installation of the foam to avoid removing foam later with the risk of non-compliance. (See Figure 6.1)

Clearance for cables and wires can be accomplished by pouring the foam over and around cardboard or plastic tubes that have been installed beforehand, thereby creating a tunnel through the foamed area.

Good practice should suggest slanting these tubes away from a horizontal position to assist draining any possible moisture. If it is desired to prevent deterioration of the cardboard tubes by moisture it is possible to impregnate them with resin.

(3) When installing foam, consideration should be given to the possibility of the dealer or owner attaching accessories or equipment that would require removal of foam. Anticipation of what that equipment might be will allow the builder to avoid foaming areas where this might occur.

(4) When pouring or dispensing foam into a blind compartment such as a box with small access holes, care must be taken to avoid some common pitfalls. Too much foam may cause a rupture of the compartment or it may distort the boat hull if the material is integral with the hull. Most foams expand with a pressure that must be considered.

Overfilling also compresses the foam in some compartments thereby raising its density and reducing its buoyancy. Underfilling will obviously reduce buoyancy. The foaming material should be carefully apportioned or metered to insure that just the right amount is installed or applied.

In blind compartments extra holes should be provided for excess foam to escape and to relieve any excess pressure. These holes also allow a visual check to make sure the compartment is completely filled.

(5) When using liquid mix foam material that is placed in the hull next to any broad surface such as the boat bottom, avoid filling to an excessive depth. The exact depth or amount will be a function of the material qualities and the design of the structure. Foam expands — then sometimes contracts during its curing process and an excessive thickness may shrink and draw the boat bottom up, creating a hooked hull or a dishpan effect.

(6) On large flat surfaces there is extreme difficulty in determining the volume of flotation material sprayed in a comparatively thin application since it cannot be accurately dimensioned. In this case the flow rate and precise mix control of the spray equipment is the only means of controlling the volume. The equipment must be accurate and calibrated regularly.

(7) Do not apply foam flotation material to an uncured laminate. The curing of the foam can distort the lay-up.

(8) In fiberglass resin formulation attention should be given to the laminating resin formulation to prevent wax build-up on the laminate surface that could ruin the bond of the flotation material applied to it.

(9) As of August 1, 1978, regulation will require foam material that is used to secure or encapsulate some fuel tanks to have different performance characteristics than other flotation foam. Check the Fuel System regulation requirements under sections 183.516 and 183.552. (See Page 54)

(10) Attention should be given to temperature control over the foam mix, the surfaces to which it will be applied on the boat and the ambient temperature during and after the foaming operations. Temperature changes can effect foam density, compressive strength and water absorption qualities as well as adhesion. Check with your foam material supplier for specifics.

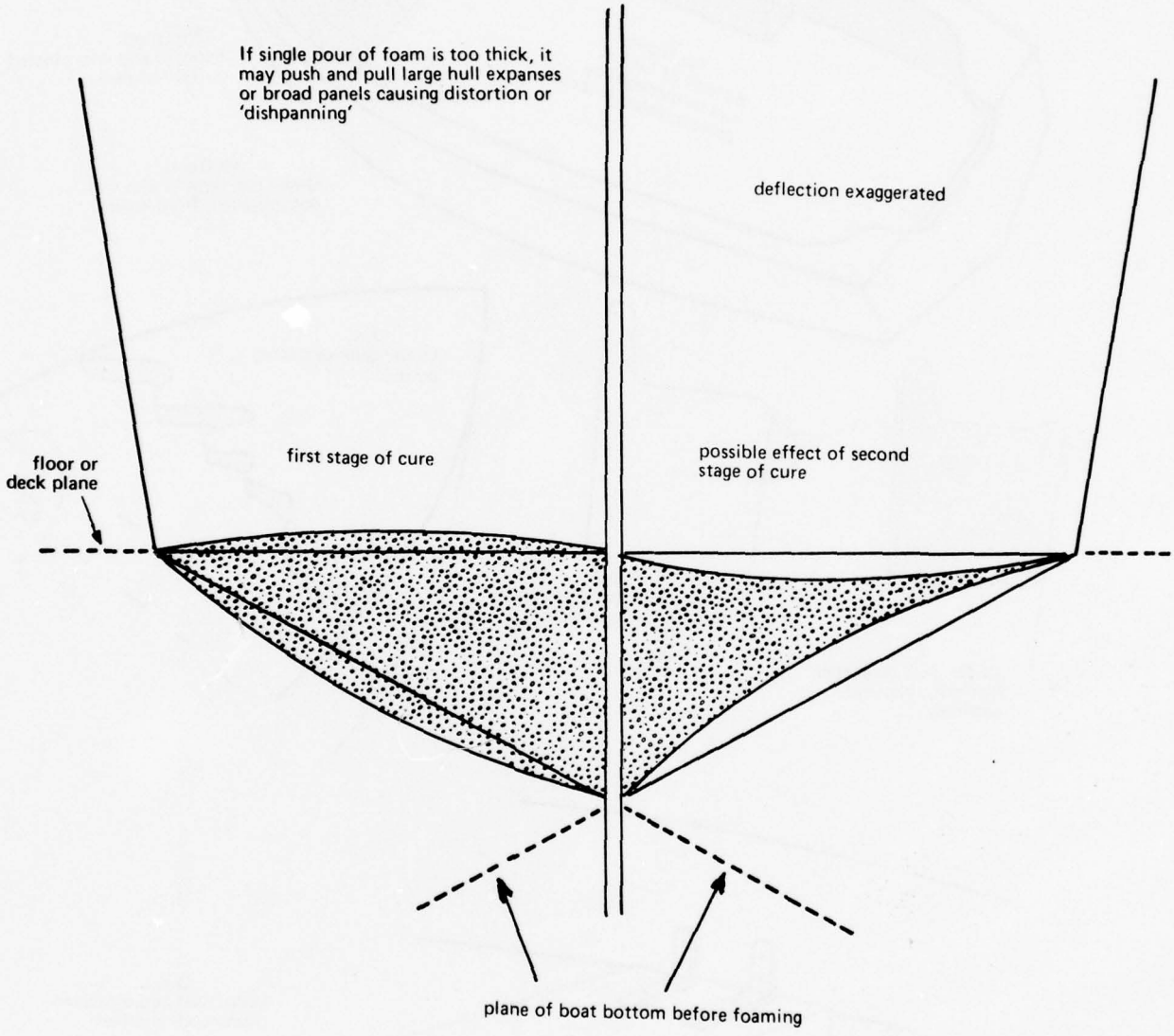

If single pour of foam is too thick, it may push and pull large hull expanses or broad panels causing distortion or 'dishpanning'
deflection exaggerated
floor or deck plane
first stage of cure
possible effect of second stage of cure
plane of boat bottom before foaming

FIGURE 6.2

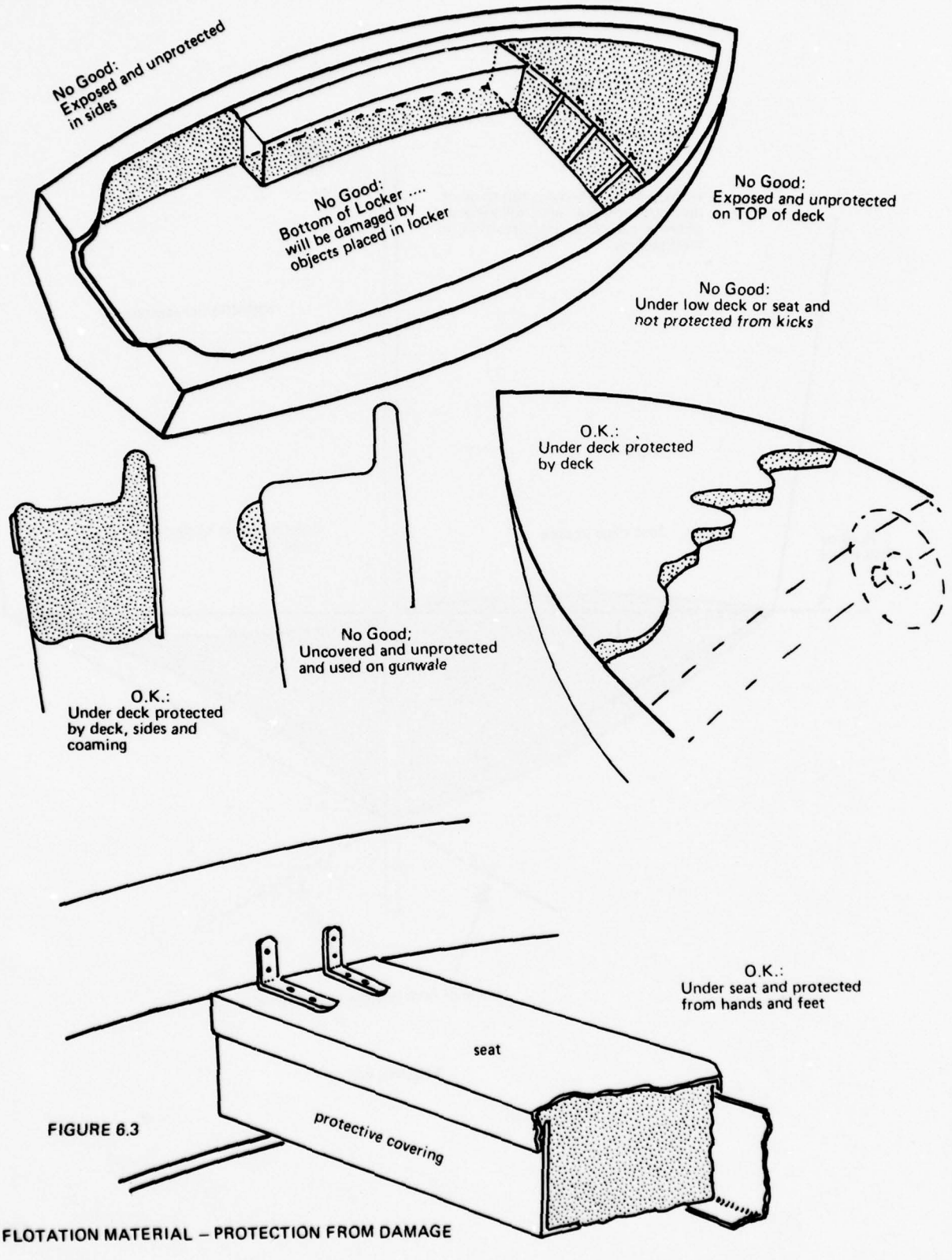
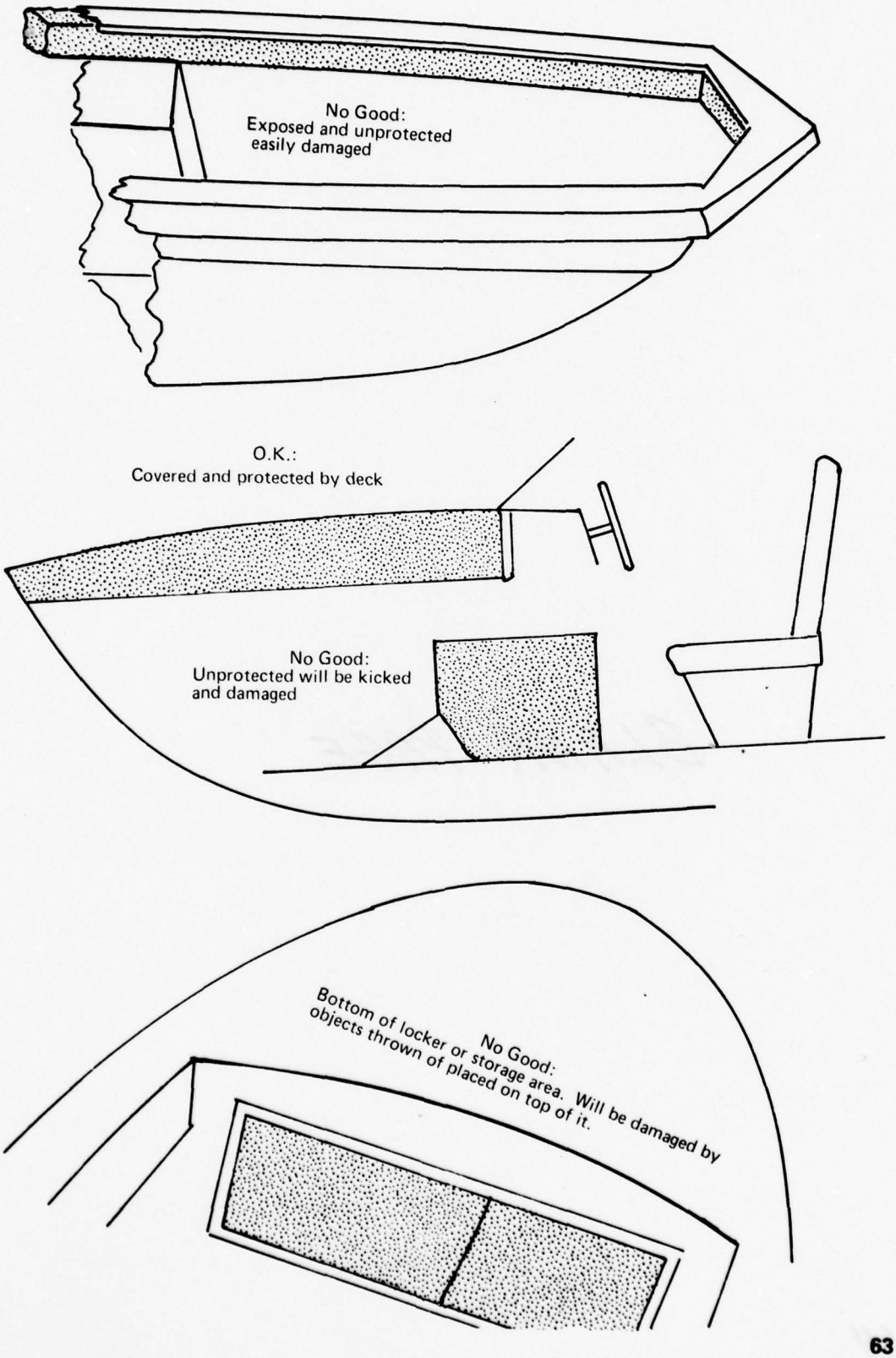


