# Section 4.0

## HULL DESIGN REQUIREMENTS


**ISSUE NUMBER**: 3

**DATE:** 2004 Edition

**NUMBER OF PAGES:** 21

THIS ISSUE SUPERSEDES

Issue Number: 2

Dated: January 2002

## 4.1 Application

4.1.1 This section applies in respect of all small vessels that are not over 6 m (19 ft 8 in) in length.

## 4.2 Monohull Vessels

### 4.2.1 General

4.2.1.1 Scuppers, freeing ports, drains, overboard discharge, and centreboard trunk openings may be located below the static float plane (SFP). Other openings are permitted below the SFP in the motor well for outboard engine controls or fuel lines. All openings below the SFP shall be provided with a boot or other means to minimize leakage.

4.2.1.2 For information on taking measurements of monohull vessels, see Appendix 1, part A1.5.

### 4.2.2 Motor Well

4.2.2.1 A motor well is acceptable if:

(a) it tends to reverse the flow of any water striking the forward face of the well rather than directing it upward and forward;

(b) it has control or other openings of minimum size for safe operation that are located as high as possible and not lower than the normal motor cutout in the transom, unless fitted with sealing devices to prevent flooding through the openings; and

(c) it has drains fitted that will allow the complete drainage of water within a maximum of five (5) minutes.

### 4.2.3 Recommended Maximum Load Calculation (Intact Condition)

4.2.3.1 Where an outboard power-driven small vessel is of monohull construction, the recommended maximum load in kilograms shall be determined as follows:

$$GL = \frac{(D_{SFP} - W_v)}{5} - W_e$$

Where;

GL = gross load in kilograms

$W_v$ = vessel weight in kilograms

$W_e$ = engine weight in kilograms, as determined from Table 4–1

$D_{SFP}$ = displacement to static float plane (kg) as calculated by the following formula:

$D_{SFP} = (V_{tot} - V_{mw}) \times 1000$

Where

$V_{tot}$ = total volume in cubic metres ($m^3$), representing the internal volume of the vessel below the static float plane as determined by Figure 4–1, including the volume of the integral structure aft of the transom below the static float plane, and excluding the volume of the integral chambers that flood automatically.

$V_{mw}$ = motor well volume in cubic metres ($m^3$),

1000 = the factor representing a weight in kilograms of 1.0 $m^3$ of fresh water

### 4.2.4 The Recommended Maximum Number of Persons

4.2.4.1 The recommended maximum number of persons shall not exceed:

(a) the number of designated occupant positions; and

(b) the live load redistributed, as required, for the stability test (subsection 4.2.8.5 and 4.2.8.6).

4.2.4.2 The recommended number of persons must not be greater than the recommended maximum load divided by 75 kg (165 lbs), the assumed weight of one adult person.

### 4.2.5 Recommended Maximum Power Calculation

4.2.5.1 This subsection is divided into two categories:

(A) for manufacturers, constructors, and importers of monohull small vessels; and

(B) for monohull pleasure craft owners and monohull second hand pleasure craft brokers using the short method to calculate the recommended maximum power.

### (A) Power calculation for manufacturers, constructors, and importers of monohull small vessels

4.2.5.2 Where an outboard power-driven small vessel is of monohull construction and not exceeding 6 m in length, the maximum recommended power in kilowatts shall be determined in relation to the overall length of the vessel ($L_h$) and maximum transom width ($D_h$), excluding handles and extensions, but including permanently installed rub-rails. The formula to apply is determined by whether f (factor) = $L_h \times D_h$ is greater or less than 5.1, the midship deadrise angle, and the type of steering.

$f = L_h \times D_h$

Alternatively, calculate the factor (f) and interpolate the recommended maximum power from the appropriate curve in Figure 4–2 based on the midship deadrise angle and type of steering.

