



South African Maritime Safety Authority

Ref: SM6/5/2/1

Date: 5 December 2011

Marine Notice No. 26 of 2011

Pontoon Boats (Excluding Passenger Vessels) – Minimum Requirements for Stability, Watertight Integrity and Survivability (in terms of the Merchant Shipping (National Small Vessel Safety) Regulations, 2007 (as amended))

TO ALL PRINCIPAL OFFICERS, SURVEY STAFF, AUTHORISED AGENTS, SAFETY OFFICERS, BOAT BUILDERS, BOAT DEALERS, BOAT OWNERS AND OTHER INTERESTED AND AFFECTED PARTIES

Summary

*Pontoon boats (also referred to as rafts), used on sheltered waters (Category R vessels), are of unique construction. This marine notice provides guidance, on application of the Merchant Shipping (National Small Vessel Safety) Regulations, 2007, to pontoon boats, which are **not** passenger vessels, on issues of construction, stability, watertight integrity and survivability in the event of damage which are important survey elements for the issue of "Local General Safety Certificates or "Certificates of Fitness",*

Sheltered waters: means any of the following:

- (a) A tidal lagoon or tidal river as defined in section 1 of the Sea-Shore Act 21 of 1935.
- (b) The waters within the breakwaters of any port in the Republic.
- (c) Inland waters

Inland waters: means the waters of any dam, lagoon, lake, river or wetland but does not include a tidal lagoon or tidal river as defined in section 1 of the Sea-Shore Act, 1935 (Act No.21 of 1935).

Passenger vessel: a vessel that carries more than 12 passengers

Passenger: any person carried on a vessel, except persons employed as crew; rescued survivors and infants under one year of age.

INTRODUCTION

1. The Merchant Shipping (National Small Vessel Safety) Regulations, 2007 (NSVR) apply to:
 - a. Non-pleasure vessels of less than 25 GT which proceed to sea and/or are used on sheltered waters.
 - b. Pleasure vessels of less than 100 GT which proceed to sea and/or are used on sheltered waters.
 - c. All vessels used on inland waters.
2. Pontoon boats, which are primarily used on inland waters, are of unique construction and some clarification of the application of the provisions of the NSVR with respect to construction, stability, watertight integrity and survivability in the event of damage (flooding, swamping or capsize) is required.
3. A pontoon boat (sometimes also referred to as a raft) is a boat, used for navigation on water, however propelled or moved, consisting of two or more flotation (hull) units to which a deck or decks are attached which persons are able to be supported on. The essential difference between a pontoon boat and a conventional boat is that the deck(s) are not integral to the hull of the boat.

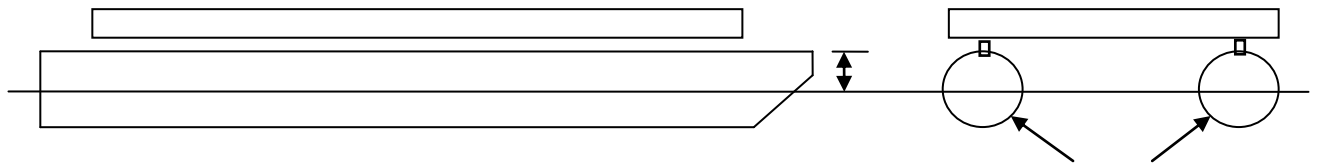


Figure 1 – Schematic of Typical Pontoon Vessel

4. The following provisions for construction, stability, watertight integrity and survivability in the event of damage must be followed for compliance with the NSVR.

5. **CONSTRUCTION**

NSVR Reg 6(1)(a) -Every vessel must be constructed of suitable materials of good quality, with due regard to sound design practice and methods of construction

NSVR Reg 6(1)(c) -The design and construction of a vessel must, in addition, comply with the requirements of Annexure 1.

The definition of sheltered waters encompasses a large variety of waters and environmental conditions which impact on vessels navigated thereon eg.