FIGURE 6.3

FLOTATION MATERIAL – PROTECTION FROM DAMAGE

FIGURE 6.4

FLOTATION MATERIAL – PROTECTION FROM DAMAGE



7.0 TEST PROCEDURES

These laboratory test procedures may be used by the boat builder to determine if boats comply with the minimum flotation requirements of the USCG Regulations 33 CFR 183, Subparts E, F, G, and H.

The intention is to provide a step-by-step testing sequence format and to aid the builder in complying with the regulations.

NON-COMPLIANCE

In the event that a boat should fail to comply with any of these minimum standards, DO NOT CONTINUE THE TEST SEQUENCE. Correct deficiencies that caused the non-compliance and retest to insure that the deficiency is satisfactorily corrected. Then, completely retest the boat to be sure that the correction does not affect compliance with any previous test.

CALIBRATION OF INSTRUMENTS

It is the responsibility of the builder to insure that the instrumentation used to determine weights and measures are accurately calibrated and that calibration is maintained throughout these tests. The time and date of calibration should be maintained in a log as a matter of record. If the calibration procedure is beyond the capability of the boat manufacturer we suggest that a regular program of inspection and adjustment by an outside organization equipped to provide this service be used.

TEST TANK AND WATER CONDITIONS

The flotation tests must be conducted in calm, clear, fresh water with an adequate depth to allow the boat to remain clear of the bottom while submerged with the proper test weights aboard during the preconditioning and during the tests. Clear water is important to allow observation and photography.

The test location must be protected from the effects of wind, current, waves or other external forces, and the arrangement and location of the test site should allow photographic documentation of all phases of the flotation test.

TEST WEIGHTS

The test weights will be submerged and should be of a material that will not absorb water or change in any way during the flotation tests. Lead, iron or steel or other dense metal are recommended.

The size of the test weights should be such that they can be conveniently handled below the water surface to achieve the correct weight distribution in the submerged boat.

The center of gravity of the weights, or combination of weights, must be able to fall within 6 inches of the side of the compartment and at least 4 inches above the floor or reference plane.

The following weight increments are suggested:

DRY WEIGHT	QUANTITY	PURPOSE
50 pounds	As required	Bulk loading on larger boats (above 16 foot)
25 pounds	As required	Bulk loading on smaller boats (below 16 foot)
10 pounds	5	Trimming weights
5 pounds	5	Trimming weights
1 pound	10	Trimming and fine tuning to exact weight requirements

To assure accuracy in recording test data, actual dry weight and actual submerged weight should be permanently marked on each weight. Because concrete absorbs water and does so at irregular rates, its submerged weight will change. Its density is lower than lead or steel creating problems with a larger bulk and a more difficult center of gravity placement. Concrete weights are not recommended for submerged ballast in flotation tests.

If concrete MUST be used, the blocks should be stored under water for at least 72 hours before using them for flotation tests. This will help to stabilize the rate of water absorption. They should not be taken from the water during the course of the test if they are to be reused later.

GLOSSARY

The definitions in this glossary describe terms used in this test procedure and in the flotation regulations. They are not necessarily the commonly accepted definitions.

Aft Reference Area = The aft most 2 feet of the top surface of the hull or deck. (See Figure 7.1)

Cockpit = See "Passenger Carrying Area".

Dead Weight = (For inboards, inboard/outdrive's and airboats) the maximum weight capacity marked on the boat, minus the persons' capacity marked on the boat. (For outboards) the maximum weight capacity marked on the boat minus the total weight shown in Table II for maximum horsepower marked on the boat, minus the persons' capacity marked on the boat.

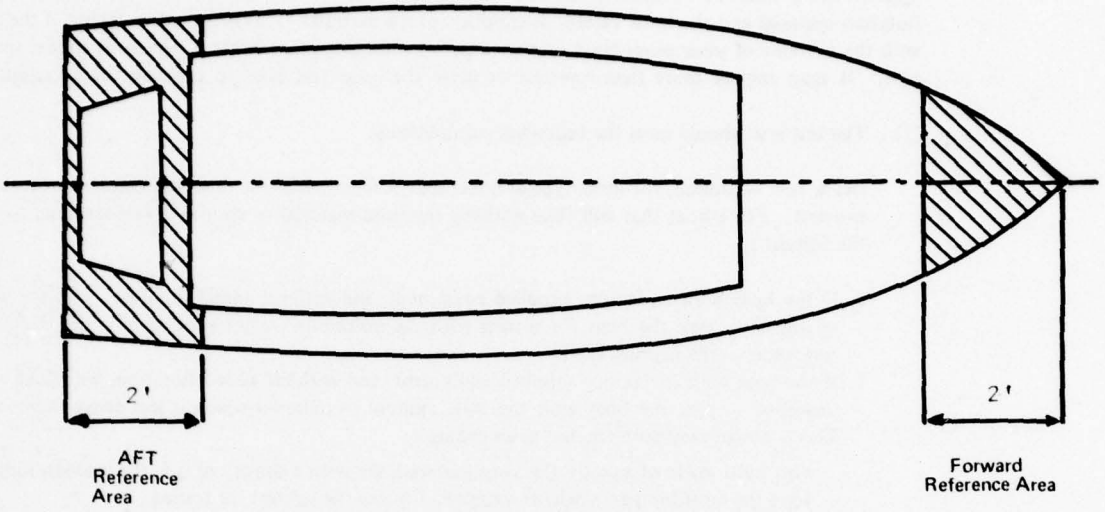
Forward Reference Area = The forward most 2 feet of the top surface of the hull or deck. (See Figure 7.1)

Loading Area = An area marked in the Passenger Carrying Area within which the CG of the test weights for passenger load must be located. This area, with its center at the meeting of lines at mid-length of the passenger carrying area and mid-breadth of the boat, measures 40 percent of the passenger carrying area LENGTH and 40 percent of the passenger carrying area BREADTH. (See Figure 7.3)

Passenger Carrying Area = Each area in a boat in which persons can sit in a normal sitting position, or stand while the boat is in operation. Breadth and length are measured as illustrated in Figures 7.3 and 7.4. If the boat has a cabin, the passenger carrying area is measured where there is at least two feet of air space between the swamped waterline and the inside of the cabin ceiling, measured in a continuous line the length and breadth of the cabin (See Figures 7.8, 7.9) *

Reference Depth = The minimum distance between the uppermost surface of the submerged reference area of a boat and the surface of the water, measured at the centerline. (See Figures 7.1 and 7.6)

**NOTE:* *A dimension of less than 12 inches between the aft end of a seat and the inside of the transom is not part of the passenger carrying area. (See Figure 7.8)*


2'
2'
AFT
Reference
Area
Forward
Reference Area

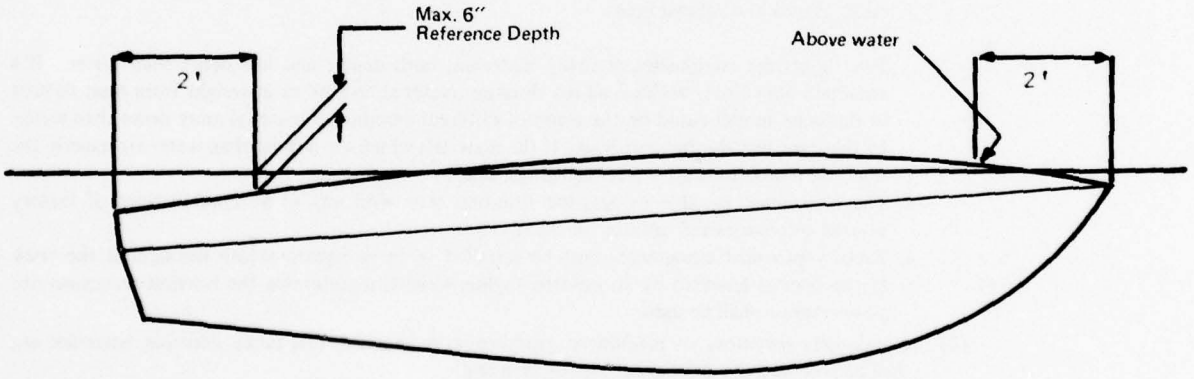

Max. 6"
Reference Depth
Above water
2'
2'

FIGURE 7.1

PROCEDURES

A. **SELECTION OF A TEST BOAT:**

To assure that ALL boats of a specific model will comply with the requirements, the test boat must incorporate the extreme production tolerances and the manufacturer supplied optional equipment offered for permanent installation which, when combined, will require the maximum quantity of flotation material and the most careful distribution of the material. This is the safety factor; if the boat with the extreme of your production tolerance passes the tests, other boats of the same model should pass. It may require more than one test or more than one test boat to evaluate these conditions.

(1) The test boat should meet the following requirements:

(As a rule of thumb, for most typical boats that will sink without flotation material --- pick the heaviest. For a boat that will float without flotation material --- such as a wooden boat --- pick the lightest.)

a. If the boat with its factory supplied equipment, and without added flotation, will sink when swamped --- pick the boat for testing with the maximum weight allowed in your production tolerances --- the heaviest boat.

b. If the boat with its factory supplied equipment, and without added flotation, will float when swamped --- pick the boat with the least amount of material which is less dense than water. This is not an easy problem, but as an example:

two hulls made of exactly the same material, say with a density of 0.5, the heaviest hull will have the most buoyancy when swamped. Choose the lightest for testing.

c. With two hulls made in a set of matching dies, in other words, exactly the same hulls dimensionally, the lightest will have the greatest buoyancy when swamped. If the dimensions are exactly the same the materials of construction must be of different densities if the hulls differ in weight. In this case, with the dimensions exactly the same, choose the heaviest boat.

If in a given model boat, the dimensions of the material which is lighter than water are not the same, choose the lightest boat.

Most boats are composites of many materials, both denser and less dense than water. If a swamped boat floats without added flotation material, variations in weight from boat to boat in the same model could be the result of different amounts of material more dense than water. In this case test the heaviest boat. If the materials which are heavier than water are exactly the same from boat to boat --- test the lightest boat.

d. The boat must be able to pass the flotation tests with any or all combinations of factory offered accessories and options for that model.

e. Factory provided equipment must be installed so as to remain secure throughout the tests.

f. If the boat is powered by an inboard engine, weights representing the heaviest recommended power option shall be used.

(2) A complete inventory of machinery, equipment, accessories, fuel tanks, controls, batteries, etc. shall be recorded in a permanent log for each test.

(3) HIN, capacity plate information, hull equipment and accessory weights must be recorded in a permanent log.

(4) Prior to each test it is recommended that the boat be photographed to show the details of the boat and equipment.

B. **PREPARATION FOR TEST:**

(1) All packaging and shipping protection material should be removed from the boat. This includes dunnage, seat protective wrappers, foam padding, chafing gear, etc.

(2) Water tanks, the water system, holding tanks, must be filled with fresh water and sealed. Putty and waterproof tape can be used. They must not leak.

