H-8 BUOYANCY IN THE EVENT OF SWAMPING

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Based on ABYC's assessment of the existing technology, and the problems associated with achieving the goals of this standard, ABYC recommends compliance with this standard for all boats, associated equipment, and systems manufactured after July 31, 2000.

8.1 ***PURPOSE***

These standards and recommended practices are guides for determining the flotation required to keep boats afloat when swamped, and where indicated, floating in an approximately level attitude when swamped.

8.2 ***SCOPE***

These standards and recommended practices apply to boats less than 20 feet in length.

EXCEPTIONS:

a. canoes and kayaks (see ABYC H-29, Canoes and Kayaks.)

b. inflatable boats (see ABYC H-28, Inflatable Boats.)

c. submersibles

d. surface effect vessels

e. amphibious vessels

f. raceboats (see American Powerboat Association Rules.)

g. pontoon boats (see ABYC H-35, Powering and Load Capacity for Pontoon Boats.)

h. sailboats

i. personal watercraft as covered by SAE J1973, Personal Watercraft-Flotation

NOTES: 1. ABYC H-37, Jet Boats-Light Weight, contains specific requirements, including that they meet the level flotation requirements of H-8.

2. Federal Regulations - Title 33 CFR Part 183 Subparts F, G, H and N requires flotation for monohull boats less than 20 feet in length except for sailboats, canoes and kayaks, inflatable boats, submersibles, surface effect vessels, amphibious vessels, and raceboats.

8.3 ***REFERENCED ORGANIZATIONS***

ABYC - American Boat & Yacht Council, Inc. - 3069 Solomons Island Road, Edgewater, MD 21037-1416. Phone: (410) 956-1050. Fax: (410 956-2737). Web site: www.abycinc.org.

ASTM - American Society for Testing And Materials, 1916 Race Street, Philadelphia, PA 19103. Phone: (610) 832-9585

CFR - Code Of Federal Regulations - Obtain the Code Of Federal Regulations and other government publications from the Superintendent Of Documents, United States Government Information, POB 371954, Pittsburgh, PA 15250-7954. Phone (202) 512-1800, or fax: (202) 512-2250. An excerpted edition of the CFR is available from American Boat & Yacht Council, Inc., 3069 Solomons Island Road, Edgewater, MD 21037-1416. Phone (410) 956-1050, or fax (410) 956-2737.

Military Specifications - A specification developed by the U.S. Armed Forces. Obtain the referenced specifications from the Naval Publications And Form Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

SAE - Society Of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096. Phone: (412) 776-4841.

U.S. Coast Guard - Flotation Compliance Guideline. Obtain from American Boat & Yacht Council, Inc., 3069 Solomons Island Road, Edgewater, MD 21037-1416. Phone (410) 956-1050 or fax (410) 956-2737.

8.4 ***DEFINITIONS***

For the purposes of this standard, the following definitions apply.

Basic Flotation - A flotation system that will keep a swamped boat from sinking when its passengers are in the water clinging to it, provided that the aggregate weight of the engine, passengers and equipment carried in or attached to the boat does not exceed that boat's maximum weight capacity. With basic flotation the swamped boat may float at any attitude.

Dead Weight - For inboards, sterndrives and airboats: The maximum capacity marked on the boat, minus the persons capacity marked on the boat.

Dead Weight - For outboard powered boats: The maximum weight capacity marked on the boat, minus the total weight shown in ABYC S-30 *Outboard Engine and Related Equipment Weights* Table I columns 3, 5, 7 & 9, for the maximum horsepower marked on the boat, minus the persons capacity marked on the boat.

Horsepower Capacity - The maximum recommended horsepower capacity of a boat as stated on the boat's capacity plate.

Inboard Boat - A boat with an inboard engine as its installed propulsion system.

Level Flotation - A flotation system that will keep a swamped boat and a specified quantity of the weights of its engine, equipment, and passengers floating in an approximately level attitude. Sufficient stability is provided to prevent the swamped craft from capsizing in calm water. Level flotation does not provide a self-righting capability.

Loading area - 40% of the length of the passenger carrying area and 40% of the width of the passenger carrying area centered in the passenger carrying area. (See Figure 11, Figure 12, and Figure 13.)

Mini Jet Boat - A boat with a boat weight of less than 1800 pounds, with an inboard engine powering a water jet pump as its primary propulsion, and designed to be operated with one or more persons within the confines of a hull.

Modified Level Flotation - A flotation system providing the same buoyancy as basic flotation but the flotation material is arranged to achieve an approximately level floating attitude.

Monohull - Any vessel on which, when at rest and carrying 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.

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. (See Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8.)

Raceboat - Any vessel for which the U.S. 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.

Reference Area - The forward-most or aft-most two feet of the top surface of the hull or deck. (See Figure 9.)

Reference Depth - The minimum distance between the upper most surface of the reference area of a boat and the surface of the water measured at the centerline of the boat. (See Figure 10.)

Sailboat - A boat designed or intended to use sail as the primary means of propulsion.

Static Floating Position - The attitude in which a boat floats in calm, fresh water with fuel tanks filled to rated capacity, but with no person or item of portable equipment aboard. The boat shall include all permanently installed factory supplied equipment and options such as, but not limited to, engine(s), battery(s), seats, engine oil, railings, fishing towers, etc., but not portable gear such as flags, searchlights, movable cushions, mattresses, portable fire extinguishers, lines, fenders, chairs, tables, anchors, chain or PFDs. Other tanks such as water, holding, and live bait well tanks are to be empty.

Swamped Waterline - A theoretical waterline above which dry weights will be used and below which submerged weights will be used when calculating for the needed flotation in H-8.8.

Transom-mounted Outboard Bracket - Any device that separates the boat transom from the mounting surface of an outboard engine.

8.5 ***GENERAL REQUIREMENTS***

8.5.1 Minimum Flotation By Boat Type - As a minimum, each boat shall be provided with flotation as indicated in the following table.

BOAT TYPE	FLOTATION	REFERENCE
Inboard, Sterndrive, Water Jet Drive, Airboat	Basic	H-8.6 H-8.7
Outboard - Over 2 h.p.	Level	H-8.6 H-8.8
Mini Jet Boats	Level	H-8.6 H-8.8
Outboard - 2 h.p. and less	Modified level	H-8.6 H-8.9
Manually-propelled	Modified level	H-8.6 H-8.9

NOTE: Level flotation can alternatively be applied to inboard boats, stern drive boats, air boats, water jet boats, outboard boats less than two h.p. and manually-propelled boats.

8.5.2 Each boat shall be manufactured, constructed, or assembled to pass the stability and flotation tests prescribed in Title 33, CFR section 183.225(a), section 183.230(a), and section 183.235(a).