- a. Long stretches of water subject to wind “fetch” with resultant wave formation.
- b. Area’s of water subject to high windage which may affect a vessels manoeuvrability.
- c. Area’s of water subject to high water flows as a result of flooding, tidal action or dam level management.
- d. Area’s of water with additional navigation hazards such as shallow waters, rocky floors and restricted area’s of operation.

The attending surveyor is required to evaluate the construction of pontoon boats (and any other type of boat) presented for survey against the intended operation of the boat.

In the event that the surveyor is not satisfied with the vessels construction he/she may:

- a. Refuse to issue safety certification for the vessel.
- b. Require that improvements to the vessel construction be carried out prior to the issue of safety certification.
- c. Limit the vessels area of operation to a specific area for which the vessel construction is considered suitable.

STABILITY

NSVR Reg 6(1)(a) - . . . under normal operating conditions the design must provide sufficient reserve of positive stability so that the vessel cannot capsize easily when carrying a load.

6. Pontoon boats typically have poorer stability characteristics than boats of more conventional construction. The following principles must be applied to reduce the risk of capsize:
- a. Transverse Extent of Deck(s) the deck(s) of a pontoon vessel should not extend beyond the outer edge of the pontoons.

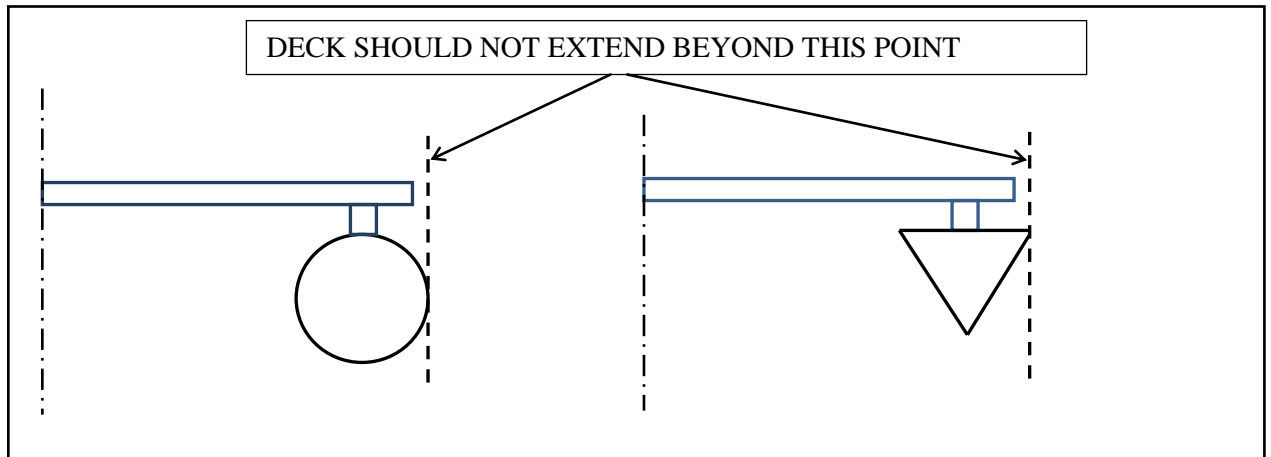


Figure 2 – Maximum Transverse Extent of Decks

- b. Longitudinal Extent of Decks pontoons boats must be provided with pontoons which extend at least 500mm forward and aft of the ends of the pontoon deck area (s) where persons will be accommodated.
- c. Deck Heights The pontoon boats transverse stability characteristics must be taken into account when pontoon boats are provided with upper decks. Consideration must be given to:
 - i. Reducing the breadth of upper decks.
 - ii. Reducing the number of persons carried on upper decks.
 - iii. Keeping the height of upper decks to a minimum.