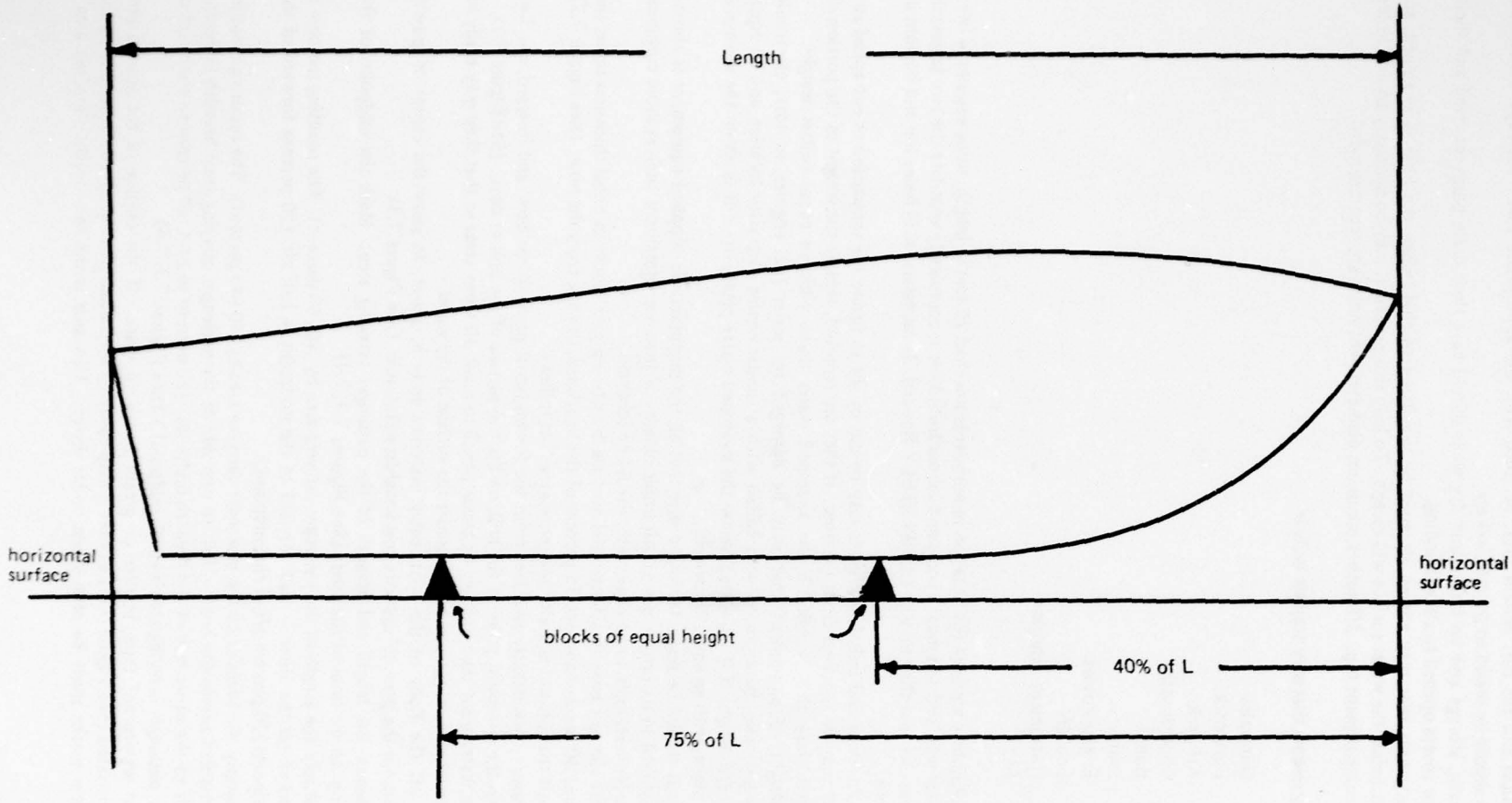

Length
horizontal surface
horizontal surface
blocks of equal height
40% of L
75% of L

FIGURE 7.2

(3) Fuel tanks and the fuel system must be filled with the appropriate fuel. All caps, vents, and outlets should be sealed to prevent leakage.

(4) Bait wells, storage and ice boxes, and dry wells should have their drain plugs removed and their doors or covers opened to allow flooding.

(5) Compartments that may entrap air must be ventilated so that, when the boat is swamped, air pockets below the water surface will escape. To help this process it may be necessary to drill holes in the compartment top. 3/8 inches minimum diameter vent holes are recommended.

Compartments that may trap air include:

Gunwales
Fore deck
Aft deck
Cockpit sole
Bunks
Seats
Engine covers
Lockers
Instrument consoles
Etc.

If air chambers are used for flotation in outboards less than 20 feet in length, using engines of over 2 horsepower, and in inboard boats and inboard/outdrive's, completely ventilate the two largest air chambers so that they may be COMPLETELY flooded. If necessary, drill holes top and bottom in each end.

(6) Seats, cushions and upholstery parts may be cut or slit to insure the ventilation of entrapped air, or they may be removed from the boat. If they are removed, replace the weight of the portion of the upholstery that is ABOVE the swamped water plane with an equal ballast weight.

(7) The weight of equipment that may be damaged by water (i.e. engines, motors, electronic equipment) may be replaced with ballast with a similar center of gravity location and an equal submerged weight if it is located below the swamped water plane, or, if it is above the swamped water plane, with an equal dry weight.

(8) The boat should be inspected to be sure that all the manufacturer supplied equipment is aboard and installed in its proper place. All other objects or insecure equipment such as loose cushions, PFD's, fenders, lines, loose chairs, etc. should be removed.

(9) Support the test boat in a horizontal attitude by placing two blocks of equal thickness under the keel, one 40 percent and one 75 percent of the boat's length back from the bow. (See Figure 7.2)

(10) Mark off the forward and aft "reference areas" as follows:

a. Measure back exactly two feet from the forwardmost point at the bow, and forward, two feet from the aftermost point of the hull, on the top surface of the hull or deck. (See Figure 7.1)

b. Use waterproof tape, marker or grease pencil to mark off these areas so that they may easily be seen when photographed while under the surface of the water.

(11) Mark off the floor of the boat, using materials as in b. above, to show the center of gravity location for the persons' capacity test weights, as follows: (See Figure 7.3)

a. Measure the length and breadth of the passenger carrying area. Mark the midpoint of the beam on the floor of the boat. (See Figures 7.3, 7.4)

b. Multiply the length of the passenger carrying area by .40 (40 percent). The resulting measure is marked on the floor --- half forward of the midpoint --- half aft. (20 percent forward of the midpoint, 20 percent aft of the midpoint.)

c. Multiply the breadth of the passenger carrying area by .40 (40 percent). The resulting measure is marked across the boat --- half to one side of the passenger carrying areas breadth midpoint-half to the other side of the breadth midpoint. (20 percent to port, 20 percent to starboard of the passenger carrying area breadth midpoint.) (See Figures 7.3, 7.4)

d. Use waterproof tape, marker or grease pencil to mark off the outline of the shaded area illustrated (See Figure 7.3) so that it may easily be seen when photographed, remembering that these marks must be seen when under water. This area is the test weight "loading area".

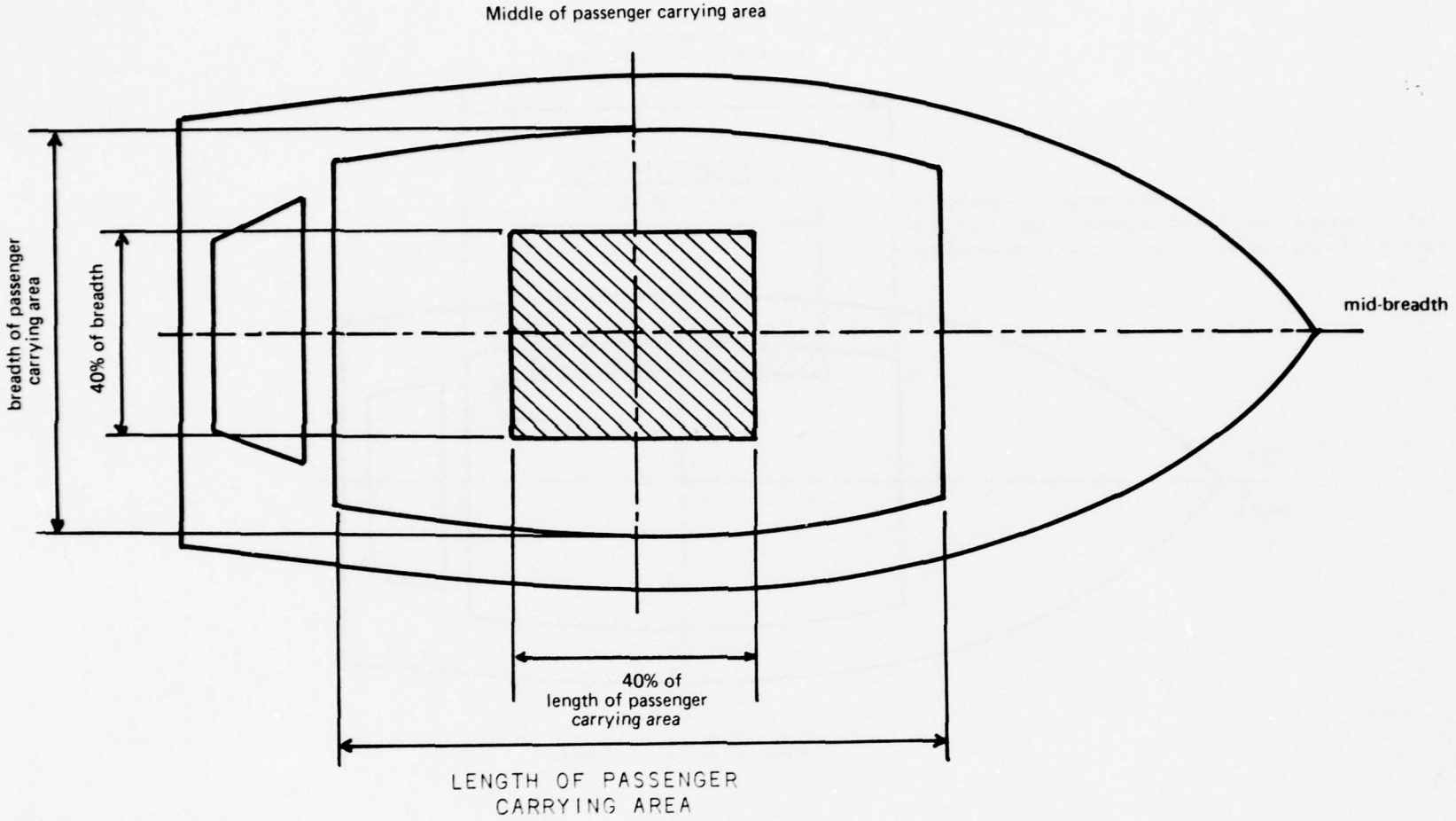
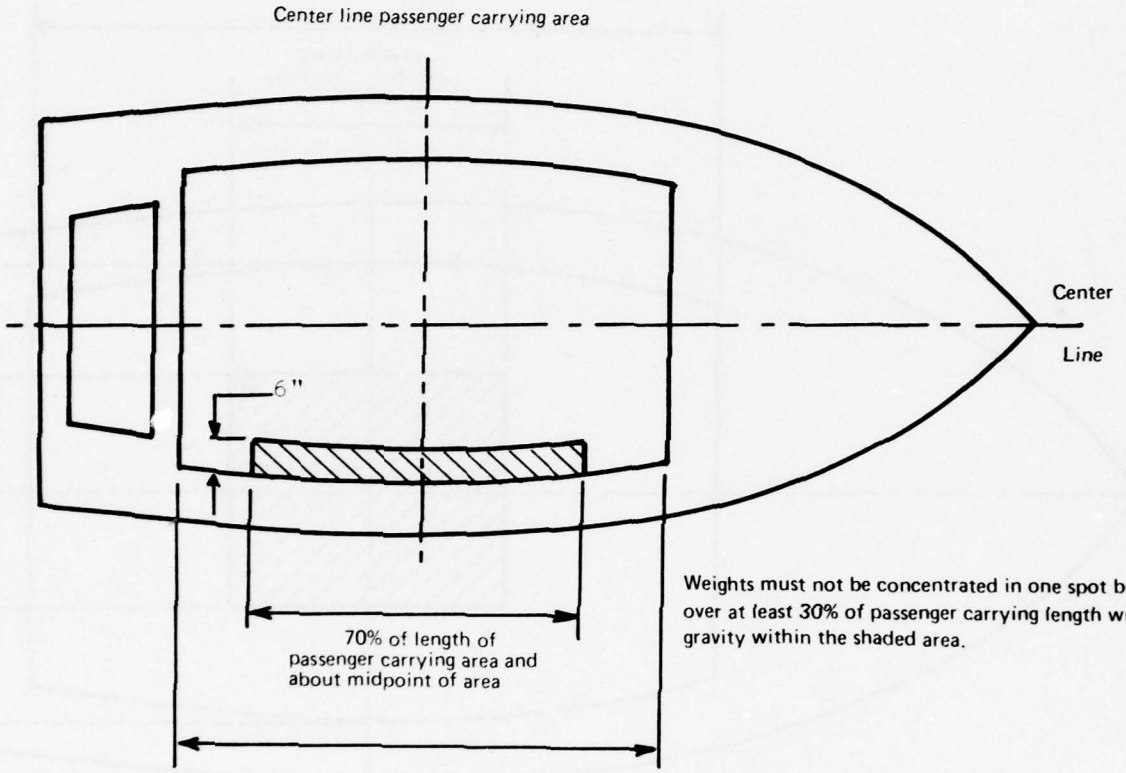


FIGURE 7.3 LOADING AREA

CENTER OF GRAVITY OF WEIGHTS MUST BE:

1. Longitudinally: Within 70% of the cockpit length
2. Transversely: Within 6" of side of passenger carrying area
3. Vertically: 4" or more above floor and seats



Weights must not be concentrated in one spot but must be spread out over at least 30% of passenger carrying length with the center of gravity within the shaded area.