NOTE: Title 33 CFR Subpart F, G and H require specific performance characteristics for each type of flotation system.

8.5.2.1 To assure that all boats of a specific model will comply with the requirements for quantity and distribution of flotation materials, the flotation shall provide for

8.5.2.1.1 the heaviest production tolerance, and

8.5.2.1.2 the manufacturer supplied optional equipment offered for permanent installation, and

8.5.2.1.3 all other optional equipment for which the manufacturer has made design provisions for future permanent installation by the dealer and/or purchaser, to include, but not limited to, trolling motors, additional batteries, towers, arches, casting seats, etc.

8.5.3 Main propulsion transom mounted outboard brackets shall be part of the boat weight.

8.5.4 If a boat is intended for use with a transom mounted main propulsion outboard engine bracket that is

not furnished by the boat manufacturer, specifications shall be provided for installation of the bracket(s) for the distance to the transom engine mounting surface and the weight of the bracket that affect capacity and flotation.

8.5.5 Boats that are designed for twin engines shall be provided with flotation for both engines.

8.6 ***REQUIREMENTS - PRECONDITIONING***

8.6.1 In preparation for the tests described in H-8.7.3, H-8.8.3 and H-8.9.3, all boats shall be preconditioned as follows:

8.6.1.1 vent the two largest non-integral air flotation chambers at their high and low points, and

8.6.1.2 fill fuel tanks with fuel and seal openings, or ballast the boat for equivalent buoyancy of tank and fuel in the same location, and

8.6.1.3 fill water and holding tanks with water, and

8.6.1.4 flood bait wells, storage boxes, ice boxes and dry wells, and

8.6.1.5 vent compartments that may entrap air, and

8.6.1.6 vent seats, cushions and upholstery items, and

8.6.1.7 attach weights to simulate the outboard engine(s), controls, and battery(s) (see ABYC S-30 *Outboard Engine and Related Equipment Weights*), and

8.6.1.8 place weights in the boat to simulate the persons capacity and deadweight, in accordance with the type of flotation required in H-8.5.1, and

8.6.1.9 swamp the boat for at least 18 hours.

8.6.2 At the end of the preconditioning period, tests are to be conducted according to the type of flotation required in H-8.5.1 (see H-8.7.3, H-8.8.3 and H-8.9.3).

8.7 ***REQUIREMENTS - BASIC FLOTATION***

8.7.1 General Requirements

8.7.1.1 Boats requiring basic flotation shall be fitted with buoyant materials or acceptable flotation systems in at least the minimum quantity as determined below. Void compartments or air chambers integral with the hull shall not be included as part of the required flotation materials.

8.7.1.2 If non-integral air chambers are used for flotation the basic flotation requirements shall be met excluding the two largest air chambers.

8.7.2 Calculations - Basic Flotation

8.7.2.1 Perform the following steps to calculate the volume of flotation material required to support the swamped boat (Fb), the submerged propulsion equipment (Fp), the persons capacity (Fc_1), and the dead weight (Fc_2).

8.7.2.1.1 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, i.e., everything below swamped water line
Wd = dry weight of deck and superstructure
We = dry weight of factory installed equipment, hardware, and accessories
K_1 and K_2 = conversion factors for materials used from Table I (See Note 1.)
B = buoyancy of flotation material in pounds per cubic foot (See Notes 2 & 3.)

NOTES: 1. Greater accuracy for Fb can be obtained if K (conversion factors) for the different materials used in the construction of the boat are calculated. Where possible use Table I. Weigh parts of each material and multiply by the proper conversion factor. When added and applied to the formula, a figure for Fb will be obtained that will approximate the submerged weight accurately enough in nearly all cases to determine the flotation needed.

2. If air chambers are used for flotation, "B" will be 62.4, i.e., the weight in pounds of a cubic foot of fresh water.

3. If other flotation materials are used, "B" will equal 62.4 minus the weight of one cubic foot of the material used, less appropriate allowances for the 18 hour pre-soak characteristics of the material.

EXAMPLE

Calculate the flotation material needed to support the swamped boat (Fb).

Assume
Wh = weight of hull (fiberglass) = 600 lbs.
Wd = weight of deck and superstructure (plywood) = 120 lbs.
We = weight of equipment, hardware and accessories = 50 lbs.

$Fb = ((Wh \times K_1) + (Wd \times K_2) + (0.69 \times 50)) \div B$
$Fb = ((600 \times 0.33) + (120 \times -0.81) + 0.69 \times 50)) \div 60.4$*
$Fb = (198 - 97.2 + 34.5) \div 60.4$
$Fb = 135.3 \div 60.4$
$Fb = 2.24$ cu. ft.

*The figure for a two pound flotation material. (See Note 3 above.)

8.7.2.1.2 Step 2: Determine the flotation material needed to support the submerged propulsion equipment (Fp).

Formula: Fp = G ÷ B

Where: For inboards and sterndrives, G = 75 percent of the installed weight of the propulsion system and battery(s) in pounds to the nearest whole number.

EXAMPLE: STERNDRIVE

Calculate the flotation material needed to support the submerged propulsion equipment (Fp).

Assume the boat is a sterndrive, and the weight of the propulsion system and battery = 900 lbs.

Fp = G ÷ B
Fp = (900 x .75) ÷ 60.4
Fp = 675 ÷ 60.4
Fp = 11.18 cu.ft.

8.7.2.1.3 Step 3: Determine the flotation material needed to support the persons capacity (Fc_1) and the dead weight (Fc_2).

Formula: Fc = .25 (Fc_1+ Fc_2) ÷ B

Where: For inboard, stern drive, and water jet drive, Fc_1 = the maximum persons weight capacity minus the fuel weight (fuel weight = six pounds/gallons times the tank capacity in gallons).

Where: Fc_2 = maximum weight capacity minus maximum persons weight. A negative number shall be raised to zero.

EXAMPLE: STERNDRIVE

Calculate the flotation material needed to support the persons capacity and the dead weight (Fc).

Assume a 19' length sterndrive boat where
the maximum weight capacity = 2400 lbs.
the maximum persons capacity = 2400 lbs.
permanent fuel system = 40 gals. (240 lbs.)

Fc = 0.25 (Fc_1 + Fc_2) ÷ B
Fc = .25 ((2400 - 240) + (2400 - 2400)) ÷ B
Fc = 540 ÷ 60.4
Fc = 8.94

8.7.2.1.4 Step 4: Determine the total flotation material required (F).

Formula: F = Fb + Fp + Fc

EXAMPLE

F = 2.24 + 11.18 + 8.94
F = 22.36 cu.ft.

8.7.3 Flotation Performance - Basic Flotation

NOTE: For further details and test procedures refer to the USCG Flotation Compliance Guideline or USCG Flotation Test Procedures.