## Figure 4–1 Length and Width Definitions for Load Calculations

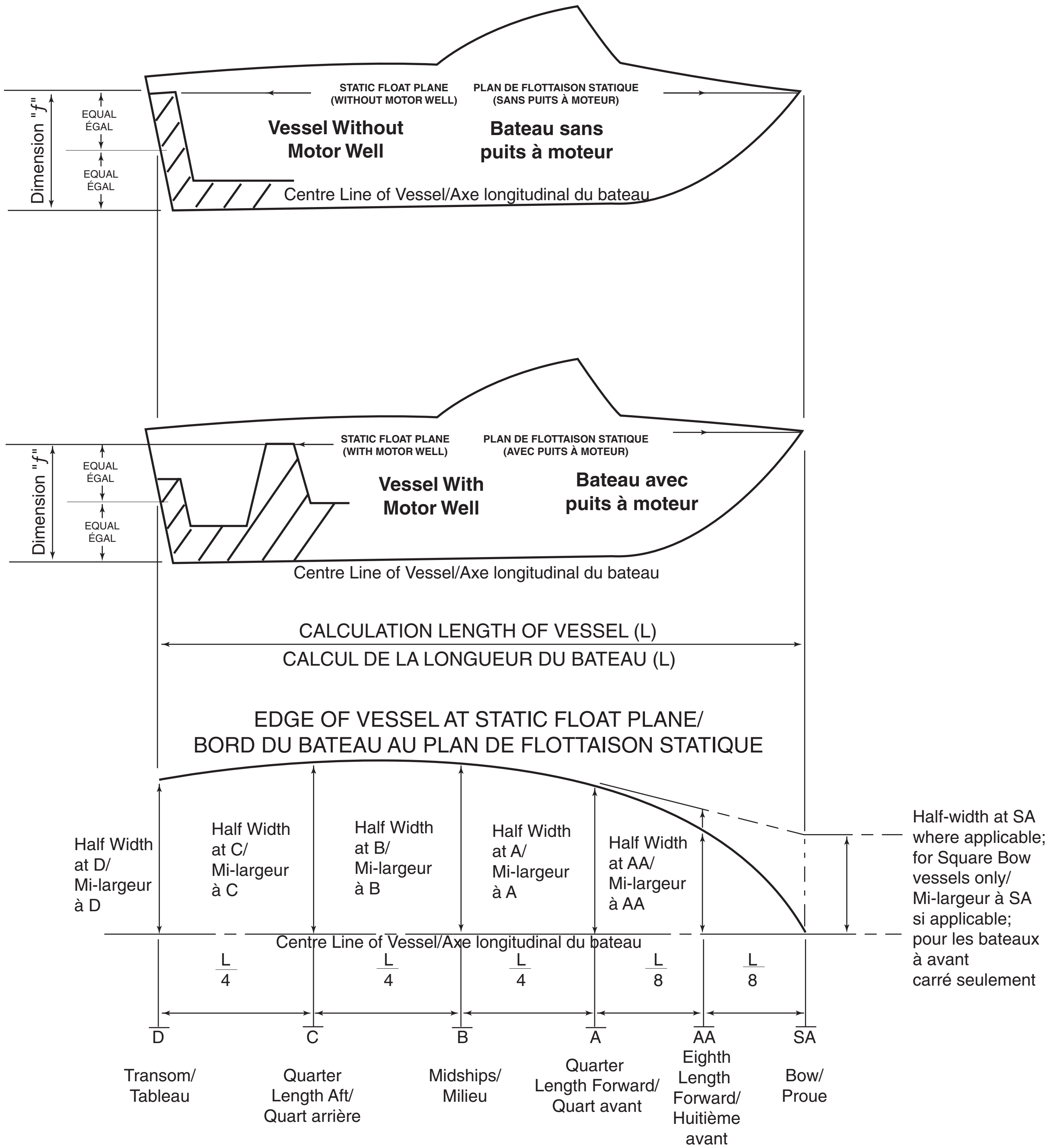


**Figure 4–2 Graph Used by Manufacturers, Constructors and Importers to Interpolate the Recommended Maximum Power of Small Vessels of Monohull Construction**