FIGURE 7.4

(12) Mark off the boat to show the center of gravity locations for the stability test weights as follows: (See Figure 7.4)

a. The midlength and midbreadth of the passenger carrying area has been previously marked; multiply the length of the passenger carrying area by .70 (70 percent). The resulting measure is marked off on the starboard gunwale, its center being centered at the midlength of the passenger carrying area.

b. Repeat a. above for the port side.

(13) Remove all the drain plugs and hull plugs. As an alternative, when the boat is in the water it can be filled (using a hose or other method) so that the water level inside the boat and outside the boat is the same, and the boat is in a swamped condition.

FOR ALL OUTBOARD OR UNPOWERED BOATS

(NOTE: The quantity of weights for persons and dead weight differ above and below 2 horsepower). See Calculation Section, Pages 34, 40.

LEVEL FLOTATION

(1) Place weights representing outboard motor, controls and battery in normal operating position. Use weights of maximum rated outboard motor from Table II, Chapter 3.0. The CG of the weights representing the outboard motor and controls shall not be less than 2 inches above the top of the transom and 2 inches aft of the top aft edge of the transom at the centerline.

(2) Place boat in water.

(3) Before swamping the boat it is recommended that restraining lines or straps be secured to the boat to prevent it from rolling over or assuming unusual attitudes while you are loading ballast into the boat.

(4) Swamp the boat by flooding through the hull drains, or over the transom or sides, or with a hose.

(5) Place weights in the boat representing persons and dead weight as determined by calculation. (See the Flotation Standard, Section 183.320(b)(1) and (2) for 2 horsepower and less, and Section 183.220(b)(1) and (2) for engines over 2 horsepower).

(6) Eliminate any remaining trapped air by sloshing and tilting the boat.

(7) Slacken the restraining lines and allow the boat to attain its equilibrium. Check to be sure the boat is clear of the bottom.

(8) If necessary to attain the required longitudinal and transverse trim (See Section 183.225) adjust weight location within the designated loading area marked on the floor of the boat.

(9) The boat must remain in this position for at least 18 hours before further testing.

(NOTE: It is recommended that trim measurements and documentation photos be taken at the beginning and end of the 18 hour preconditioning immersion period.)

(10) Record water conditions. (See Form Section)

(11) If necessary, re-do step (8) to attain proper trim.

Level Flotation Test For Persons' Capacity

(12) After the test boat has remained swamped for at least 18 hours, test the boat for level flotation in accordance with 183.225 of the standard.

183.225	**..... the boat must float in fresh, calm water as follows:**
	(a) The angle of heel does not exceed 10 degrees from the horizontal.

a. Measure the angle of heel of the swamped boat; record data.

183.225 (b) Any point on either the forward or aft reference area is above the surface of the water.

b. Determine if a point on either the forward or aft reference areas is above the water surface. Record data.

183.225 (c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less.

c. Measure the reference depth as illustrated in Figures 7.1, 7.6.

d. If the boat is not in compliance, the weights may be moved as long as the center of gravity of the weights for both the persons' capacity and the dead weight is within the loading area marked on the floor.

Stability Test

(13) After completion of the flotation test for persons' capacity, test the boat for stability in accordance with 183.230 of the standard.

183.230 (b) Quantity of weight used. Load the boat with a quantity of weight that when submerged is equal to the sum of the following:

(1) One half the quantity of weight required by 183.220(b)(1)
(2) The quantity of weight required by 183.220(b)(2)

a. Remove half of the weight used to simulate persons' capacity in the preceding test. USE CAUTION. If the remaining weight is off center, capsizing may result.

b. Be sure that the weights representing dead weight, engine and batteries and controls are still in place. Dead weight must remain in the same location as was used in the previous test.

183.230 (d) Placement of Quantity of Weight, Starboard Side. Place the weight required by (a) of this section in the boat so that –

(1) (it) is uniformly distributed ... along the starboard side of the passenger carrying area (and extending over) at least 30 percent of the length of the passenger carrying area. The center of gravity of the floor weight ..... at least 4 inches above the floor, .. and of the seat weight .. at least 4 inches above the seat.

Adjust the restraining lines to allow the boat to heel freely.

c. Move the remaining half of the persons' capacity weights to the starboard side of the passenger area so that the center of gravity falls in the area of the boat illustrated in Figure 7.4. The vertical center of gravity must fall at least 4 inches above the seats or floor.

d. Distribute the weight along at least 30 percent of the passenger area length, placing the weights on the floor and seats. Weights may be placed forward or aft of the loading area as long as the CG is within the fore and aft limits of this area.

e. Swamp the boat to allow a free flow of water between the outside and the inside.

183.230 (a) ... the boat must float in fresh calm water as follows:

(1) The angle of heel does not exceed 30 degrees from the horizontal.
(2) Any point on either the forward or aft reference area is above the surface of the water.
(3) The reference depth of the reference area that is opposite the reference area that is above the surface of the water is 12 inches or less.

(No. 3 means the reference depth must be 12 inches or less at the center line. (See Figure 7.6)

f. Measure the angle of heel and record the data.
g. Determine if a point on either the forward or aft reference area is above the water's surface. Record that data.
h. Measure the reference depth as illustrated in Figures 7.1, 7.6)

183.230	**(d) Placement of Quantity of Weight, Port Side ...** **(See 183.230 (d) Page 68.**

i. Repeat Steps a. through h. as above, placing the weights on the port side.

Level Flotation Test Without Weights For Persons' Capacity

(14) After completion of the test for stability, test the boat for level flotation without weights for persons' capacity and the dead weight in accordance with 183.235 of the standard.

183.235	**... When the conditions prescribed in 183.220(a), (d) through (h) are met, the boat must float in fresh, calm water as follows:** **(a) The angle of heel does not exceed 10 degrees from the horizontal.** **(b) Any point on either the forward or aft reference area is above the surface of the water.** **(c) The reference depth at the reference area that is opposite the reference area that is above the surface of the water is 6 inches or less.**

a. Carefully remove all weights for persons' capacity and dead weight.
b. Leave only the weights for the engine, batteries and controls. Adjust the slings so that the boat is not restrained.
c. Swamp the boat to allow a free flow of water between the outside and the inside.
d. Measure the angle of heel. Record the data.
e. Determine if a point on either the forward or aft reference area is above the surface of the water. Record the data.
f. Measure the reference depth as illustrated in Figures 7.1 and 7.6 record the data. A 6 inch depth is the maximum allowable here.
g. Drain or remove the water from the boat and remove the boat from the water.