8.7.3.1 After preconditioning in accordance with H-8.6, a boat shall have flotation to keep a portion of the boat above the surface of the water when loaded as follows:

8.7.3.1.2 weights that, when submerged, equal 75% of the dry weights of propulsion system and battery(s), and

8.7.3.1.3 weights that, when submerged, equal 25% of the persons capacity marked on the boat; and

8.7.3.1.4 weights that, when submerged, equal 25 percent of the dead weight, and

8.7.3.1.5 if air chambers are used for flotation, weight in pounds that, when submerged, equal 62.4 times the volume in cubic feet of the two largest air chambers.

NOTE: Alternately, flood the two largest air chambers at their high and low points.

8.8 ***REQUIREMENTS - LEVEL FLOTATION***

8.8.1 General Requirements

8.8.1.1 Boats requiring level flotation shall be fitted with buoyant materials or acceptable flotation systems in at least the minimum quantity as determined below. Void compartments or air chambers integral with the hull shall not be included as part of the required flotation material.

NOTE: Flotation located at the sides as far aft and as high as possible can make boats with machinery located aft float level when swamped. Some boats may require the keel area to be void of flotation material so that the space can flood from either end to provide proper balance in the swamped condition.

8.8.1.2 If non-integral air chambers are used for flotation, the level flotation requirements shall be met excluding the two largest air chambers.

NOTES: 1. In concept, this standard divides the boat's flotation into quantities necessary to float

a. the swamped boat (Fb) with its factory supplied permanently installed optional equipment without its propulsion equipment, and

b. the swamped propulsion equipment (Fp), and

c. a percentage of the persons capacity (Fc_1), and

d. a percentage of the dead weight (Fc_2) resulting from the following calculation, but not less than zero: the maximum weight capacity marked on the boat, less the sum of the weights shown in columns 3, 5, 7 and 9 of ABYC S-30 Outboard Engine and Related Equipment Weights, Table I for the maximum horsepower marked on the boat, less the persons capacity in pounds marked on the boat.

2. Symmetrical location criteria is established for each of the quantities above. Symmetrical means having a balanced moment. For example, one cubic foot of flotation material three feet forward of the boat's balance point can be balanced by three cubic feet of flotation material one foot aft of the boat's balance point. The symmetry may be varied to account for equipment, such as batteries, if they are located off center.

8.8.2 Calculation - Level Flotation

8.8.2.1 To calculate the flotation needed for level flotation follow these steps:

8.8.2.1.1 Step 1: Determine the flotation needed to support the swamped boat (Fb)

Formula: Fb = ((Wh x K) + Wd) ÷ B

Wh = dry weight of hull material, i.e., everything below the swamped waterline
Wd = dry weight of deck, i.e., everything above the swamped waterline including factory supplied windshield, hardware, and accessories
K = conversion factors for materials used from Table I.
B = buoyancy of flotation materials used in pounds per cubic foot

EXAMPLE

Calculate the flotation material needed to support a swamped boat (Fb).

Fb = ((Wh x K) + Wd) ÷ B

Where: (Wh x K) = ((Wh_f x K_f) + (Wh_p x K_p))

Assume
weight of hull (fiberglass) Wh_f = 500 lbs.
weight of hull (plywood) Wh_p = 220 lbs.
weight of deck and superstructure Wd =185 lbs.

Fb = ((500 x 0.33) + (220 x -0.81) + (185)) ÷ 60.4
Fb = (165 - 178.2 + 185) ÷ 60.4
Fb = 171.8 ÷ 60.4
Fb = 2.85 cu. ft.

8.8.2.1.1.1 This flotation material shall be distributed symmetrically about the balance point of the boat. (See Figure 1.)

8.8.2.1.2 Step 2: Determine the flotation material needed to support the swamped propulsion equipment (Fp)

Formula:

Fp = G ÷ B (inboard or sterndrive boats)
Fp = Gs ÷ B (outboard boats)

Where, for inboard and sterndrives, G = 75% of installed weight of the propulsion system, or, for outboard boats,
Gs = swamped engine weight, in ABYC S-30 *Outboard Engine and Related Equipment Weights,* Table 1 column 4, of the outboard engine for the maximum horsepower capacity for which the boat is rated.

EXAMPLE: OUTBOARD

Calculate the flotation material needed to support the swamped propulsion equipment and the battery (Fp).

Assume the boat is rated for a 140 horsepower outboard engine.

Weight from Table II: Gs = 379 lbs + 25 lbs.

Fp = 404 ÷ 60.4
Fp = 6.69 cu.ft.

8.8.2.1.2.1 The material shall be distributed symmetrically within three feet, or 30 inches for boats less than 15 feet long, of

8.8.2.1.2.1.1 the top of the outboard engine mounting surface,

8.8.2.1.2.1.2 about the propulsion system(s), if engine(s)is not stern mounted.

8.8.2.1.3 Step 3: Determine the flotation material needed to support the posted persons capacity (Fc_1) and dead weight (Fc_2).

Formula: $Fc = (0.5 \text{ (first 550 lbs. of } Fc_1) + 0.125 (Fc_1 - 550) + 0.25(Fc_2)) \div B$

EXAMPLE: OUTBOARD

Calculate the flotation material needed to support the persons capacity and the dead weight (Fc).

Assume
maximum weight capacity = 1600 lbs.
140 hp outboard engine = 580 lbs.
persons capacity = 1040 lb.

$Fc = (0.5(550) + 0.125(1040 - 550) + 0.25 (1600 - 580 - 1040)) \div 60.4$
$Fc = (275 + 61.25 + 0) \div 60.4$
$Fc = 336.25 \div 60.4$
$Fc = 5.57$ cu.ft.

8.8.2.1.3.1 This flotation material shall be distributed symmetrically on both sides and fore and aft of the passenger carrying area midpoint, at the hull sides as close to the sheer line as possible, and within six inches of the hull sides at the widest point on the floor line. (See Figure 1.)

8.8.2.1.4 Step 4: Determine the total flotation material needed (F)

Formula: $F = Fb + Fp + Fc$

EXAMPLE

Calculate the total flotation material needed.

$F = Fb + Fp + Fc$
$F = 2.85 + 6.69 + 5.57$
$F = 15.11$ cubic feet

8.8.3 Flotation Performance - Level Flotation

NOTE: For further details and test procedures refer to the USCG Flotation Compliance Guideline or USCG Flotation Test Procedures.

8.8.3.1 After preconditioning (see H-8.6.) a boat shall float as follows:

8.8.3.1.1 TEST I

8.8.3.1.1.1 The angle of heel does not exceed ten degrees.

8.8.3.1.1.2 Any point on either the forward or aft reference area is above the surface of the water and the reference depth measured at the immersed reference area is six inches or less. (See Figure 9, Figure 10, and Figure 14.)