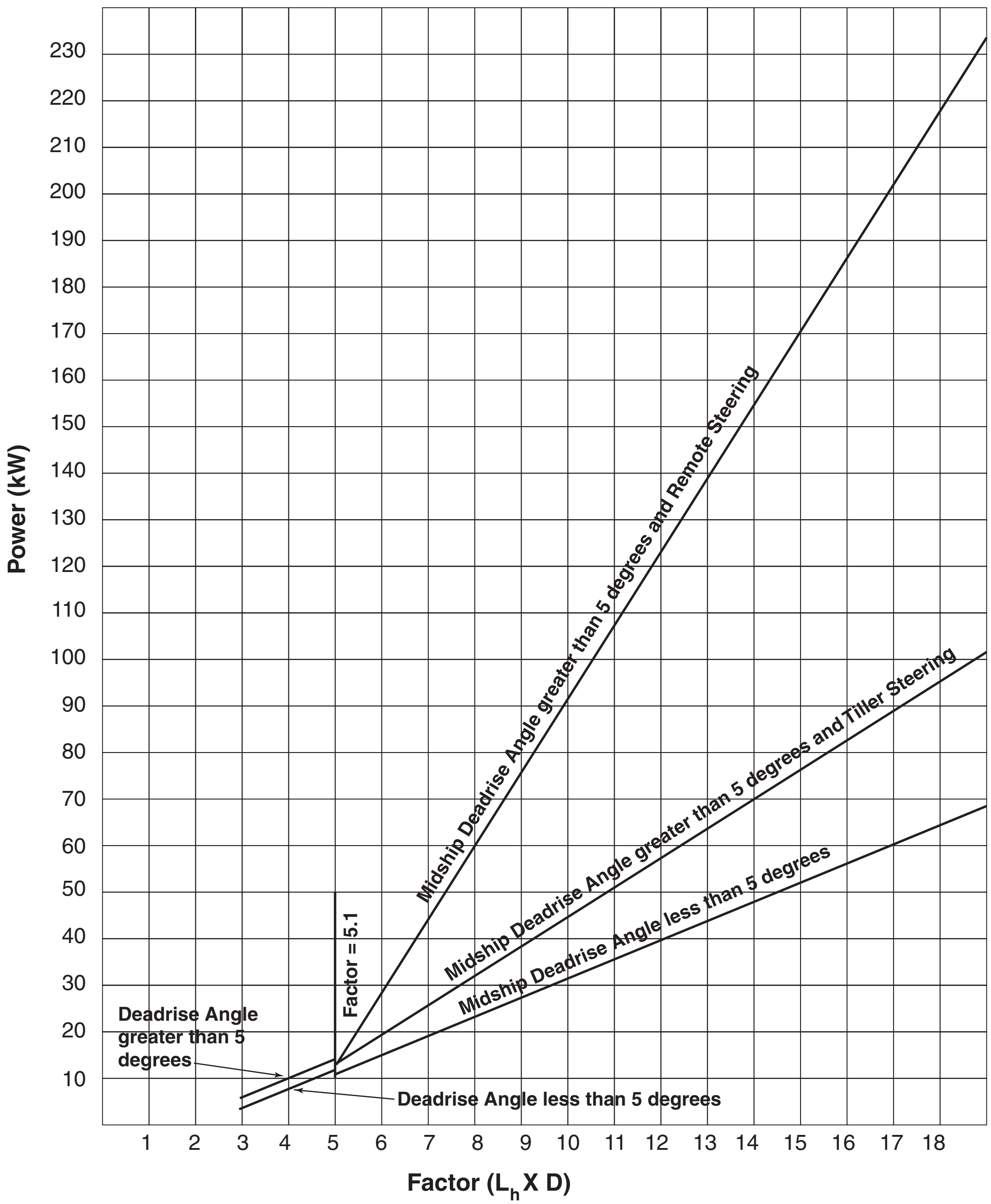


**Table 4–1 Weights (in kilograms) of Gasoline Outboard Engines and Related Equipment for Various Kilowatt Ratings**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Vessel Kilowatt Rating (KW)** | **Dry Weight + Fluids + Heaviest Propeller (Kg)** | **Controls (Kg)** | **Remote Oil Tank (Kg)** | ***Dry Battery Weight (Kg)** | **Full Portable Fuel Tank (Kg)** | **Total Weight (Kg)** |
| **SINGLE ENGINE INSTALLATIONS** | | | | | | |
| 0.0 – 1.5 | 13.7 | 0.0 | 0.0 | 0.0 | 0.0 | 13.7 |
| 1.6 – 2.9 | 18.2 | 0.0 | 0.0 | 0.0 | 0.0 | 18.2 |
| 3.0 – 5.2 | 40.9 | 0.0 | 0.0 | 0.0 | 11.4 | 52.3 |
| 5.3 – 11.2 | 60.0 | 0.0 | 0.0 | 9.1 | 22.7 | 91.8 |
| 11.3 – 18.7 | 104.5 | 0.0 | 0.0 | 20.5 | 22.7 | 147.7 |
| 18.8 – 33.6 | 119.5 | 4.6 | 0.0 | 20.5 | 45.4 | 190.0 |
| 33.7 – 44.8 | 157.1 | 4.6 | 0.0 | 20.5 | 45.4 | 227.6 |
| 44.9 – 56.0 | 183.9 | 4.6 | 0.0 | 20.5 | 45.4 | 254.4 |
| 56.1 – 74.6 | 203.0 | 4.6 | 0.0 | 20.5 | 45.4 | 273.5 |
| 74.7 – 108.2 | 242.0 | 4.6 | 11.4 | 20.5 | 45.4 | 323.9 |
| 108.3 – 164.1 | 256.1 | 4.6 | 11.4 | 20.5 | 45.4 | 338.0 |
| 164.2 and up | 282.9 | 4.6 | 11.4 | 20.5 | 45.4 | 364.8 |
| **Vessel Kilowatt Rating (KW)** | **Dry Weight+ Fluids + Heaviest Propeller (Kg)** | **Controls (Kg)** | **Remote Oil Tank (Kg)** | ***Dry Battery Weight (Kg)** | **Full Portable Fuel Tank (Kg)** | **Total Weight (Kg)** |
| **TWIN ENGINE INSTALLATIONS** | | | | | | |
| 37.6 – 67.2 | 238.8 | 9.1 | 0.0 | 40.9 | 45.4 | 334.3 |
| 67.3 – 89.6 | 314.2 | 9.1 | 0.0 | 40.9 | 45.4 | 409.6 |
| 89.7 – 112.0 | 367.7 | 9.1 | 0.0 | 40.9 | 45.4 | 463.2 |
| 112.1 – 149.2 | 405.9 | 9.1 | 0.0 | 40.9 | 45.4 | 501.3 |
| 149.3 – 216.4 | 484.0 | 9.1 | 22.7 | 40.9 | 45.4 | 602.1 |
| 216.5 – 328.2 | 512.1 | 9.1 | 22.7 | 40.9 | 45.4 | 630.3 |
| 328.3 and up | 565.7 | 9.1 | 22.7 | 40.9 | 45.4 | 683.8 |

*The total weights provided in table 4–1 includes the weight of one battery per engine.

4.2.5.2.1 If the factor is less than 5.1 ($f < 5.1$), use the following formulas to obtain the recommended maximum power in kilowatts (kW) or horsepower (hp):

(a) midship deadrise angle less than 5 degrees (minimum factor $f = 3.6$)

Maximum Power (kW) = 5.82 X f – 18

Maximum Power (hp) = (5.82 X f – 18) / 0.745

(b) midship deadrise angle greater than or equal to 5 degrees (minimum factor $f = 3.0$)

Maximum Power (kW) = 5.5 X f – 13

Maximum Power (hp) = (5.5 X f – 13) / 0.745

4.2.5.2.2 If the factor is equal to or greater than 5.1 ($f \geq 5.1$), use the following formulas to obtain the power in kilowatts (kW) or horsepower (hp):

(a) midship deadrise angle less than 5 degrees, remote and tiller steering

Maximum Power (kW) = 4.2 X f – 11

Maximum Power (hp) = (4.2 X f – 11) / 0.745

(b) midship deadrise angle greater than or equal to 5 degrees, tiller steering

Maximum Power (kW) = 6.4 X f – 19

Maximum Power (hp) = (6.4 X f – 19) / 0.745

(c) midship deadrise angle greater than or equal to 5 degrees, remote steering

Maximum Power (kW) = 16 X f – 67

Maximum Power (hp) = (16 X f – 67) / 0.745

## (B) Power calculation for monohull pleasure craft owners and second-hand monohull pleasure craft brokers

4.2.5.3 Where an outboard power-driven, second-hand pleasure craft is of monohull construction and is not over 6 m, the maximum recommended power in kilowatts shall be determined by obtaining a value, Numeral, in relation to the gross load (GL) and maximum transom width ($D_h$), and applying that Numeral to the appropriate curve in Figure 4–3.