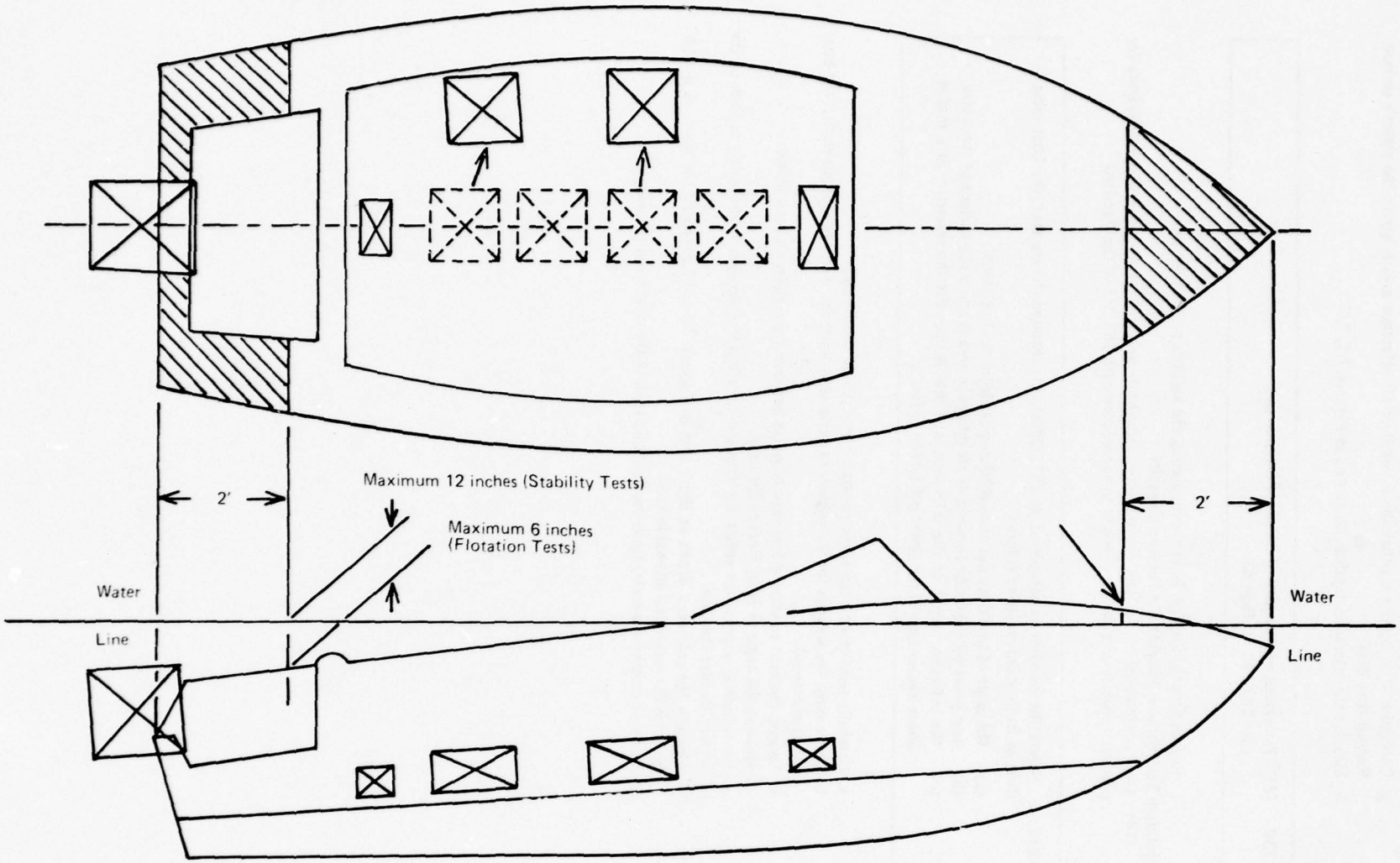


FIGURE 7.5 WEIGHT SHIFT FOR STABILITY TESTS

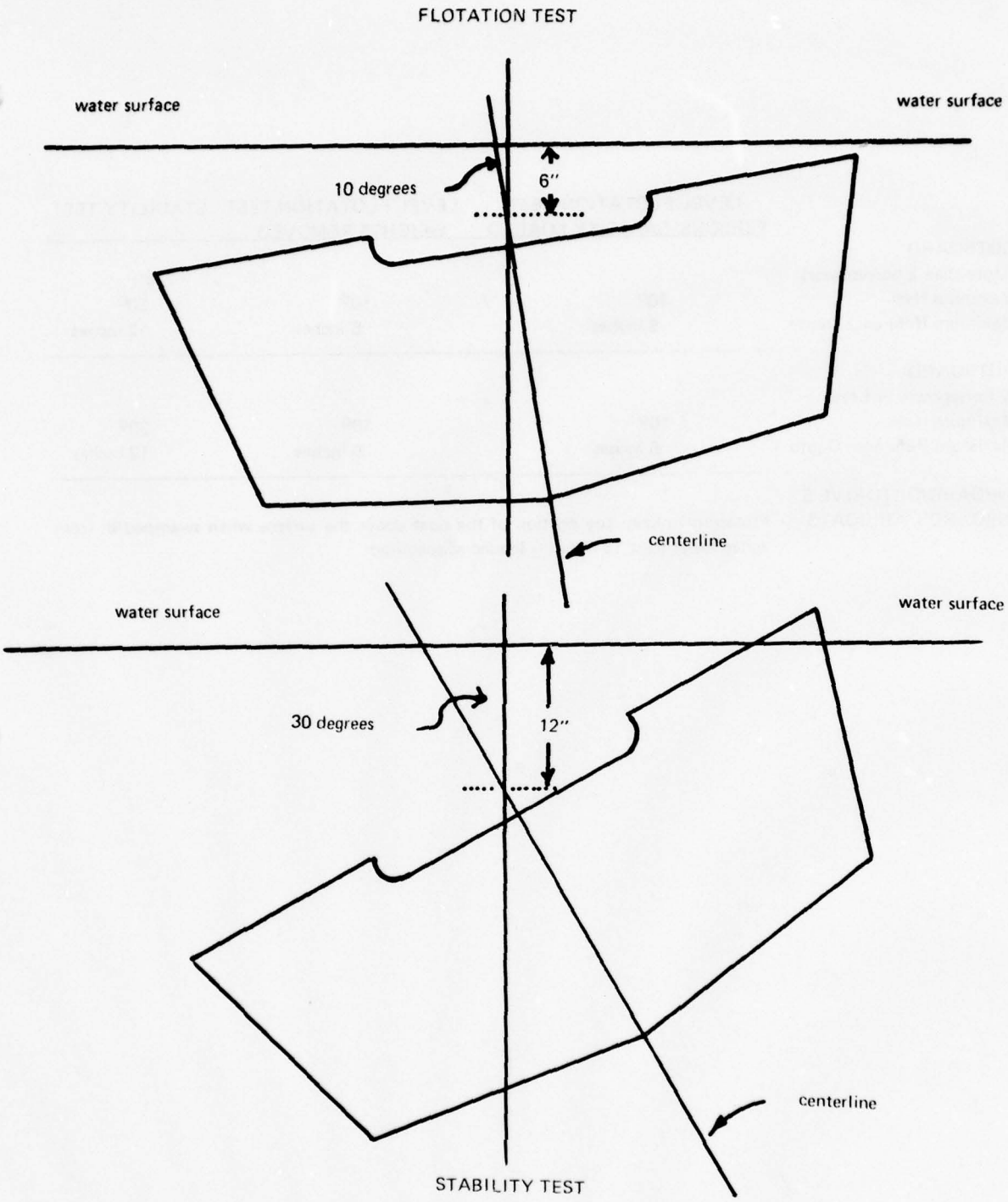
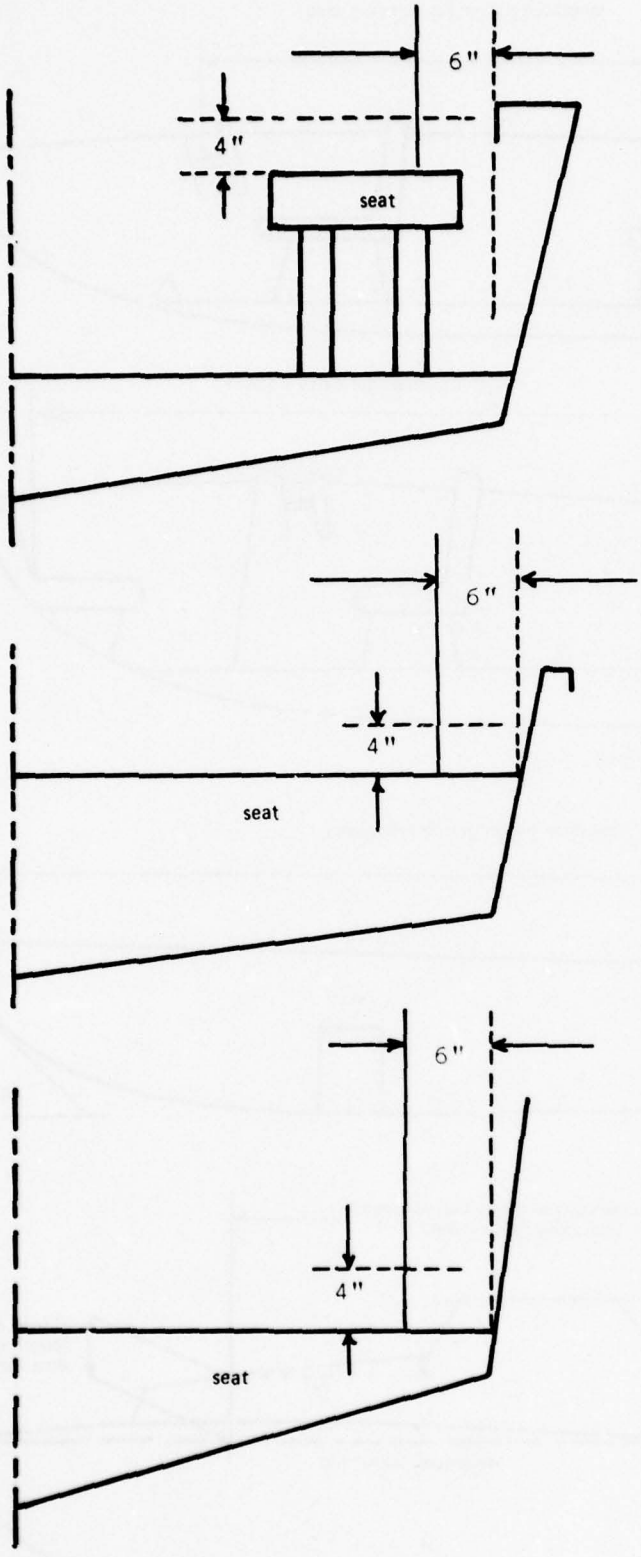

FLOTATION TEST
water surface
water surface
10 degrees
6"
centerline
water surface
water surface
30 degrees
12"
centerline
STABILITY TEST

FIGURE 7.6

	LEVEL FLOTATION TEST PERSONS' CAPACITY LOADED	LEVEL FLOTATION TEST WEIGHTS REMOVED	STABILITY TEST
OUTBOARD (More than 2 horsepower)			
Maximum Heel	10°	10°	30°
Maximum Reference Depth	6 inches	6 inches	12 inches
OUTBOARD (2 horsepower or Less)			
Maximum Heel	10°	10°	30°
Maximum Reference Depth	6 inches	6 inches	12 inches
INBOARD/OUTDRIVE'S INBOARDS, AIRBOATS	Flotation to keep any portion of the boat above the surface when swamped in fresh water for at least 18 hours --- loaded as specified		



Location of center of gravity of weights on seats

FIGURE 7.7

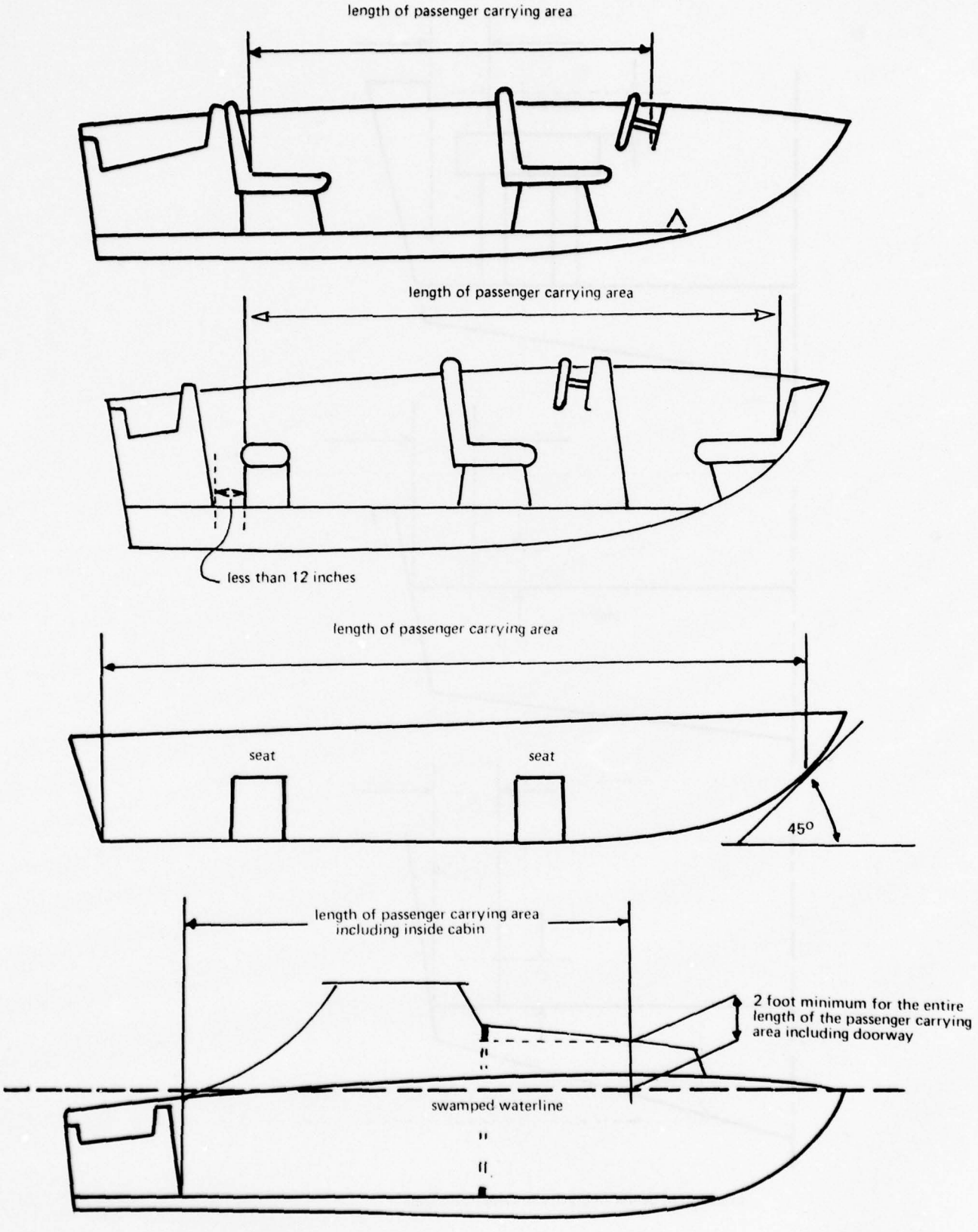
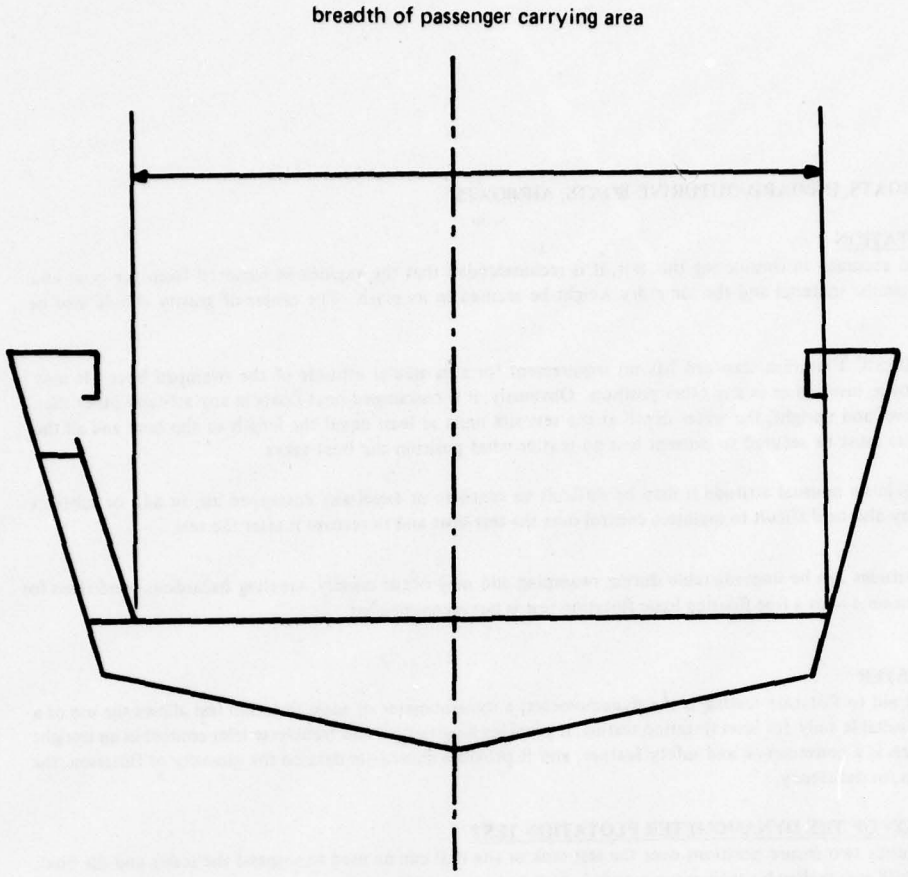

length of passenger carrying area
length of passenger carrying area
less than 12 inches
length of passenger carrying area
seat
seat
45°
length of passenger carrying area
including inside cabin
2 foot minimum for the entire
length of the passenger carrying
area including doorway
swamped waterline