8.8.3.1.1.3 For this test the boat is loaded as follows:

8.8.3.1.1.3.1 Weights that, when submerged, equal the swamped weight of engine(s), controls and battery(s) for the maximum horsepower capacity marked on the boat;

8.8.3.1.1.3.2 Weights that, when submerged, equal the sum of 50 percent of the first 550 pounds of persons capacity, plus 12 1/2 percent of any remainder of the persons capacity marked on the boat;

8.8.3.1.1.3.3 Weights that, when submerged, equal 25 percent of the dead weight; and

8.8.3.1.1.3.4 Weight in pounds that, when submerged, equal 62.4 times the volume in cubic feet of the two largest air chambers, if air chambers are used for flotation.

8.8.3.1.1.4 For placement of weights. (See Figure 11.)

8.8.3.1.2 TEST II

8.8.3.1.2.1 The angle of heel does not exceed 30 degrees.

8.8.3.1.2.2 Any point on either the forward or aft reference area is above the surface of the water, and the reference depth measured at the immersed reference area is 12 inches or less. (See Figure 9, Figure 10, and Figure 15.)

8.8.3.1.2.3 For this test the boat is loaded as follows:

8.8.3.1.2.3.1 Weights that, when submerged, equal the swamped weight of engine(s), controls and battery(s) for the maximum horsepower capacity on the boat;

8.8.3.1.2.3.2 Weights that, when submerged, equal one half of, the sum of 50 percent of the first 550 pounds of persons capacity plus 12 1/2 percent of any remainder of persons capacity marked on the boat;

8.8.3.1.2.3.3 Weights that, when submerged, equal 25 percent of the dead weight; and

8.8.3.1.2.3.4 Weight in pounds that, when submerged, equal 62.4 times the volume in cubic feet of the two largest air chambers, if air chambers are used for flotation.

8.8.3.1.2.4 For placement of weights see Figure 12 and Figure 13. The boat must meet the performance requirements when tested on each side of the boat.

8.8.3.1.3 TEST III

8.8.3.1.3.1 The flotation attitude requirements for this test are the same as for Test I but the loading excludes weights for persons capacity and dead weight.

8.9 ***REQUIREMENTS - MODIFIED LEVEL FLOTATION***

8.9.1 General Requirements

8.9.1.1 Boats requiring modified level flotation shall be fitted with buoyant materials or acceptable flotation systems in at least the minimum quantity as determined below. Void compartments or air chambers integral with the hull shall not be included as part of the required flotation material.

8.9.1.2 If non-integral air chambers are used for flotation, the modified level flotation requirements shall be met excluding the two largest air chambers.

NOTE: Assume that you want to determine the flotation material necessary for the same boat in the following example, but for manual propulsion only. Step 1 is the same. Step 2 is omitted (no engine), and there is one change in Step 3 whereby C = maximum weight capacity with no deductions; therefore, Step 4 adds two factors instead of three.

8.9.2 Calculation - Modified Level Flotation

8.9.2.1 To calculate the modified level flotation required, follow these steps.

8.9.2.1.1 Step 1: Determine the flotation needed to support the swamped boat (Fb).

Formula: $Fb = ((Wh \times K) + Wd) \div B$

Where:
Wh = dry weight of hull (everything below swamped waterline)
Wd = dry weight of deck and superstructure (everything above the swamped waterline).
K = conversion factors for materials used from Table I.
B = buoyancy of flotation materials used in pounds per cubic foot.

EXAMPLE

Calculate the flotation material needed to support the swamped boat (Fb).

Assume
weight of hull (fiberglass): $Wh_f = 80$ lbs.
weight of hull (plywood): $Wh_p = 5$ lbs.
weight of deck: Wd = 28 lbs.

$Fb = ((Wh_f \times K_f) + (Wh_p \times K_p) + Wd) \div B$
$Fb = ((80 \times 0.33) + (5 \times -0.81) + 28) \div 60.4$
$Fb = (26.4 - 4.0 + 28) \div 60.4$
$Fb = 0.84$ cu.ft.

8.9.2.1.1.1 This flotation material shall be distributed symmetrically about the balance point of the boat.

8.9.2.1.2 Step 2: Determine the flotation needed to support the swamped propulsion equipment (Fp). If boat is rated for manual propulsion only, proceed to Step 3.

Formula: $Fp = Gs \div B$

Where:
Gs = swamped weight of outboard engine from ABYC S-30 *Outboard Engine and Related Equipment Weights,* Table 1 column 4.
B = buoyancy of flotation materials used in pounds per cubic foot.

EXAMPLE

Calculate the flotation material needed to support the swamped propulsion equipment (Fp).

Assume the boat is equipped with a 2.0 hp outboard engine: Gs = 24 lbs.

$Fp = Gs \div B$
$Fp = 24 \div 60.4$
$Fp = 0.40$ cu.ft.

8.9.2.1.2.1 This flotation material shall be distributed symmetrically within 30 inches of the outside of the transom top at the engine mounting area.

8.9.2.1.3 Step 3: Determine the flotation needed to support the persons capacity (Fc_1) and the dead weight (Fc_2)

Formula: $Fc = (0.1333 (Fc_1) + 0.25(Fc_2)) \div B$

EXAMPLE

Calculate the flotation material needed to support the persons capacity and the dead weight (Fc).

Assume
maximum weight capacity = 300 lbs.
persons capacity = 300 lbs.
boat is rated for 2 horsepower or less (30 lbs.)

$Fc = (0.1333 (300) + 0.25(300\text{-}300\text{-}30)) \div B$
$Fc = (39.99 + 0) \div 60.4$
$Fc = 0.67$ cu.ft.

8.9.2.1.3.1 This flotation material shall be distributed symmetrically transversely, and fore and aft of the midpoint of the passenger carrying area, and at the hull side, as close to the gunwales as possible.

8.9.2.1.4 Step 4: Determine the total flotation material needed.

Formula: F = Fb + Fp + Fc

Where:
Fb = flotation for the boat (Step 1)
Fp = flotation for outboard engine, two horsepower or less, if any (Step 2)
Fc = flotation for live load and gear (Step 3).

EXAMPLE

Calculate the total flotation material needed.

F = Fb + Fp + Fc
F = 0.84 + 0.40 + 0.67
F = 1.91 cu.ft.

8.9.3 Flotation Performance - Modified Level Flotation

NOTE: For further details and test procedures refer to the USCG Flotation Compliance Guideline or USCG Flotation Test Procedures.