It is recognised that the designer of a pontoon vessel may design a boat with good stability characteristics which are not necessarily in line with the above provisions. In these cases or in the event that doubt exists regarding the transverse and/or longitudinal stability of a vessel, the surveyor may require that a heeling test(s) be carried out as follows:

- a. Transverse Stability With the vessel in the fully loaded condition transfer the weights of all the persons on board to one side of the vessel (eg. port) in a controlled manner, taking care not to create a capsizing moment. Repeat the heeling test to the other side of the vessel (eg. starboard).

Criteria: With the persons crowded as far to one side as is practicable, the top of the outboard pontoon shall not submerge at any point.

- b. Longitudinal Stability With the vessel in the fully loaded condition transfer the weights of all the persons on board to the extreme forward positions on the deck space(s) available to the persons on board. Repeat the test transferring the weight of all persons as far aft as is practicable.

Criteria: With the persons crowded as far forward or aft as is practicable, the tops of the pontoons may not submerge at any point.

Guidance on Weights and Centres of Gravity for Heeling Test(s)

Persons or weights may be used for the test(s). In the event of weights being used, each person must be represented by a weight of 75 kg. Standing persons shall be assumed to congregate at 0.25 m² per person and their centre of gravity shall be assumed to be at 1.0 m above the deck. Seated persons shall be provided with a minimum seat spacing of 500mm with their centre of gravity 0.3 m above the seat.

WATERTIGHT INTEGRITY

NSVR Reg 6(1)(b) - On decked vessels no point of possible water ingress of water, except scuppers, may be less than 200 mm above the surface of the water, measured when the vessel is afloat in an undamaged condition in calm water.

7. Regulation 6(1)(b) is aimed at preventing flooding of small vessels. In the case of pontoon boats, any condition which results in submergence of a pontoon will normally result in capsize of the vessel. It is accordingly required that the distance between the waterline and the top of the pontoon in the fully loaded condition is not less than 200mm (See figure 1). The freeboard must be measured with the vessel in a fully loaded condition with persons on board distributed in accordance with the arrangements provided for the vessel.

In the event that the pontoon boat freeboard is found to be less than 200mm, then a transverse and longitudinal heeling test must be carried out in accordance with the provisions and criteria specified in paragraph 6 of this marine notice.

8. The following hull types may be encountered on pontoon boats:
- a. Hull consisting of two or more pontoons, not sub-divided internally.
 - b. Hull consisting of two or more pontoons, subdivided internally.
 - c. Hull consisting of numerous independent flotation units (200 litre drums or similar).
9. When considering the watertight integrity characteristics of pontoon boats, there are two (2) important considerations:
- a. Consideration 1 What provisions are in place to allow the condition of the hull(s) to be determined prior to the vessel being operated and/or during operation.

NSVR Reg 29 - The owner and skipper of a vessel must ensure that the condition of the vessel and its equipment, structure, appliances, arrangements and material are maintained so as to comply with the requirements of these regulations.

NSVR 7(3)(b) - On each occasion before any vessel is operated, the skipper must ensure the safety appliances and equipment required to be on board the vessel are fit and ready for use.

- b. Consideration 2 What provisions are in place to drain/empty water from the hull(s) in the event of water ingress having taken place.

NSVR Reg 6, Annex 1 (11) - Bilge Pumping Arrangements

- (1) This regulation does not apply to –
- (a) Ski-boats having self-draining decks;
 - (b) Inflatable or semi-rigid inflatable vessels having semi-rigid decks; or
 - (c) Sailing or rowing dinghies,
- But such vessels must be provided with an efficient bailing device.