FIGURE 7.8


breadth of passenger carrying area

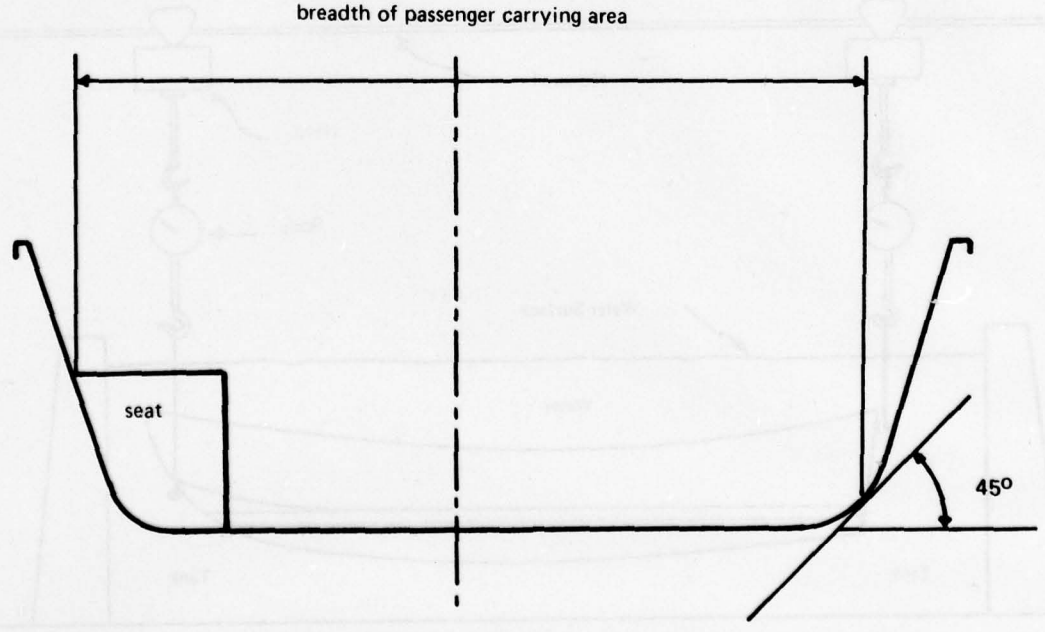

breadth of passenger carrying area
seat
45°

FIGURE 7.9

INBOARD BOATS, INBOARD/OUTDRIVE BOATS, AIRBOATS

BASIC FLOTATION

For ease and accuracy in conducting this test, it is recommended that the engines be removed from the boat and ballast of a similar material and the same dry weight be secured in its place. The center of gravity should also be matched.

The USCG BASIC Flotation standard has no requirement for a particular attitude of the swamped boat. It may float stern down, inverted or in any other position. Obviously, if the swamped boat floats in any attitude other than reasonably level and upright, the water depth at the test site must at least equal the length of the boat and all the ballast weights must be secured to prevent loss no matter what position the boat takes.

If the boat is in an unusual attitude it may be difficult to ventilate or expel any entrapped air, or add or subtract ballast. It may also be difficult to maintain control over the test boat and to recover it after the test.

Unusual attitudes can be unpredictable during swamping and may occur rapidly, creating hazardous conditions for the test personnel --- so a free floating basic flotation test is not recommended.

DYNAMOMETER

An excellent aid to flotation testing is the dynamometer; a dynamometer or scale flotation test allows the use of a tank that is suitable only for level flotation testing, it provides longitudinal and transverse trim control in an upright attitude which is a convenience and safety feature, and it provides immediate data on the quantity of flotation, the safety margin, or deficiency.

DESCRIPTION OF THE DYNAMOMETER FLOTATION TEST

This test requires two secure positions over the test tank or site that can be used to suspend the scales and the boat. A monorail with two trolley-hoists is recommended. One test arrangement is shown.

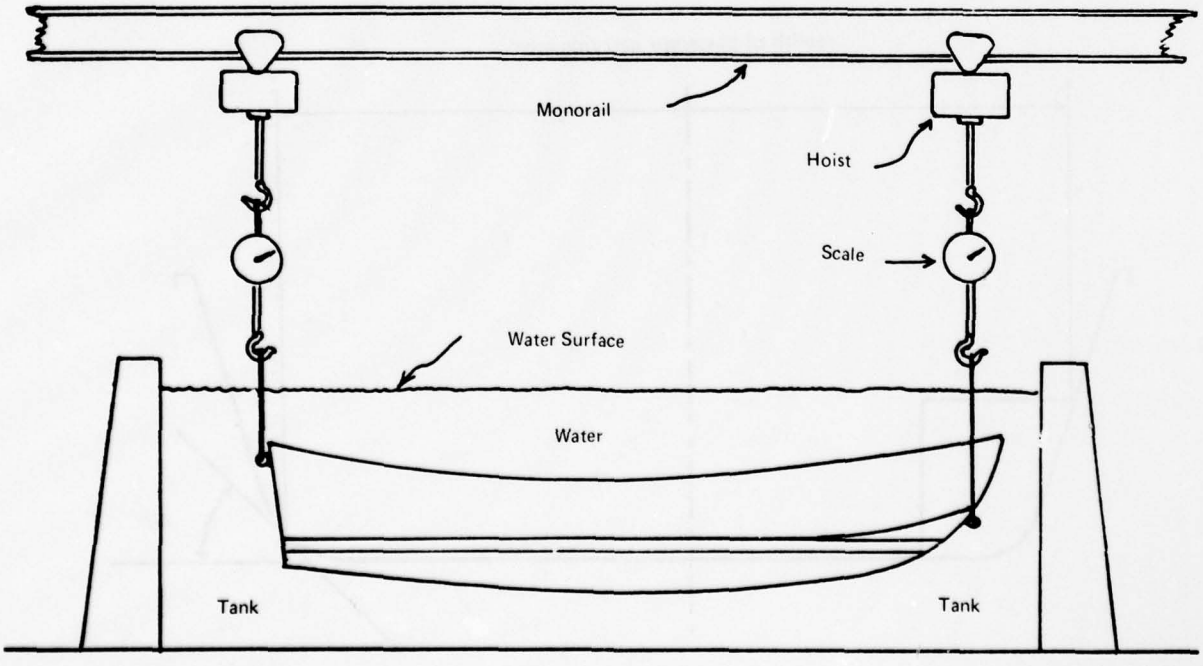


FIGURE 7.10

SCALES

If, before the ballast for persons and dead weight is added, the swamped boat will float without touching the bottom of the tank, the accuracy of the test will be improved through the use of small capacity scales. (For example, 25 pound capacity) If the boat will not float clear of the bottom, the scale capacity for the submerged end of the boat must exceed its submerged weight.

DO NOT attempt to lift a boat into or out of the tank while it is hanging from the scales in slings. Remove the scales first or they may be permanently damaged or fail completely and let the boat drop.

BASIC FLOTATION TEST – DYNAMOMETER METHOD

(1) Before the scales are attached, lift the boat into the tank.

(2) With the slings still attached, but slightly loose, fill the boat with water by flooding through the hull drains, swamping or by pumping water in until the level of the water is the same inside as outside the boat. As the boat fills, slacken the slings until each end of the boat either sinks below the surface or reaches equilibrium.

(3) Install the scales between the slings and the hoist hooks.

(4) When placing ballast in a boat always record the submerged weight of each weight unit as it is placed aboard.

(5) Load the ballast in the boat toward the high end until the boat is submerged and approximately level – AND – there is a positive reading on each scale.

(6) Record the scale readings and photograph the swamped boat.

(7) Allow the boat to remain in this position for the required 18 hours.

(8) After 18 hours, check to be sure that there is still a positive reading on each scale AND the capacity of each scale has not been reached. If the initial ballast load (See Fig. 7.10) is altered, correct the data sheet and total the submerged weight.

(9) After all motion of the water in the tank has settled down and the scale readings are steady, record each scale reading on the data sheet after subtracting the weight of the slings themselves.

NOTE: The ratio of the total scale readings after and before the 18 hour submersion test is the efficiency of the flotation system. This is a useful figure in designing future flotation systems.

(10) Subtract the sum of the two net scale readings from the total submerged ballast weight and record on the data sheet in a box marked "AF", (Actual Flotation).

(11) Photograph the boat and scales in this position.

CALCULATING THE SUBMERGED BALLAST WEIGHT FOR BASIC FLOTATION

DYNAMOMETER TEST

(1) 2/15 x Persons' Capacity marked on boat capacity plate =

(2) 25 percent of the Dead Weight =

(3) If air chambers are used for flotation
62.4 x volume (in Ft^3) of two largest air chambers =

(4) Total = "RF" (Required Flotation) Total

COMPLIANCE DETERMINATION

If the actual flotation "AF" is greater than the required flotation "RF", the boat complies with the basic flotation requirement. Quantity "AF" minus quantity "RF" equals the reserve flotation or safety factor. If the required flotation, "RF", is greater than the actual flotation, "AF", the boat has failed the test. The quantity "RF-AF" is equal to the minimum amount of flotation that must be added to the system to meet this requirement with no reserve.

NOTE: If after the 18 hour preconditioning before the test the boat fails to show any portion above the water, the following procedure can determine how much additional flotation is required:

1. *Attach a pendant from one of the scales to the bow of the boat (or whichever portion of the boat is closest to the water surface).*
2. *Lift up at the point until it is above the water surface. Record the pounds of lift that were necessary to bring the boat up. Flotation material to provide that much more buoyancy is required.*

REMOVAL OF THE BOAT FROM THE TEST TANK

Before attempting to lift or move the boat, remove the ballast and record each unit of submerged weight as you take it from the boat. Compare this with the corrected tabulation of weights put into the boat. The total must be equal. If not, retest.

Remove the scales from the sling system. DRAIN THE BOAT.

Remove the boat from the water. REMEMBER the great weight of any water retained in the hull. Lift to the surface slowly allowing the water to drain from the hull through drain fittings, or lift slowly to permit the use of a pump to drain the retained water. NEVER try to lift the hull, weights and the hull full of water.

Drain carefully and fully before lifting.

8.0 QUALITY CONTROL

Strict control over the quality, quantity and installation of flotation materials is as important to regulation compliance as proper design and accurate calculations. The following information can be used as a guide by the boat builder to establish quality control procedures for use before and during construction.

Regulations for performance and installation are contained in 33 CFR Part 183, Subparts E, F, G, and H, and in their amendments. Refer to the information on flotation materials in the MATERIALS and FLOTATION MATERIALS REQUIREMENTS sections of this guideline.

PROBLEM AREAS:

Some pitfalls encountered in controlling flotation materials and in installation methods are:

a. Maintaining density and buoyancy of materials.
b. Excessive water absorption by materials.
c. Material degradation due to exposure to harmful agents.
d. Foam equipment malfunctions or improper use.
e. Inadequate securement of materials.
f. Leaks in chambers used for flotation or to encase flotation materials.
g. Poor quality control including hull weight testing.
h. Poor installation planning resulting in excessive material removal during boat assembly.

QUALITY CONTROL OF MATERIALS:

A. **VENDOR SPECIFICATIONS:**

The builder should insure that all foam flotation materials purchased will meet USCG requirements, specifying this in his purchase order and requiring vendor verification on each shipping invoice. He should insist that a specification sheet be supplied by the vendor that covers all performance characteristics including compressive strength, density, water absorption, and resistance to fuels, oils, fuel vapors, cleaning solutions, styrene fumes and sunlight exposure.

At the same time, mix instructions and installation procedures should be obtained.

SPECIFICATIONS

(1) Specify materials that will meet USCG requirements.
(2) Require verification of compliance on each invoice.
(3) Insist on a specification sheet.
(4) Request mix instructions and procedures.

B. **RECEIVING INSPECTION:**

Beside visual inspection, the builder should conduct buoyancy tests on a representative sample or samples of incoming pre-cast flotation materials, foam blocks, and air filled molded shapes.

INSPECTION

(1) Inspect visually.
(2) Conduct buoyancy test; can be performed per ASTM D-2842.
(3) If test is unsatisfactory --- notify vendor.

This will require a test apparatus similar to the one shown in Figure 8.2.