8.9.3.1 After preconditioning (see H-8.6.), a boat shall float as follows:

8.9.3.1.1 TEST I

8.9.3.1.1.1 The angle of heel does not exceed ten degrees.

8.9.3.1.1.2 Any point on either the forward or aft reference area is above the surface of the water and the reference depth measured at the immersed reference area is 6 inches or less. (See Figure 14.)

8.9.3.1.1.3 For this test the boat is loaded as follows:

8.9.3.1.1.3.1 Weights that, when submerged, equal the swamped weight of engine and controls, which is 30 pounds for up to two horsepower rating;

8.9.3.1.1.3.2 Weights that, when submerged, equal two fifteenths of the persons capacity marked on the boat;

8.9.3.1.1.3.3 Weights that, when submerged, equal 25 percent of the dead weight; and

8.9.3.1.1.3.4 Weights in pounds that, when submerged, equal 62.4 times the volume in cubic feet of the two largest air chambers, if air chambers are used for flotation.

8.9.3.1.1.4 For placement of weights see Figure 11.

8.9.3.1.2 TEST II

8.9.3.1.2.1 The angle of heel does not exceed 30 degrees.

8.9.3.1.2.2 Any point on either the forward or aft reference area is above the surface of the water and the reference depth measured at the immersed reference area is 12 inches or less. (See Figure 15.)

8.9.3.1.2.3 For this test the boat is loaded as follows:

8.9.3.1.2.3.1 Weights that, when submerged, equal the swamped weight of engine and controls, which is 30 pounds for up to two horsepower rating;

8.9.3.1.2.3.2 Weights that, when submerged, equal one fifteenth of the persons capacity marked on the boat;

8.9.3.1.2.3.3 Weights that, when submerged, equal 25 percent of the dead weight; and

8.9.3.1.2.3.4 Weight in pounds that, when submerged, equal 62.4 times the volume in cubic feet of the two largest air chambers, if air chambers are used for flotation.

8.9.3.1.2.4 For placement of weights see Figure 12. The boat must meet the performance requirements when tested on each side of the boat.

8.9.3.1.3 TEST III

8.9.3.1.3.1 The floating attitude requirements for this test are the same as for Test I, but the loading excludes weights for persons capacity and dead weight.

8.10 ***MATERIALS***

8.10.1 There are specific performance specifications for flotation materials based upon their location in a boat; the degree of performance depends on the degree of exposure to detrimental agents.

8.10.2 With the unloaded boat floating in calm water, transversely level, the waterline in Figure 16 establishes the reference line for the four-inch bilge and 12-inch engine room levels. They will parallel the reference waterline, with their heights measured at the lowest spot where water may accumulate within the boat in an unloaded static floating position. Figure 16 depicts these levels.

8.10.3 Performance Specifications

8.10.3.1 Flotation material installed in an engine compartment less than 12 inches above the lowest point where liquid can collect in that compartment (area A in Figure 16) when the boat is in its static floating position must not reduce in volume by more than five percent after being immersed in any of the following liquids for 30 days at 29°C (See the note following H-8.10.3.2.):

8.10.3.1.1 Reference Fuel B - ASTM D-471, or

8.10.3.1.2 No. 2 Reference Oil - ASTM D-471, or

8.10.3.1.3 a five percent solution of trisodium phosphate in water.

8.10.3.2 Flotation material installed outside the engine compartment (this includes inside the hull of outboard boats) less than four inches above the lowest point where liquid can collect (area B in Figure 16) when the boat is in its static floating position, must not reduce in volume by more than five percent after being immersed in any of the following liquids for 24 hours at 29°C (see note following):

8.10.3.2.1 Reference Fuel B - ASTM D-471

8.10.3.2.2 No. 2 Reference Oil - ASTM D-471

8.10.3.2.3 a five percent solution of trisodium phosphate in water.

NOTE: The change in volume and buoyancy may be measured in accordance with ASTM D-2842 or USCG Test Procedures. The maximum size of a test sample shall be 6" x 6" x 3", and cut by the same method used to shape it for use in the boat.

8.10.3.3 Flotation material installed in the engine compartment more than 12 inches above the lowest point where liquid can collect in that compartment (area C in Figure 16) when the boat is in its static floating position must not reduce in volume by more than five percent after being immersed in a fully saturated gasoline vapor atmosphere for 30 days at 38°C.

8.10.3.4 Flotation material does not have to be gasoline, oil, gasoline vapor, or trisodium solution resistant if used in manually propelled boats, or

8.10.3.4.1 is installed outside the engine compartment more than four inches above the lowest point where liquid can collect when the boat is in its static floating position (area D in Figure 16), or

8.10.3.4.2 is enclosed or encased to resist seeping or leaking one-quarter ounce of fresh water per hour when the enclosure is submerged to a depth of 12 inches.

8.11 ***INSTALLATION***

8.11.1 Three flotation systems are outlined:

8.11.1.1 non-integral air chambers;

8.11.1.2 plastic foam blocks and other shapes, pre-molded, or cut to shape from billets;

8.11.1.3 liquid mix, plastic foam prepared in plant, and poured or sprayed in place or in molds.

8.11.2 Non-integral Air Chambers

8.11.2.1 Non-integral air chambers shall maintain their integrity under pre-test conditioning and under flotation test conditions.

8.11.2.1.1 They shall not leak when subjected to an internal air pressure test, and

8.11.2.1.2 shall not allow the ingress of water when submerged to at least a depth equal to that required in the floating test.

8.11.2.2 Provision shall be made for venting pressure differentials in air chambers due to temperature changes.

8.11.2.3 A means shall be provided for periodic checks for water and for draining.

8.11.3 Plastic Foam Blocks and Other Shapes

8.11.3.1 A method of identifying foam blocks and other shapes shall be employed to assure that each boat gets the correct amount of flotation in the correct location.

8.11.3.2 Expanded polystyrene foam shall not come in contact with uncured polyester resin or fumes.

8.11.3.3 Foam blocks and other shapes shall be secured so that no movement, in any direction, occurs that will affect the flotation's performance.

8.11.3.4 Consideration shall be given to installation in a manner that will prevent damage from occupant contact, and

8.11.3.4.1 deterioration from exposure to direct sunlight, and

8.11.3.4.2 damage from normal use of the boat.

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

8.11.4 Sprayed or Poured Liquid Mix

8.11.4.1 When liquid flotation material is installed directly in place, constraint shall be provided in the form of bulkheads, boxes, or dams to insure the proper volume, and that the centers of buoyancy are correctly placed.