$$\text{Numeral (N)} = \frac{GL \times D_h}{1.382}$$

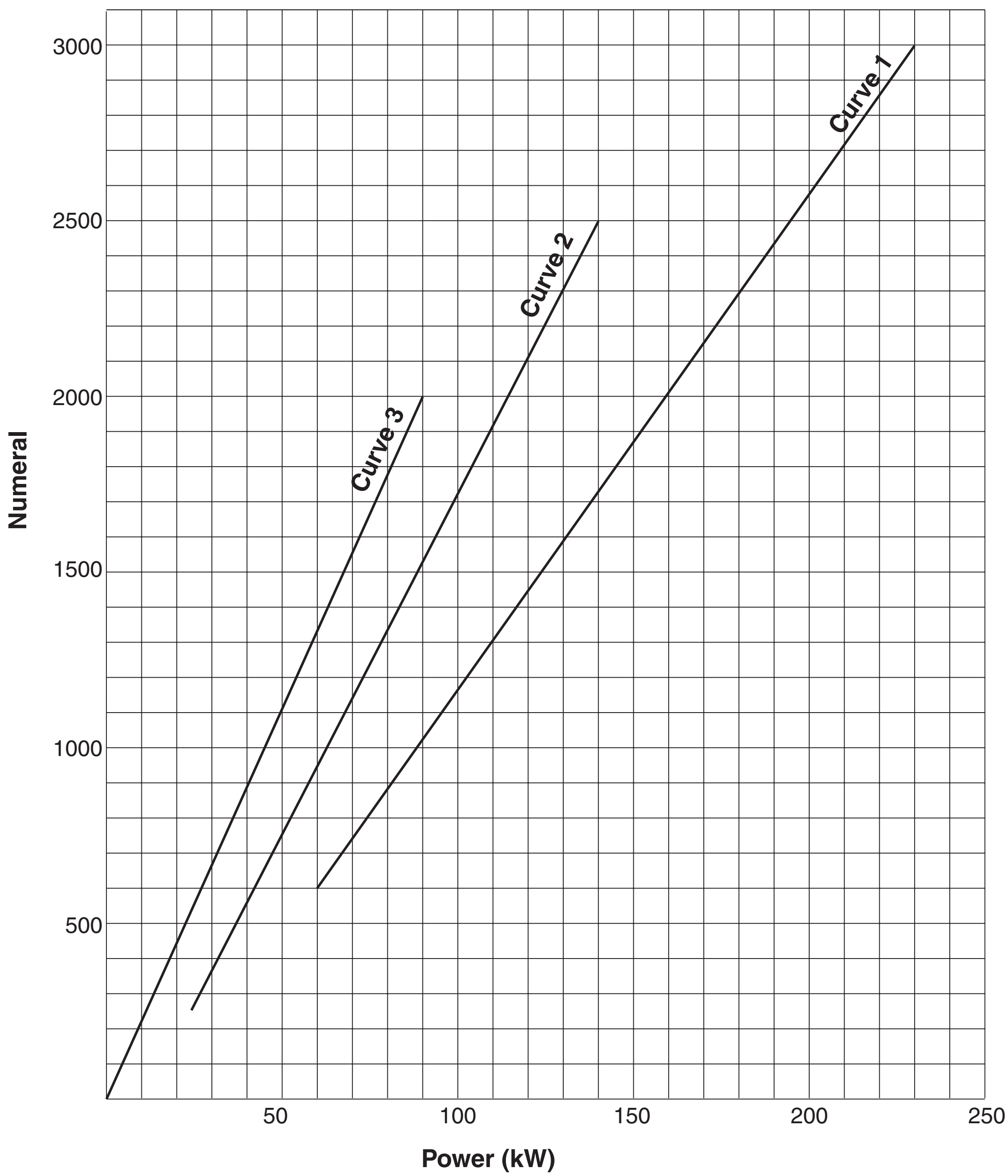
Where

Numeral = the calculated value used to interpolate power in kilowatts from Figure 4–3 or to calculate power in equations 4.2.5.3.1 (a), (b), and (c).

GL = gross load in kilograms

$D_h$ = maximum transom width in metres

**Figure 4–3 Graph Used by Owners of Pleasure Craft of Monohull Construction and Brokers of Second-hand Pleasure Craft of Monohull Construction to Interpolate the Recommended Maximum Power**



4.2.5.3.1 As an alternative to using Figure 4–3, calculate the Numeral as indicated in 4.2.5.3 and apply this value to the appropriate formula listed below, determined by the Numeral value, overall vessel length, maximum transom width, midship deadrise angle, and type of steering.

(a) The following formulas apply for maximum power (Curve 1):

Maximum Power (kW) = (0.071 X Numeral) + 18

Maximum Power (hp) = [(0.071 X Numeral) + 18] / 0.745

if the pleasure craft meets all the following conditions:

(i) its numeral is equal to or exceeds 600 ($N \geq 600$);

(ii) the length of vessel is greater than or equal to 4.75 m and it does not exceed 6 m ($4.75 \leq L_h \leq 6$ m);

(iii) its transom width is greater than or equal to 1.22 m ($D_h \geq 1.22$ m);

(iv) its midship deadrise angle is greater than 5 degrees (no flat bottom vessels);

(v) the pleasure craft is fitted with remote steering.

(b) The following formulas apply for maximum power (Curve 2):

Maximum Power (kW) = (0.056 X Numeral) + 11

Maximum Power (hp) = [(0.056 X Numeral) + 11] / 0.745

if the pleasure craft meets all the following conditions:

(i) its numeral is greater than or equal to 250, but less than 600 ( $250 \leq N < 600$ ),

(ii) $D_h$ is greater than or equal to 1.14 m but less than 1.22 m (1.14 m $\leq D_h <$ 1.22),

(iii) its midship deadrise angle is greater than 5 degrees (no flat bottom vessels),

(iv) the pleasure craft is fitted with remote steering.

(c) The following formulas apply for maximum power (Curve 3)

Maximum Power (kW) = 0.04 X Numeral

Maximum Power (hp) = (0.04 X Numeral) / 0.745

for pleasure craft not represented by (a) or (b)

### 4.2.6 Power Rating Restriction (Racing Hydroplanes)

4.2.6.1 Racing hydroplanes and similar low-volume racing craft are rated to a maximum of 7.4 kW (9.9 hp). This type of craft may use engine power greater than 7.4 kW (9.9 hp) only when engaged in, or in preparation for, an official competition.

### 4.2.7 Minimum Flotation Test (Swamped Condition)

### 4.2.7.1 Application

4.2.7.1.1 This subsection applies to all power-driven small vessels not over 6 m (19 ft 8 in) in length that are subject to swamping.

4.2.7.1.2 This subsection does not apply to the following:

(a) small vessels powered by outboard engines, which are required to meet the criteria of the level flotation and stability standard in subsection 4.2.8; or

(b) personal watercraft.

4.2.7.1.3 The method set out in subsection 4.2.7.3 or physical testing may be used to determine compliance with the relevant flotation criteria.

### 4.2.7.2 Requirements for Minimum Flotation Test

4.2.7.2.1 Every small vessel shall be fitted with inherently buoyant flotation material that provides sufficient buoyancy to keep the vessel from sinking when it is swamped and when the passengers are clinging to the outside of the vessel, where the individual weights of the motor, the passengers, and the equipment carried in or attached to the vessel do not exceed the weights used in the formula set out in paragraph 4.2.7.3.2.

4.2.7.2.2 The buoyancy required shall not be provided by air chambers greater than 0.014 $m^3$ (0.5 $ft^3$) in volume or by any air chambers that are integral with the hull structure.

4.2.7.2.3 The quantity of flotation material required for a small vessel to meet the requirements of paragraph 4.2.7.2.1 shall be calculated using the formula set out in paragraph 4.2.7.3.2.