NOTE: Test weights should be lead, steel, or other dense, non-absorbent material to aid in accurate determination of their submerged weight. The weight of concrete varies markedly as does its water absorption; it should NOT be used.

A known quantity of the material to be tested should be submerged in fresh water to a depth of three feet for 18 hours. Once pre-conditioned, a test of the weight which can be supported by the test sample should be conducted as shown in Figure 8.2. If a foam sample fails to provide the rated buoyancy, several factors could be at fault --- poor cure, improper density, too much water absorption, bad cell structure and others. Carefully re-test another sample and notify the vendor if the shipment is suspect.

C. **IN-HOUSE PRODUCED FOAM**:

The builder should conduct buoyancy tests on flotation foams produced in-house from component mixes. Each production station that pours or dispenses components to create flotation foam should produce a test sample during each work shift, at a minimum.

TEST PROGRAM

(1) Conduct buoyancy test on sample produced each day or each shift.
(2) Conduct buoyancy test on a sample from each dispensing station.
(3) Conduct test at each change of drums.

There are two factors here; the frequency of obtaining samples, and the frequency of testing them. Both should be adjusted by the builder depending upon production volume and past problems.

The samples should be produced employing the same method used in the production process. For example, if the foam is allowed to expand in an enclosed compartment, the test sample should be prepared in the same manner. EACH test sample should be identified by station so that problem materials can be traced back to specific production runs.

An example of a condition that requires more frequent sampling and testing is where there are large variations in ambient temperature at the production station. Foam produced on a cold morning COULD be deficient due to improper reaction of chemical components.

If a sample fails, its components and the dispensing equipment, as well as the temperature should be suspect. Carefully re-test another sample and take corrective action as necessary.

PROBLEMS

(1) Increase frequency of tests if problems appear.
(2) Use same method to produce sample as used in boat.
(3) Be alert to temperature changes at each station.

D. **PREPARING A FOAM SAMPLE IN-HOUSE**:

A test mold may be used. The mold cavity should be in the shape of a cube, one possible mold has inside dimensions of about 13 inches. Bottom and top should be detachable. The top should have 1/2 inch vent holes in each corner, located about 1/2 inch from the edges. The mold should be rigid enough to prevent deformation caused by expanding foam.

It is best to be able to firmly secure the mold with its top and bottom clear so that the sample may be removed. (See Figure 8.1)

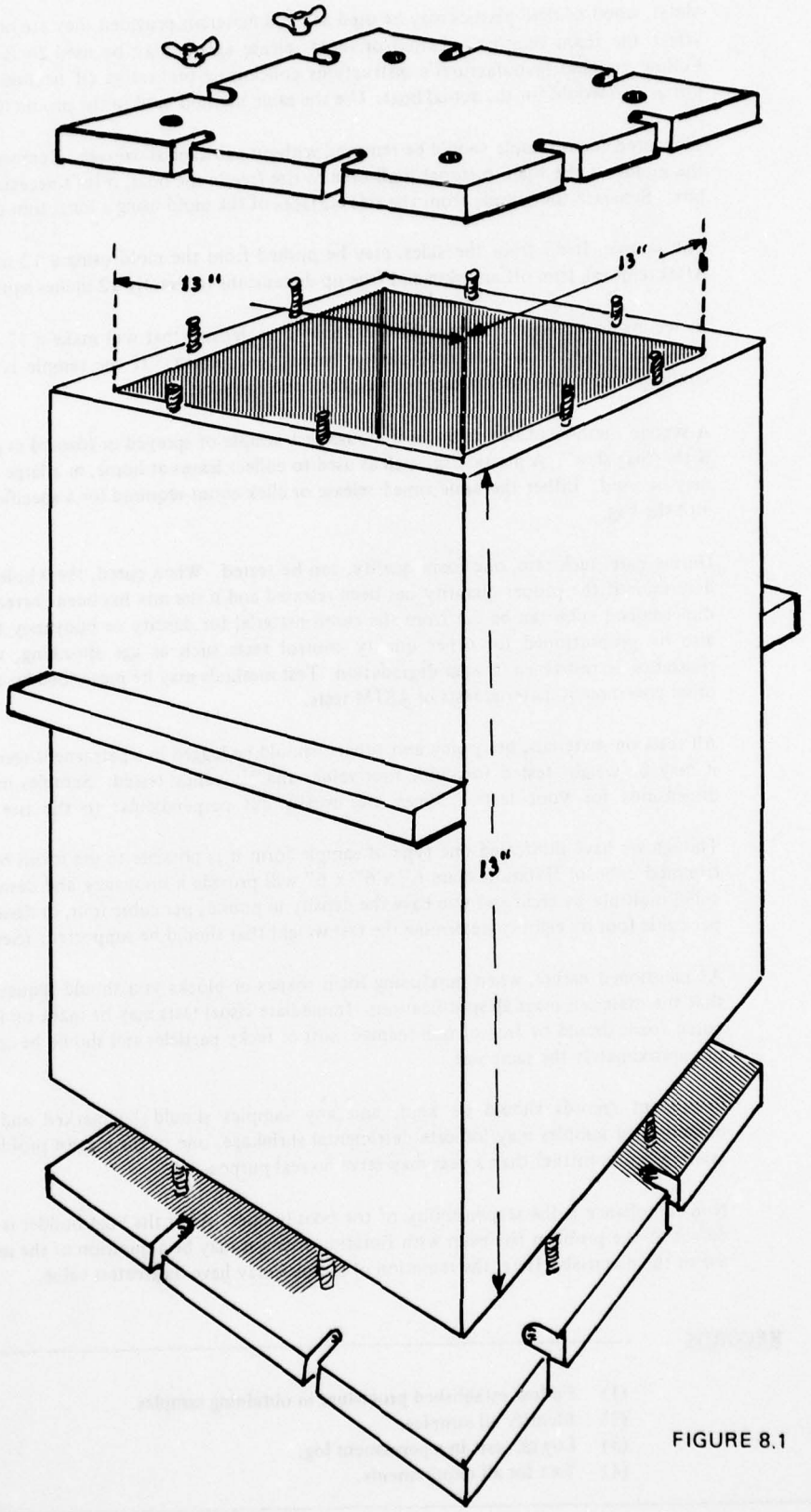


FIGURE 8.1

Metal, wood of rigid plastics may be used as mold materials provided they are not affected by, or do not affect the foam mixture. Teflon or mold release agents may be used to facilitate sample removal. Follow material manufacturer's instructions concerning preheating (if necessary), pouring and curing just as you would for the actual boat. Use the same method used in the production process.

The cured foam sample should be removed without substantial damage. Remove the top and bottom of the mold. If the foam material is allowed to rise free in the boat, it isn't necessary to use the top of the box. Separate the sample from the side surfaces of the mold using a long, thin cutting tool if necessary.

The sample, freed from the sides, may be pushed from the mold using a 12 inch square wood board. After removal, trim off any skin and true up dimensions to exactly 12 inches square.

In testing foam materials most builders aim for a density that will make a 12 inch square block (one cubic foot) weigh two pounds, plus or minus ten percent. If the sample is cast and weighed in a container, remember to subtract the weight of the container.

A second method of obtaining an in-house test sample of sprayed or foamed in place flotation material is the "bag shot". A plastic bag, such as used to collect leaves at home, or a large disposal container liner may be used. Either the same timed release or click count required for a specific application is released into the bag.

During cure, tack rate, one foam quality, can be tested. When cured, the whole bag can be weighed to determine if the proper quantity has been released and if the mix has been correct. Then, an accurately dimensioned cube can be cut from the cured material for density or buoyancy tests. The material can also be proportioned for other quality control tests such as age shrinking, water absorption, fuel resistance or resistance to solar degradation. Test methods may be prescribed by the CG or you may use other government material tests or ASTM tests.

All tests on materials, buoyancy and others, should be logged in a permanent record. In the cubic form it may be weight tested for cubic foot values and buoyancy tested. Samples may be cut into proper dimensions for your tests. Slices are usually cut perpendicular to the rise of the plastic foam.

Though we have illustrated one type of sample form it is possible to use forms of other dimensions. A trimmed cube of flotation foam 6" x 6" x 6" will provide a buoyancy and density check. Weigh the cube, multiply by eight and you have the density in pounds per cubic foot, or divide the rated buoyancy per cubic foot by eight to determine the test weight that should be supported. (See Figure 8.2)

As mentioned earlier, when purchasing foam shapes or blocks you should request invoice certification that the materials meet all specifications. Immediate visual tests may be made on in-house samples. The cured foam should be free of non-foamed, soft or tacky particles and should be composed of small cells of approximately the same size.

Permanent records should be kept, and any samples should be marked and stored. Accurately dimensioned samples may indicate detrimental shrinkage, one of the biggest problems, within a year, so saving samples further than a year may serve no real purpose.

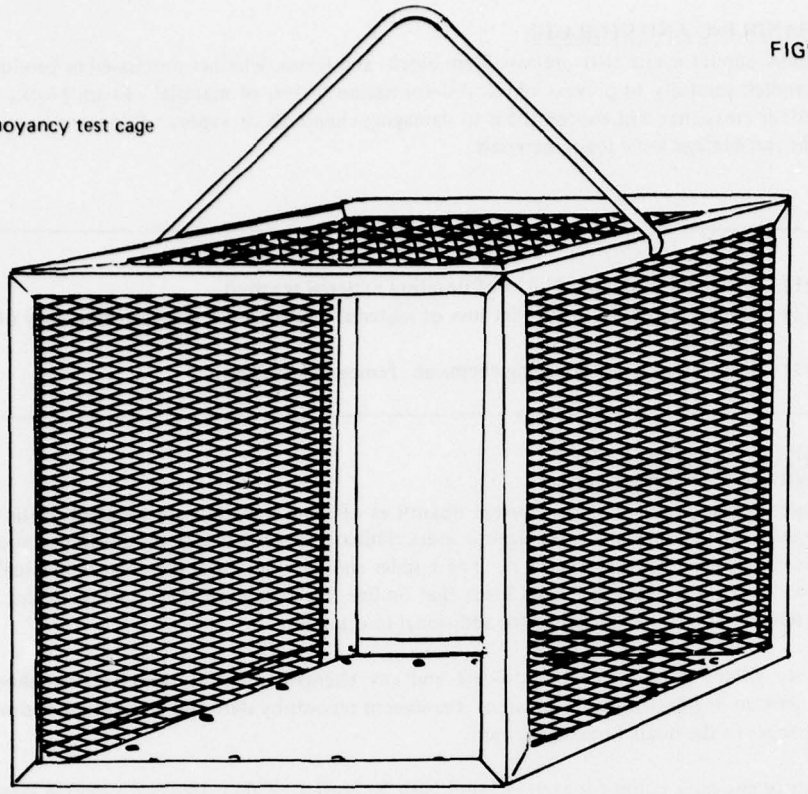
Non-compliance is the responsibility of the boat builder. After the boat builder is required to remedy a defect, if the problem has been with flotation foam, it may be a question of the materials or method of use of the materials. Here, the retention of samples may have its greatest value.

RECORDS

(1) Follow established procedure in obtaining samples.
(2) Identify all samples.
(3) Log all tests in a permanent log.
(4) Test for all requirements.

FIGURE 8.2

buoyancy test cage

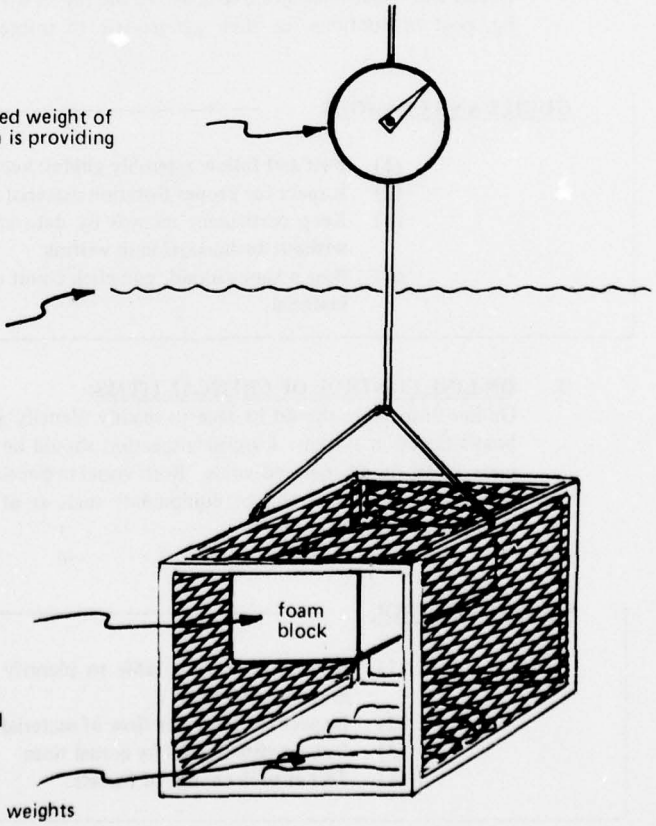


scale reading equal to submerged weight of empty test cage indicates foam is providing required buoyancy

water level

66.4 lbs. of dry lead equals 60.4 lbs. submerged (66.4 x 0.91 = 60.4)

one cubic foot of 2 lb. density foam should support 60.4 lbs.