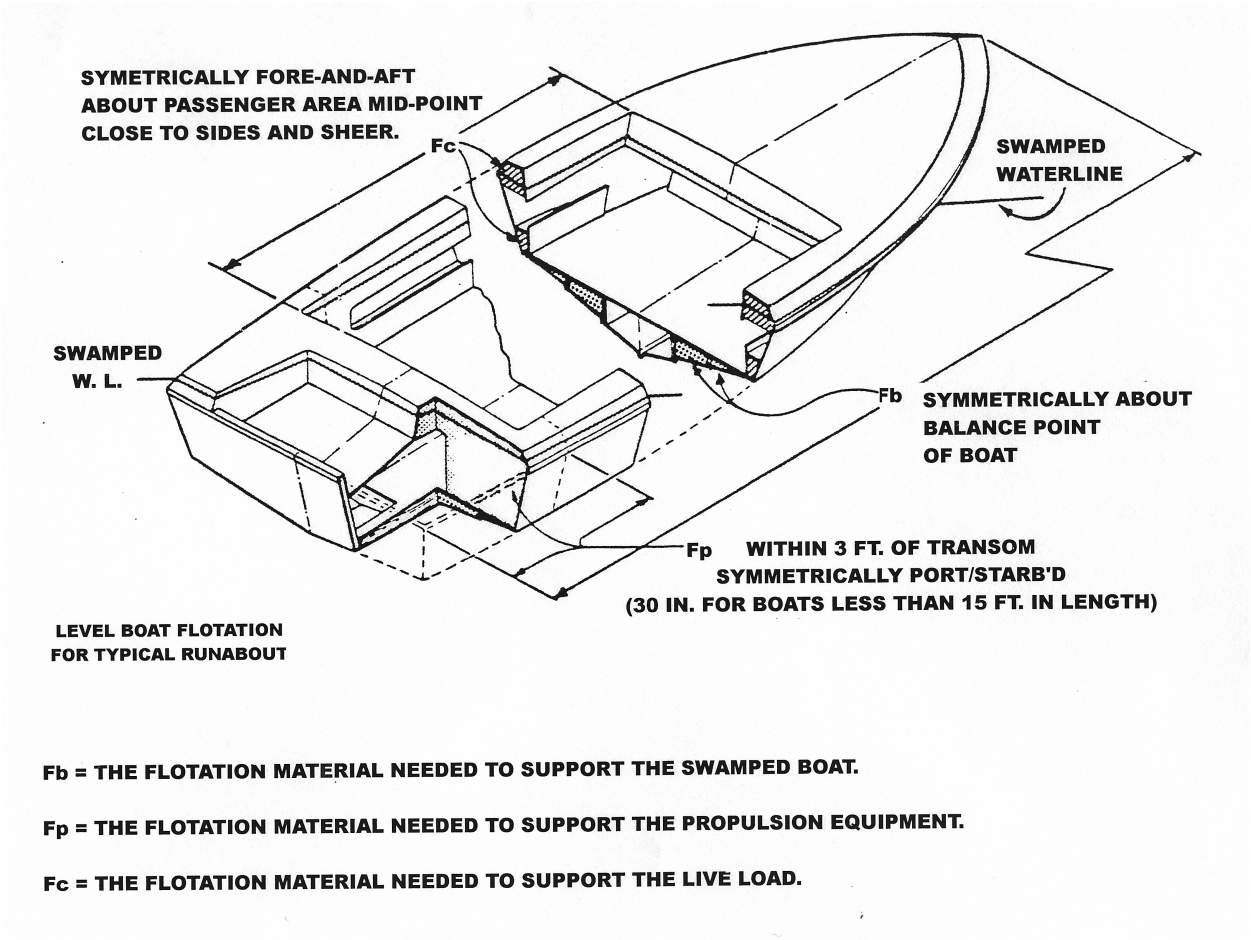
8.11.4.2 Clearance around and passages through the foam shall be provided for routing controls, cables and wires, and

8.11.4.2.1 access to windshields, fasteners, cleat and chock fasteners, railing fasteners, ventilation ducts, other deck hardware, and standard accessories, and

8.11.4.2.2 bilge drainage, and

8.11.4.2.3 drainage of the top of metallic fuel tanks.

FIGURE 1 - FLOTATION FOAM 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 NEEDED TO SUPPORT THE LIVE LOAD.