4.2.7.2.4 Flotation material shall be placed or secured so that it cannot be accidentally moved or floated out of place.

4.2.7.2.5 Flotation material shall be protected, as far as practicable, from mechanical damage.

| Table 4–2 Factors for Converting Various Small Vessel Material from Dry Weight to Submerged Weight | | |
|---|---|---|
| **Materials** | **Specific Gravity** | **Factor (k)** |
| Lead | 11.38 | 0.91 |
| Copper | 8.91 | 0.89 |
| Monel Metal | 8.91 | 0.89 |
| Bronze | 8.88 | 0.89 |
| Nickel | 8.61 | 0.88 |
| Brass | 8.56 | 0.88 |
| Stainless Steel (rolled) | 8.00 | 0.88 |
| Steel | 7.85 | 0.88 |
| Cast Iron | 7.08 | 0.86 |
| Zinc-Cast Alloy | 6.63 | 0.85 |
| Aluminum | 2.73 | 0.63 |
| Glass | 2.60 | 0.62 |
| Ferro-Cement | 2.40 | 0.58 |
| Rubber | 1.51 | 0.34 |
| Fibreglass-Laminate | 1.50 | 0.33 |
| Kevlar-Laminate | 1.30 | 0.24 |
| Plexiglass-Lucite | 1.20 | 0.17 |
| A.B.S. | 1.12 | 0.11 |
| Teak | 0.99 | – 0.01 |
| Oak-White | 0.85 | – 0.18 |
| Oil-Diesel | 0.85 | – 0.18 |
| Gasoline | 0.73 | – 0.37 |
| Oak-Red | 0.63 | – 0.56 |
| Blandex-Particle Board | 0.58 | – 0.70 |
| Mahogany-Philippine | 0.58 | – 0.72 |
| Mahogany-Honduras | 0.56 | – 0.78 |
| Ash | 0.56 | – 0.78 |
| Yellow Pine | 0.55 | – 0.81 |
| Fir Plywood | 0.55 | – 0.81 |
| Mahogany-Plywood | 0.54 | – 0.83 |
| Royalex | 0.50 | – 0.95 |
| Mahogany-African | 0.51 | – 0.96 |
| Fir | 0.51 | – 0.96 |
| Cedar-Port Orford | 0.48 | – 1.08 |
| Spruce | 0.45 | – 1.22 |
| Pine-White | 0.42 | – 1.38 |
| Cedar-White | 0.33 | – 1.95 |
| Cork | 0.24 | – 3.17 |
| Balsa | 0.16 | – 5.24 |

***Notes on Table 4–2***

1. Factor (k) = [Specific Gravity – 1] / Specific Gravity

2. Specific Gravity of fresh water at 4°C = 1

### 4.2.7.3 Formulas for Minimum Flotation Test

4.2.7.3.1 To determine the volume of buoyant material required, the swamped weight of the vessel must first be calculated (see 4.2.7.3.2). This value is then used to find the amount of flotation required (see 4.2.7.3.3). The amount of flotation is in turn used in the formula to determine the volume of buoyant material required (see 4.2.7.3.4).

4.2.7.3.2 The swamped weight ($W_s$) of the vessel and permanently installed fittings, excluding the engine and engine related equipment, shall be determined as follows:

$$W_s = \sum Whk + W_d + 0.69W_f$$

Where

$W_s$ = Swamped weight in kilograms of vessel and fittings other then engine and engine related equipment

$\sum Whk = Wh_1k_1+Wh_2k_2+Wh_3k_3...$

$Wh_1$, $Wh_2$, $Wh_3$ ... = the dry weight in kilograms of various materials used in hull construction;

$k_1$, $k_2$, $k_3$ ... = a conversion factor applied to the weight of each piece of hull material ($W_h$), to convert the dry material (h) to an equivalent weight when submerged in fresh water as determined by Table 4–2

$W_d$ = weight of deck and superstructure in kilograms

$W_f$ = weight in kilograms of permanent fittings not included in $W_d$.

4.2.7.3.3 The amount of flotation required ($W_{fl}$) is determined by the following formula:

$$W_{fl} = W_s + 0.75\ W_e + 0.25\ W_l$$

Where

$W_s$ = swamped weight of the vessel in kilograms

$W_e$ = dry weight of the engine and related equipment in kilograms as installed

$W_l$ = the maximum load in kilograms, less the weight of the installed engine and related parts

4.2.7.3.4 The volume of buoyant material ($V_b$) required in cubic metres shall be determined as follows:

$$V_b = \frac{W_{fl}}{1000 - W_b}$$

Where

$W_b$ = weight in kilograms of 1 $m^3$ of buoyant material used

$W_{fl}$ = as calculated in 4.2.7.3.3

### 4.2.7.4 Flotation Material

4.2.7.4.1 Flotation material, when used in the bilge or engine room bilge, shall not change volume by more than 5% after being immersed, for a period of time as set out in 4.2.7.4.2 and 4.2.7.4.3, at 29°C in each of the following liquids:

(a) reference fuel B, in accordance with American Society of Testing and Materials ASTM D471;

(b) No. 2 reference oil, in accordance with American Society of Testing and Materials ASTM D471; and

(c) a 5% solution of trisodium phosphate in water.

4.2.7.4.2 The immersion time for flotation material used in the bilge shall be 24 hours.

4.2.7.4.3 The immersion time for flotation material used in the engine room bilge shall be 30 days.

4.2.7.4.4 Flotation material, when used in an engine room that is not open to the atmosphere, shall not reduce in volume by more than 5% after being immersed in a fully saturated gasoline vapour atmosphere for 30 days at 38°C.

4.2.7.4.5 The requirements of this subsection do not apply to flotation material used in a sealed compartment.

## 4.2.8 Level Flotation and Stability Tests (Swamped Condition)

### 4.2.8.1 Application

4.2.8.1.1 This subsection applies to all outboard power-driven small vessels not over 6 m (19 ft 8 in) in length, except small vessels not subject to swamping, sailboats, canoes, kayaks, inflatable crafts, amphibious craft, and vessels designed for racing.

4.2.8.1.2 Inboard and inboard-outboard small vessels are required to meet the standards of subsection 4.2.7 and are not included in this subsection.

4.2.8.1.3 Numerical methods or physical testing may be used to determine compliance with the relevant flotation criteria.

### 4.2.8.2 Preconditioning for Level Flotation Test

4.2.8.2.1 Every permanently installed fitting supplied by the manufacturer or constructor, such as windshields and convertible tops, shall be secured in place.

4.2.8.2.2 The vessel shall be loaded with weights that, when submerged, are equivalent to the weight of the following:

(a) 50% of the live load of the vessel as defined in paragraph 1.2.1, up to 250 kg (550 lbs) and, if the live load exceeds 250 kg (550 lbs), 12% of the excess;

(b) 25% of the difference between maximum load and live load after deducting the weight of the engine, battery, and full fuel tank from the maximum load; and

(c) the engine, battery, and fuel.

4.2.8.2.3 The weights in 4.2.8.2.2 (a) and (b) shall be placed so that their centre of gravity lies at the centre of the person-carrying area, but they shall all be contained within 16% of the person-carrying areas, as shown in Figure 4–5.

4.2.8.2.4 The weights in 4.2.8.2.2 (c) shall be placed as close as practicable to the position of those components they replace.

4.2.8.2.5 Permanent fuel tanks shall be filled with fuel and sealed.

4.2.8.2.6 Water and holding tanks shall be filled with fresh water.

4.2.8.2.7 For the purpose of physical testing, the vessel shall be swamped for a period of not less than 18 hours so that all compartments integral with the hull are flooded, no trapped air remains in the hull, and water is free to flow in and out of the hull.