E. **IN-PLANT HANDLING AND STORAGE:**

The boat builder should insure that pre-cast foam blocks and forms, whether purchased or produced in-house, are handled carefully to prevent physical deformation or loss of material. Foam blocks should not be stored in areas that will expose them to damaging chemicals or vapors. Exposure to excessive direct sunlight can damage some foam materials.

HANDLING

(1) Check all forms and blocks of flotation material received.
(2) Handle carefully to prevent loss of material which would decrease buoyancy of the unit.
(3) Store away from damaging chemicals, fumes and sunlight.

QUALITY CONTROL OF FOAM INSTALLATION:

A. **ASSEMBLY GUIDES AND RECORDS:**

The boat builder must insure that the correct quantities of foam materials are installed in the proper location, properly secured and protected against indiscriminate removal during the assembly process, in transit and during dealer rigging of the boat. The builder should work from drawings or manuals that clearly depict the correct installation and insist that on-line inspectors use these guides. Refer to the INSTALLATION section of this guideline for additional information.

These assembly guides must be kept up-to-date and any changes to the flotation system should be preceded by written engineering authorization. Permanent records by date and serial number should be kept on all changes to the boats flotation system.

A time-second or gun-click count for each location must be posted, (if they are your metering methods). If you use visual references, such as "to the top of the wood brace", post these. If you use a configured jig, post instructions for their proper use to insure correct installation of proper foam quantities.

GUIDES AND CHANGES

(1) Post and follow assembly guides; keep them current.
(2) Inspect for proper flotation material securement in the boat.
(3) Keep permanent records by date and serial number of all changes; make none without authorization in writing.
(4) Post a time-second, gun-click count or visual reference guide for foamed in place material.

B. **ON-LINE CONTROL OF CRITICAL ITEMS:**

On-line inspectors should be able to readily identify any variations from the assembly drawings of the boat's flotation system. Careful inspection should be made to insure that there is an adequate flow of material to fill all required voids. Both visual inspection and some testing will be required. Test at each major change of material or equipment, such as at the start of each new barrel of foam material component placed on-line.

ON LINE CONTROL

(1) Inspectors must be able to identify any variation from specifications between drawings and boat.
(2) Inspect for adequate flow of material into voids.
(3) Inspect visually and by actual tests.
(4) Test at each change of barrels.

AIR CHAMBERS AND FLOTATION MATERIAL CHAMBERS:

On boats using air chambers and on boats using encased flotation material, each chamber on every boat should be tested for air tightness or leakage. The test method must not cause structural damage to the boat or chamber, but it must insure that the chamber will comply with the 18 hour submergence criteria and the tests.

PRECONDITIONING

(1) Test air chambers and encased flotation material for 18 hour preconditioning submergence requirements.

FOAM MATERIALS:

The builder should clearly identify all pre-cast foam blocks or shapes that are similar in appearance but of different volumes. On-line inspectors should verify that these blocks or forms are properly positioned and secured.

IDENTIFICATION

(1) Identify or mark all blocks and shapes to prevent misapplication.

On foams that are poured or sprayed in place, visual inspection of the foam consistency should be conducted on every boat. Careful inspection should be made to insure that there is an adequate amount of flotation material on thinner applications where no guide or gauge is used. As previously stated, some method of assuring proper quantities is recommended other than conjecture. At times, when the calculated amount of required foam has been figured close, and long, narrow spaces are being filled, insufficient flotation results. An inadequate flow of foam often causes rapid surface hardening and high density.

INSPECTION

(1) Visually inspect each boat, particularly in long, narrow spaces and shallow surface applications.
(2) Inspect for adequate flow of material.

PRODUCTION WEIGHT TOLERANCES:

On-line inspection should include weighing a representative sample of production boats to insure that the weights used in the flotation calculations are maintained. Use the heaviest boat, in most cases, to verify weight calculations.

SAMPLING AND CONTROL

(1) Weigh sampling of production boats.
(2) Use weight of heaviest boat to verify flotation material requirements. (This may not be true in wooden hulls.)
(3) Keep running check on the total number of boats produced and total flotation material used as a quick quality control method.

WEIGHT CALCULATIONS

OUTBOARDS WITH MOTORS OF 2 HORSEPOWER OR LESS:

183.320(b) (1) and (2)

Model _____ HIN _____

Maximum Weight Capacity _____ lbs.

Persons Weight Capacity _____ lbs.

Weight of Engine and Controls _____ lbs.

TEST WEIGHT EQUALS:

Persons Weight:

.133 x Persons' Capacity of Boat = a._____ lbs.

AND:

Dead Weight:

Maximum Weight Capacity –(minus) Weight from Table II Column 6 (20 pounds)

= ZZZ

THEN:

ZZZ – Persons' Capacity of Boat

= YYY

THEN:

.25 x YYY = b._____ lbs.*

TOTAL (a. + b.) = _____ lbs.

**NOTE:* *The result b. must not be less than zero.*

WEIGHT CALCULATIONS

OUTBOARDS WITH MOTORS OF MORE THAN 2 HORSEPOWER:

183.220(b) (1) and (2)

Model _____ HIN _____

Maximum Weight Capacity _____ lbs.

Persons Weight Capacity _____ lbs.

Weight of Engine, Controls and Battery _____ lbs.

TEST WEIGHT EQUALS:

Persons Weight:

.50 x The first 550 lbs. of the boats Persons' Capacity (maximum result is 275 lbs.) = a. _____ lbs.

THEN:

.125 x The remainder of the Persons' Capacity = b. _____ lbs.

AND:

Dead Weight:

Maximum Weight Capacity –(minus) Weight from Table **II Column 6**

= ZZZZ

THEN:

ZZZZ – Persons' Capacity

= YYYY

THEN:

.25 x YYYY = c. _____ lbs.*

TOTAL (a. + b. + c.) = _____ lbs.

**NOTE:* *The result c. must not be less than zero.*

OUTBOARD BOAT

LEVEL FLOTATION TESTS:

DATA RECORDING FORM

Model _____ HIN _____ Date _____

Date and Time of Preconditioning Start ____/____/____ ____ AM PM

Date and Time of Tests ____/____/____ ____ AM PM

Capacity Plate Information:

Maximum Horsepower Capacity _____ HP

Maximum Weight Persons' Capacity _____ lbs.

Maximum Weight Capacity _____ lbs.

Other Information:

Boat Weight (without Engine, Controls, Battery, etc.) _____ lbs.

Swamped Buoyancy - Boat Alone: Positive (Floats) _____ Negative (Sinks) _____

(Specific Gravity: If Positive - Less Than 1; If Negative - More than 1)

Fuel Tank Capacity: _____ gallons. (If Permanent Tank _____ x 6 = _____ lbs.)

Weather Conditions:

Air Temperature _____ °F Water Temperature _____ °F

Wind Strength _____ miles. Height of Chop _____ inches

Test Check List:

Photographs: Before Test _____ During Test (when Stable) _____

Fuel Weight (simulated for Test) _____ lbs.

Air Chambers Flooded (over 2 horsepower) _____

Bait-Storage Wells, Open and Flooded _____

Upholstery Parts Prepared _____ Removed _____

All Shipping Materials Removed _____

All Factory Offered Options Aboard _____

Loose and Not Required Equipment Removed _____

Reference Areas Marked _____

Passenger Carrying Areas Marked _____

Stability Test Passenger Weight Area Marked _____

All Entrapped Air Vented _____

TEST PERFORMED BY: _____

LEVEL FLOTATION TEST FORM:

Model _____ HIN _____ Date _____

Date and Time of Start of Preconditioning Submersion ____/____/____ AM PM _____

Photographs: Before Start _____ Preconditioning _____ Test _____

Initial Angle of Heel _____° Pass _____ Fail _____

(IF NECESSARY – WHAT WEIGHT OR FLOTATION MATERIAL ADJUSTMENTS WERE MADE?)

_____

_____

_____

Angle of Heel-Second Trial _____° Pass _____ Fail _____ Photograph _____

Forward Reference Area: Submerged _____ inches - Above Surface _____ inches

Aft Reference Area: Submerged _____ inches - Above Surface _____ inches

Reference Depth _____ inches Pass _____ Fail _____ Photograph _____

(IF NECESSARY – WHAT ADJUSTMENTS WERE NECESSARY TO ATTAIN PROPER DEPTH?)

_____

_____

_____

Second Trial: Pass _____ Fail _____ Photographs _____

TEST CONDUCTED BY: _____

STABILITY TEST FORM:

Model _____ HIN _____ Date _____

Passenger Weight Removed from Center _____ lbs. dry

Passenger Weight Placed at Starboard Side _____ lbs. dry

Angle of Heel _____ ° Pass _____ Fail _____ Photograph _____

Forward Reference Area: Submerged _____ inches - Above Surface _____ inches

Aft Reference Area: Submerged _____ inches - Above Surface _____ inches

Reference Depth _____ inches Pass _____ Fail _____

Passenger Weights Moved to Port Side _____ lbs. dry

Angle of Heel _____ ° Pass _____ Fail _____ Photograph _____

Reference Depth _____ inches Pass _____ Fail _____

Forward Reference Area: Submerged _____ inches - Above Surface _____ inches

Aft Reference Area: Submerged _____ inches - Above Surface _____ inches

Pass _____ Fail _____ Photograph _____

TEST CONDUCTED BY: _____

AD-A052 758 AMERICAN BOAT AND YACHT COUNCIL NEW YORK F/G 13/10
LEVEL FLOTATION COMPLIANCE GUIDELINE.(U)
JAN 78 DOT-CG-1601-96
UNCLASSIFIED USCG-B-004-78 NL

2 OF 2
AD
A052758

END
DATE
FILMED
5-78
DDC

BASIC FLOTATION TEST

INBOARD BOATS, INBOARD/OUTDRIVE BOATS, AND AIRBOATS:

DATA RECORDING FORM

Model _____ HIN _____ Date _____

Maximum Weight Capacity _____ lbs. Fuel _____ gallons.

Persons Weight Capacity _____ lbs. x 6

Engine, Control, Drive _____ lbs. dry = _____ lbs.

_____ lbs. swamped

Battery Weight _____ lbs. dry

_____ lbs. swamped

Volume-Two Largest Air Chambers (if used) _____ cubic feet

*(Weight to be added to hull IF air chambers are not completely flooded for test.) x 62.4

*c. _____ lbs.

Persons Weight to be Added for Test:

.133 x Persons' Capacity of Boat = a. _____ lbs.

Dead Weight to be Added:

Maximum Weight Capacity –(minus) Persons' Capacity

= Dead Weight

Dead Weight x .25 = b. _____ lbs.

Air Chamber Compensating Weight (c. from above) = c. _____ lbs.

Engine and Control Weight = d. _____ lbs.

Battery Weight = e. _____ lbs.

TOTAL TEST WEIGHT _____ lbs.

Weather Conditions:

Air Temperature _____ °F

Water Temperature _____ °F

Wind Strength _____

Height of Chop(if any) _____

Test Check List:

Photographs:

Before Test _____

During Test (Stable Attitude) _____

Tanks, Filled and Sealed _____

Air Chambers Flooded _____

OR

Air Chamber Compensating Weight Added _____

Bait-Storage Wells, Ice Chest, Compartments (opened and flooded) _____

Upholstery Parts Prepared _____

OR

Removed _____

All Shipping Material Removed _____

All Factory Offered Options Aboard and Secured _____

All Loose and Not Required Gear Removed _____

NAME OF PERSON CONDUCTING TEST _____

FLOTATION MATERIAL

RECEIVING INSPECTION:

Date: _____

Order Number: _____ Order Number Date: _____

Supplier: _____

Received By: _____

Visual Inspection By: _____

Accepted: _____ Rejected: _____

IF REJECTED – SUPPLIER NOTIFIED **DATE:**

COMMENTS:

Tests:

	Pass	Fail
Density	_____	_____
Compression	_____	_____
Fuel Resistance	_____	_____
Buoyancy	_____	_____

Other: _____

_____

_____

COMMENTS:

SUPPLIER NOTIFIED OF FAILURES: _____ **DATE:** _____

TEST PERFORMED BY: _____ **DATE:** _____

INDEX

ILLUSTRATIONS

TABLES

*U.S. GOVERNMENT PRINTING OFFICE : 1978 0-721-088/694