FIGURE 2 - LOCATION OF SUPPORTS FOR LEVEL BOAT

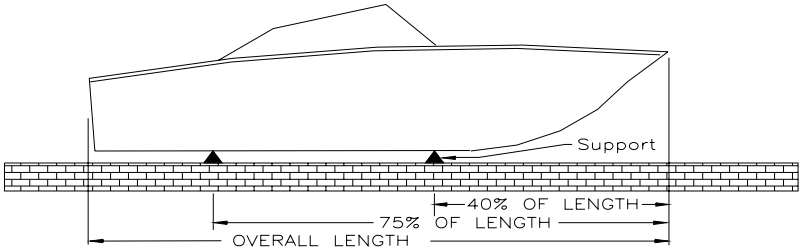


FIGURE 3 - BOAT WITH DECK

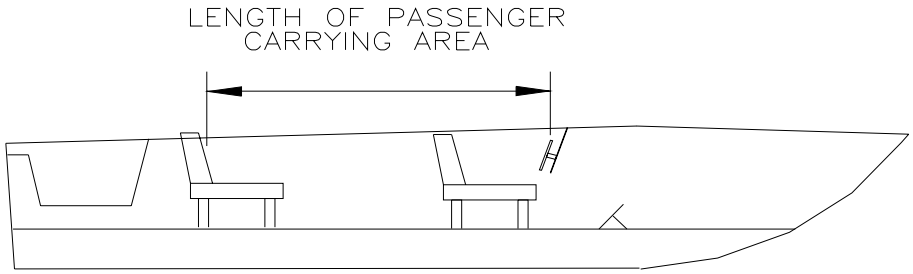


FIGURE 4 - BOAT WITH CENTER CONSOLE

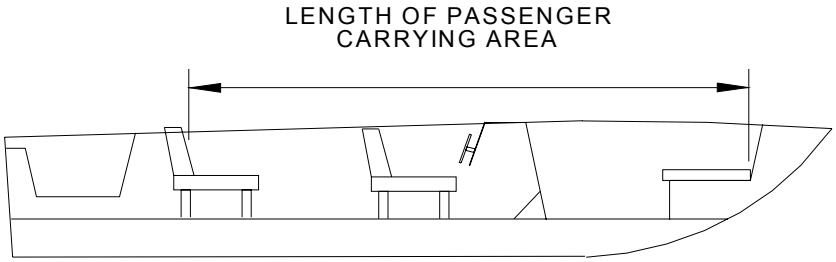


FIGURE 5 - OPEN BOAT WITH CURVED STEM

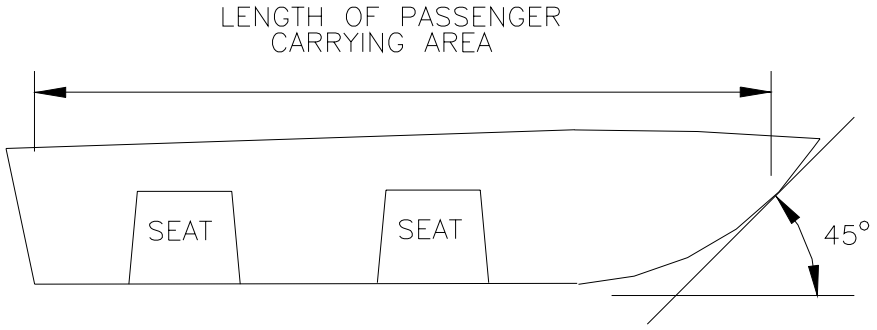


FIGURE 6 - BOAT WITH CABIN

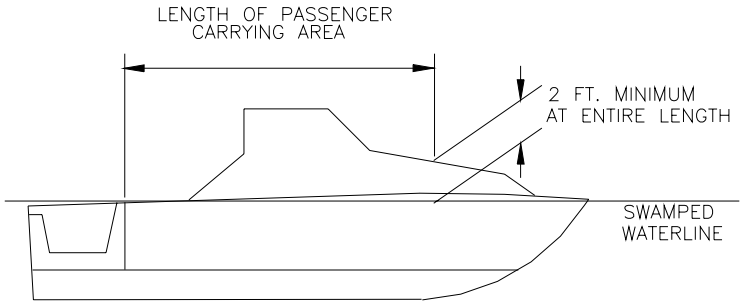


FIGURE 7

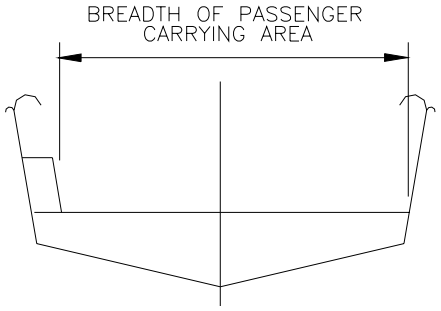


FIGURE 8 - BOAT WITH ROUND CHINE

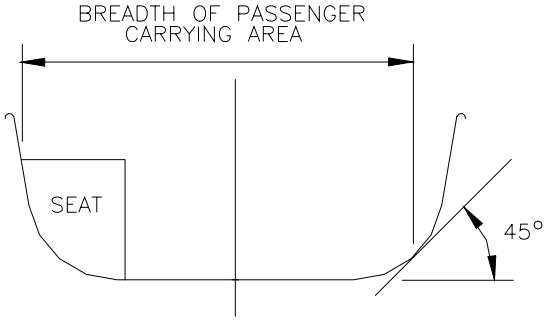


FIGURE 9 - REFERENCE AREAS

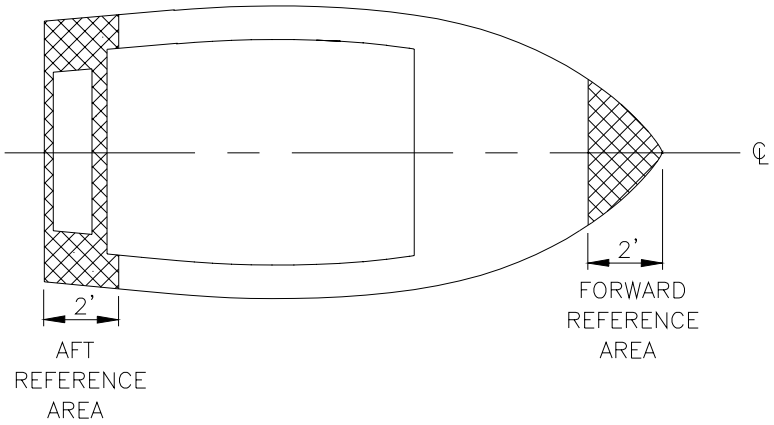


FIGURE 10 - REFERENCE DEPTH

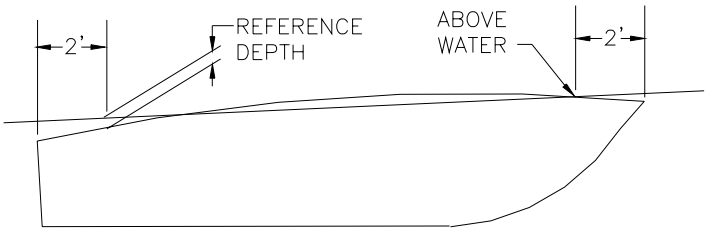


FIGURE 11 - PASSENGER CARRYING AREA: LOCATION OF CENTER OF GRAVITY OF WEIGHTS

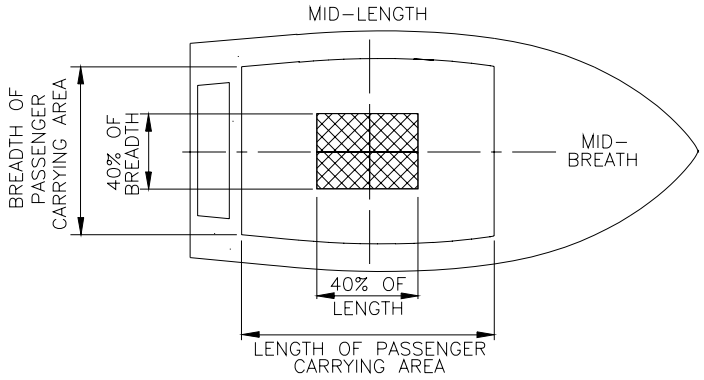


FIGURE 12 - STABILITY TEST LOCATION OF CENTER OF GRAVITY OF WEIGHTS: STARBOARD SIDE

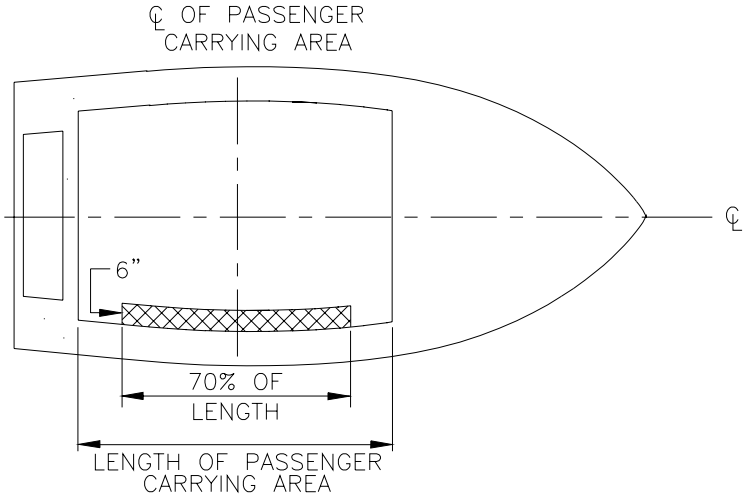


FIGURE 13 - LOCATION OF CENTER OF GRAVITY OF WEIGHT ON SEATS

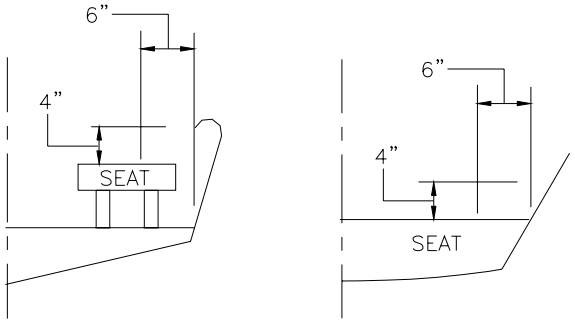


FIGURE 14 - FLOTATION TEST

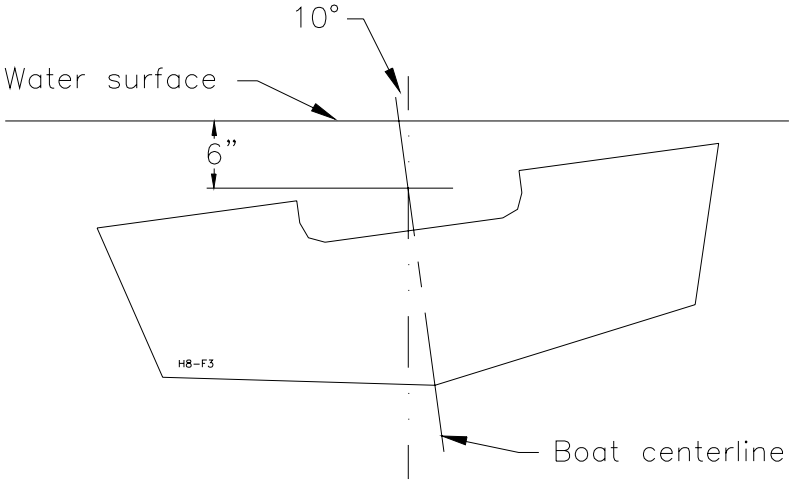


FIGURE 15 - STABILITY TEST

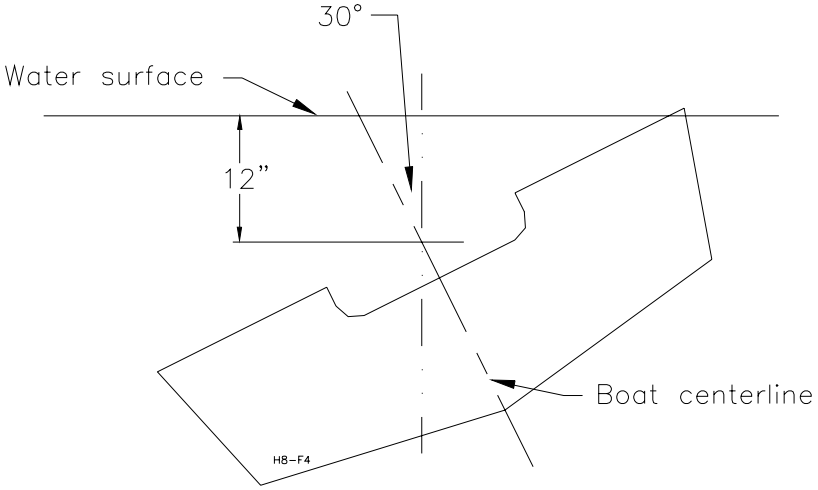


FIGURE 16 - LEVELS OF FLOTATION FOAM SELECTION