4.2.8.2.8 Where air chambers are part of the flotation, the two largest shall be perforated so as to allow complete flooding.

### 4.2.8.3 Person-Carrying Area

4.2.8.3.1 The person carrying area is the area of a small vessel in which people may assume a safe sitting or standing position while the vessel is in operation.

4.2.8.3.2 The length of the person-carrying area is the distance along the centre line of the vessel between two assumed vertical lines, one forward and one aft of the area, when the vessel is on an even keel. For small vessels with a curved stem inside the person-carrying area, the forward vertical line intersects the stem at a point where a line drawn at 45 degrees to the horizontal is tangential to the stem. For small vessels with enclosed cabins, the forward vertical line is perpendicular to the centre line at the forward limit of that area where there is 0.6 m (2 ft) of headroom between the inside of the cabin top and the swamped waterline (see Figure 4–4).

4.2.8.3.3 The breadth of each person-carrying area is the distance between two assumed vertical lines at mid-length, excluding consoles, of the person-carrying area when the small vessel is upright (see Figure 4–4). For small vessels with round chines, the vertical lines intersect the hull on each side at a point where lines drawn at 45 degrees to the horizontal are tangential to the hull on either side.

## Figure 4–4 Criteria for Measuring the Length of Person-carrying Area

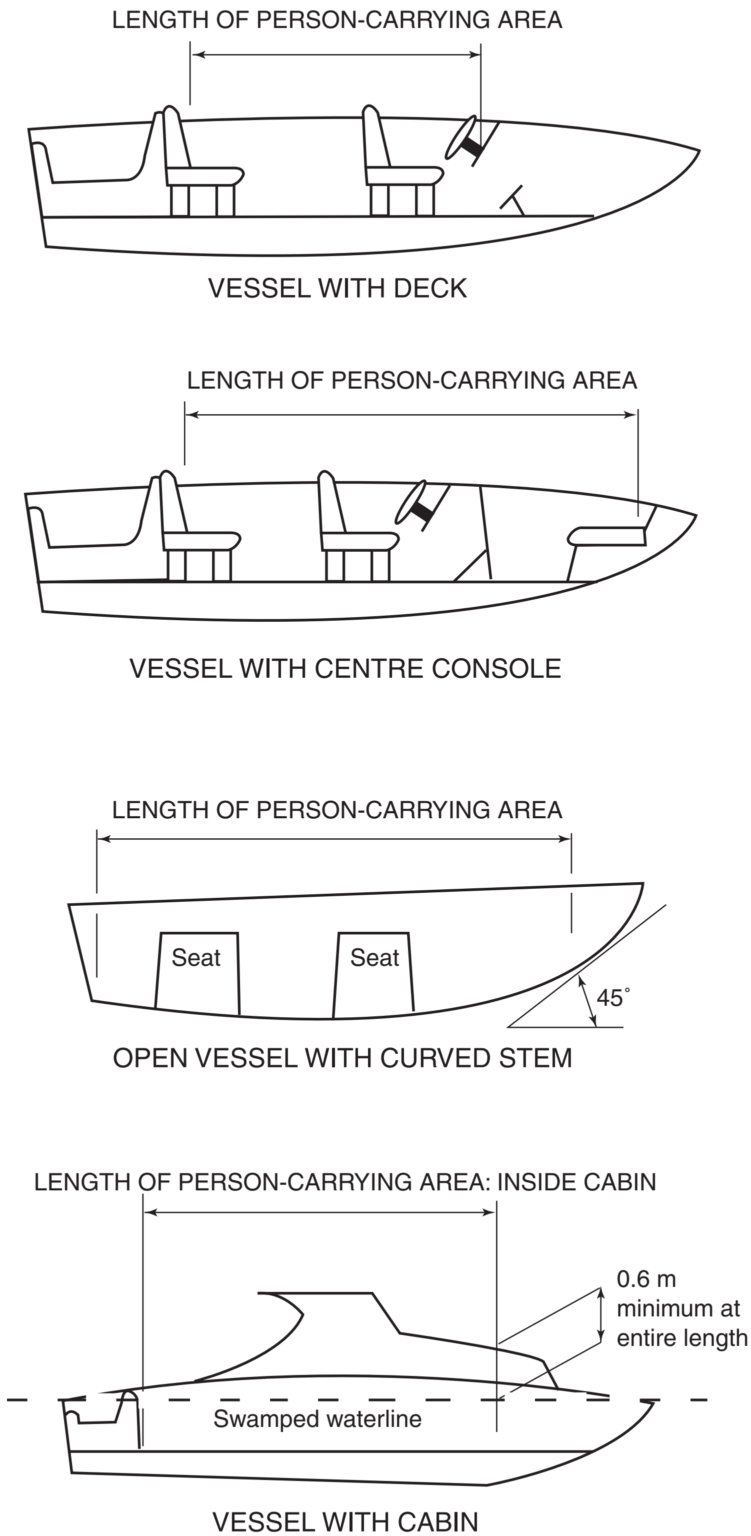
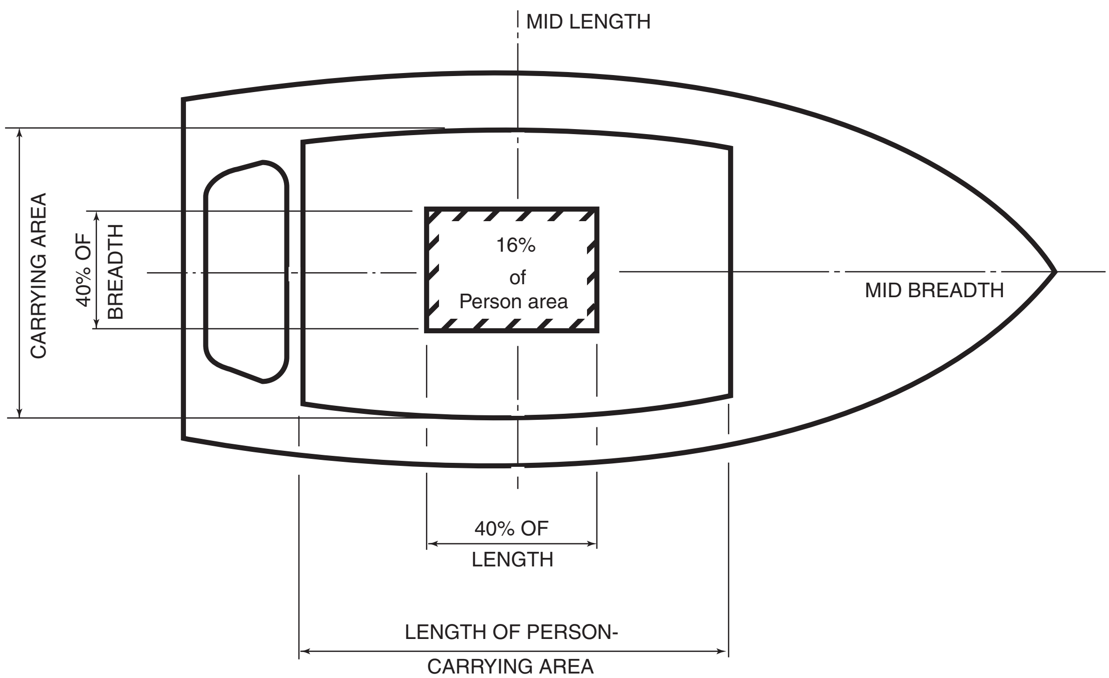