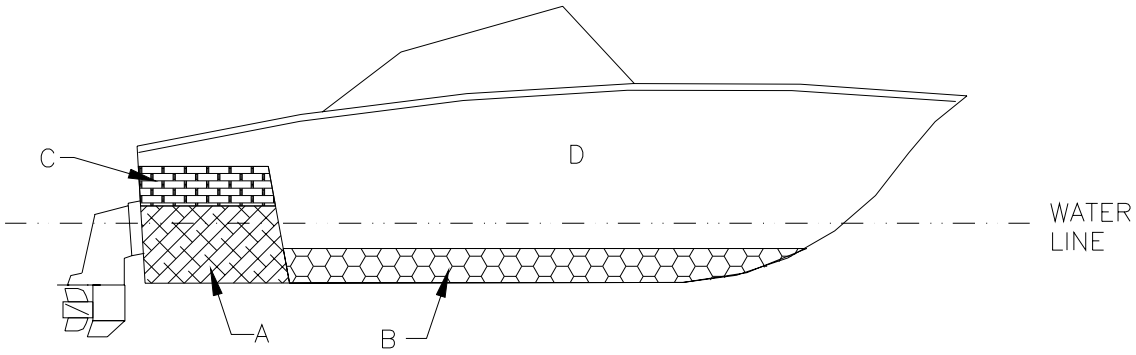


TABLE I - FACTORS FOR CONVERTING VARIOUS BOAT MATERIALS FROM DRY TO SUBMERGED WEIGHT

MATERIALS	SPECIFIC GRAVITY	FACTOR	POUNDS PER CUBIC FT.
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
Ferrocement	2.40	0.58	150
Rubber	1.51	0.34	94
Fiberglass Laminate	1.50	0.33	94
Kevlar Laminate	1.30	0.24	81
Plexiglas/Lucite	1.20	0.17	75
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 (Red)	0.63	-0.56	39
Blandex/Particle Board	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
Spruce	0.45	-1.22	28
Pine (White)	0.42	-1.38	26
Cedar (White)	0.33	-1.95	21
Cork	0.24	-3.17	15
Balsa	0.16	-5.24	10

FACTOR = (sp.gr.-1) ÷ sp.gr.

weight of fresh water, at 39°F = 62.4 lbs./cu.ft.
specific gravity of fresh water, at 39°F = 1.0
one gallon of fresh water = 0.134 cu.ft. or 231 cu. in.
one gallon of fresh water = 8.34 pounds
one cubic foot = 7.48 gallons

* * * * *

Origin and Development of H-8, Buoyancy In The Event of Swamping.

ABYC published H-8 for the first time in 1973. Subsequent revisions were published in 1980 and 1987. The 1999 revised edition is the work of the Hull Performance Project Technical Committee.

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