**Figure 4–5 Location of Centre of Gravity of Weights (level Flotation)**




### 4.2.8.4 Requirements for Level Flotation Test

4.2.8.4.1 When the specified preconditioning has been completed (subsection 4.2.8.2), the small vessel shall float in fresh water as follows:

(a) the angle of heel shall not exceed 10 degrees;

(b) one part of either the bow or stern reference areas, as defined in paragraph 1.2.1, shall remain above the surface of the water; and

(c) the midpoint of the submerged bow or stern reference area shall not be more than 152 mm (6 in) below the surface of the water.

### 4.2.8.5 Preconditioning for Stability Test

4.2.8.5.1 Preconditioning shall be completed as for the level flotation test, except for deployment of live load weights specified in paragraph 4.2.8.2.2, which shall be redistributed as follows:

(a) half of the weight is to be removed from the small vessel, with the other half arranged on one side of the vessel so that the horizontal centre of gravity of the weights falls within 152 mm (6 in) of the outer edge of the person-carrying area for at least 70% of its length (Figure 4–6);

(b) the vertical centre of gravity of the weights shall be at least 102 mm (4 in) above the cockpit floor, or if the weights are placed on seats, the vertical centre of gravity of the weights shall be at least 102 mm (4 in) above the seats.

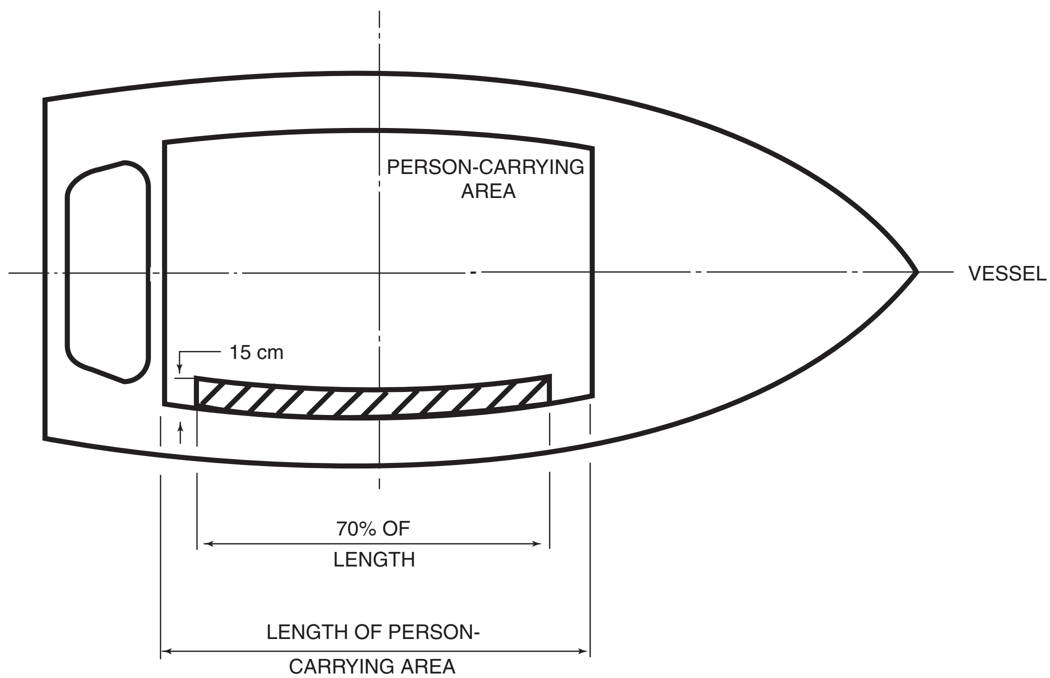
### 4.2.8.6 Requirements for Stability Test

4.2.8.6.1 While floating in calm water, the small vessel shall not list more than 30 degrees with the weight redistributed.

4.2.8.6.2 One part of either the bow or stern reference area, as defined in paragraph 1.2.1, shall remain above the surface.

4.2.8.6.3 The midpoint of the submerged bow or stern reference area shall be not more than 305 mm (12 in) below the surface.

**Figure 4–6 Location of Centre of Gravity of Weight (stability Test)**



## 4.3 Multihull Small Vessels (Pontoon)

### 4.3.1 Calculation Criteria (Intact Condition)

4.3.1.1 The criteria for developing the maximum recommended ratings are based on the flotation provided by the pontoons or multihulls. The following design conditions apply:

(a) the multihull small vessel shall have only one deck;

(b) the deck shall not extend beyond the width of the pontoons;

(c) the deck length within railings defining person-carrying area shall not be more than 80% of the pontoon length and shall not overhang the pontoons;

(d) the deck shall be located no more than 152 mm (6 in) above the pontoons; and

(e) the deck shall drain freely.

4.3.1.2 Where the design of a multihull small vessel does not conform to the criteria in paragraph 4.3.1.1, the maximum load shall be determined by the stability tests in sections 4.3.1.3, 4.3.1.4 and 4.3.1.5, conducted with the maximum engine power which is intended for use with the small vessel and with full fuel tanks and operational equipment in the normal positions.

4.3.1.3 The transverse stability shall be tested by adding weights on the highest deck to one side as far outboard as is practicable within the limits of the design, until the top of the pontoon hull on the loaded side becomes awash.

4.3.1.4 The longitudinal stability shall be tested by adding weight on the highest deck evenly about a point in the longitudinal centre line of the vessel, one quarter of the length of the deck from forward, until the edge of the lower deck becomes immersed. This test shall be repeated at the aft end of the small vessel by adding weight evenly about a point one quarter of the length of the deck from aft until the edge of the lower deck or the top of the motor mounting bracket becomes immersed, whichever occurs first.

4.3.1.5 Ninety percent (90%) of the least of the weights attained in the tests above shall be the total weight of persons allowed on board the small vessel.

4.3.1.6 Where additional confirmation of a vessel's stability is required, based on the calculation and assessment of the surveyor or inspector, the following approach shall be used: *Alternative Standard for the Intact Stability of Small Passenger Vessels of Multiple Pontoon Configuration and Restricted Passenger Movement* (Appendix B to Stab 5 of the Stability, Subdivision, and *Load Line Standards* [TP7301]).

### 4.3.2 Recommended Maximum Load Calculation

4.3.2.1 Where a power-driven small vessel is of multihull construction and is not over 6 m (19 ft 8 in) in length, the maximum recommended load in kilograms is determined by the lesser of the following (a) or (b):

(a)

$$GL = \left( \frac{(V_t \times b) - W}{2} \right) - W_e$$

Where

GL = Gross Load

b = constant buoyancy factor of 1000 kg/m$^3$

$V_t$ = the total volume in cubic metres within all of the pontoons of a vessel

W = the dry weight in kilograms of the vessel, deck, railings, console, seats, and any other permanent Structures and fittings, excluding the outboard engine or portable fuel tank

$W_e$ = outboard engine weight, as determined from Table 4–1

(b) Maximum load as defined in paragraph 4.3.1.6

### 4.3.3 The Recommended Number of Persons

4.3.3.1 Where a small vessel is of multihull construction and is not over 6 m (19 ft 8 in) in length, the recommended number of persons shall be determined in relation to the volume of pontoons, the volume of the largest compartment of the pontoon, gross load, and engine weight as follows:

$$\text{Number of Persons} = \frac{GL}{75} \times \left( 1 - \frac{V_{lc}}{V_p} \right)$$

Where

GL = gross load in kilograms

$V_{lc}$ = volume of largest compartment, in cubic metres, defined as the largest volume between separation bulkheads in any pontoon

$V_p$ = total volume in cubic meters of all pontoons

75 = assumed weight of one person in kilograms

### 4.3.4 The Recommended Maximum Power

4.3.4.1 Where a small vessel is of multihull construction and is not over 6 m (19 ft 8 in) in length, the recommended maximum power in kilowatts shall be determined in relation to the squared length and the diameter of the pontoons as follows:

$$\text{Maximum Power (kW)} = 3 \times L^2 \times D_p$$

Where

L = length of the pontoon in metres

$D_p$ = diameter of the pontoon in metres

## 4.4 Small Vessels – Inflatable and Rigid Inflatable

### 4.4.1 Calculation Criteria (Intact Condition)

4.4.1.1 The criteria for developing the maximum recommended ratings is based on the flotation provided by the inflated tubes, and in addition, where applicable, the volume of the hull below the cockpit sole.

### 4.4.2 Recommended Maximum Load Calculation

4.4.2.1 Where a power-driven small vessel is of inflatable or rigid inflatable construction, that is not over 6 m (19 ft 8 in) in length, the recommended maximum load in kilograms shall be determined in relation to the total volume of inflatable tubes (V) and the dry weight of the vessel as follows:

$$GL = (V \times b \times 0.75) - W$$

Where

GL = gross load in kilograms

V = the total volume of the inflated tubes in cubic metres, and where appropriate, the volume of the rigid or inflated hull below the cockpit sole

b = constant buoyancy factor = 1000 $kg/m^3$

W = dry weight of the vessel in kilograms

4.4.2.2 The following variances, dependent on design features, are applied to the recommended maximum load results calculated by 4.4.2.1. Load reduction for the minimum number of chambers in the collar is as follows:

(a) 1 air chamber = 50% load reduction;

(b) 2 air chambers = 33% load reduction;

(c) 3 air chambers = 25% load reduction;

(d) 4 air chambers = No load reduction.

### 4.4.3 Recommended Maximum Number of Persons

4.4.3.1 Where a power-driven small vessel is of inflatable or rigid inflatable construction and is not over 6 m (19 ft 8 in) in length, the recommended maximum number of persons shall be determined in relation to gross load and engine weight in kilograms as follows:

$$\text{Number of People} = \frac{GL - W_e}{75}$$

Where

GL = gross load in kilograms

$W_e$ = engine weight in kilograms

75 = assumed weight of one person in kilograms

### 4.4.4 The Recommended Maximum Power

4.4.4.1 Where a power-driven small vessel is of inflatable or rigid inflatable construction and is not over 6 m (19 ft 8 in) in length, the recommended maximum power shall be determined in relation to total vessel length, its beam, the total internal volume of the inflatable tubes and a design factor, as follows:

$$\text{Power (kW)} = \frac{L}{B} \times V \times f_x$$

Where

L = total length of the vessel in metres

V = total internal volume of the inflatable tubes in cubic metres

B = beam of the vessel in metres

$f_x$ = a constant factor determined by transom type as follows:

(a) Factor ($f_1$) for stern tube type (Bracket) = 2.5

(b) Factor ($f_2$) for stern transom type, vessel length not exceeding 3.0 m = 6.5

(c) Factor ($f_3$) for stern transom type, vessel length greater than 3.0 m but not exceeding 5.0 m = 7.5

(d) Factor ($f_4$) for stern transom type, vessel length greater than 5.0 m = 9.0

4.4.4.2 The following variances (Table 4–3) are applied to the recommended maximum power calculation in 4.4.4.1. Choose one of the factors from the calculation method in relation to the design features (small vessel length, stern type, type of steering and its location):

**Table 4–3 Design Variance Factors for Power Calculations**

| Item | Calculation Method |
|---|---|
| Stern – Tube Type | Inflatable Calculation (Factor $f_1$) |
| Stern – Transom Type | Inflatable Calculation (Factor $f_2$ or $f_3$ or $f_4$) |
| Steering – Aft of L/4 forward of Transom | Inflatable Calculation (Factor $f_2$ or $f_3$ or $f_4$) |
| Steering – Fwd of L/4 forward of Transom | Inflatable Calculation (Factor $f_2$ or $f_3$ or $f_4$) X 1.25 for vessels over 3.0 m in length |