10. Consideration 1 - Determination of Hull Condition Prior to Operation The following provisions are considered acceptable to allow the condition of the hull, prior to vessel use, to be determined. At least one of the below measures must be provided (Some measures may only be practical for trailer-borne vessels):
- a. Inspection hatches or sight glasses, per watertight compartment.
 - b. Electronic bilge alarms, per watertight compartment.
 - c. Sounding pipes/plugs, per watertight compartment.
 - d. Drain bungs, per watertight compartment.
 - e. Lightweight Condition Draught Marks Permanent draught marks may be provided at the forward and aft extremes (within 0.1L) of the vessel (Port and Starboard sides) clearly indicating the waterline with the vessel in its lightweight condition. The marks may be painted in contrasting colour to the hull colour (dimensions 300mm x 25mm high) or be of alternative design provided that the method of marking is as efficient/equivalent to painted marks.

Vessels provided with “Lightweight Condition Draught Marks” must be provided with buoyancy certificates which clearly indicate the position of the marks, freeboards at the associated marks

as well as the loads included in the vessel lightweight eg. engine(s), anchor, battery, safety equipment, etc.

Painted/welded marks, etc must be marked so that the underside of the mark is in line with the vessel waterline in its lightweight condition.

11. Consideration 2 - Provision for Drainage of Hull Sections in the Event of Water Ingress Acceptable alternatives to a “bailing device” are required on pontoon boats. Provisions should be able to achieve drainage of the hull(s) and/or hull sections at least prior to and at the end of every voyage. These provisions could include (Some measures may only be practical for trailer-borne vessels) At least one of the below measures must be provided unless the space(s) are 100% filled with foam of an approved type:
 - a. Drain bungs.
 - b. Manual bailing arrangements.
 - c. Manual or power pumping arrangements.
 - d. Air pressure/venturi type systems.
12. Provided arrangements on the vessel must be such that determination of the hull condition (Consideration 1) and drainage of the hull section(s) in the event of water ingress (Consideration 2) can be carried out at least prior to and following every voyage.
13. Determination of the hull condition prior to every voyage is a fundamental safety requirement and no dispensation from the requirements of paragraph 10 will be considered, however, in the event that no arrangements are provided for the drainage of hull sections in the event of water ingress (Consideration 2) then the pontoon vessel configuration shall be such that it will not capsize in the event of damage (“Extent of Damage”) taking place.

SURVIVABILITY IN THE EVENT OF DAMAGE

NSVR Reg6, Annex 1(1) - Built-in Buoyancy

(1) (d) Category R vessels may make any suitable and reasonable provisions to ensure that the vessel retains positive buoyancy when fully flooded, swamped or capsized.

(2) Watertight compartments and watertight empty cases are not a substitute for built-in buoyancy referred to in sub-item (1): Provided that a decked vessel may, instead of built-in buoyancy, be provided with at least two watertight bulkheads so positioned and of sufficient strength that, in the event of flooding of the largest compartment formed by the bulkheads, the vessel will remain afloat in its worst envisaged load condition with positive transverse stability.

14. The positive buoyancy requirement for Category R vessels in the event of damage (flooding, swamping or capsize) must be so that the full complement of the vessel are able to hold onto/cling to the damaged vessel.
15. Marine Notice 13 of 2011 interprets the requirement of the NSVR requirement by stating that theoretical compliance may be demonstrated for boats of wood/GRP construction if it can be shown by calculation that 30% of the vessels weight is fitted as additional buoyancy. It should be clearly understood that alternative theoretical or practical methods may also be used to demonstrate that the vessel meets the minimum requirement of the regulations.
16. Built-in buoyancy, for compliance with the above, may consist of:
 - a. SAMSА-Approved foam
 - b. SAMSА-Approved bottles

- c. Void Spaces Void pontoons and/or pontoon spaces may be considered as providing buoyancy in the event of damage provided that they remain watertight with the vessel in the damaged condition ie. if the vessel remains upright then the space(s) must be watertight in this condition, however, if the vessel capsizes the space(s) must then be designed so that they will remain watertight in that condition.

In consideration of the water tightness of void pontoons and/or pontoon spaces all openings through which water could flood into the space must be provided with watertight closing arrangements with the exception of compartment vents with $\text{Ø} \leq 3\text{mm}$.

Positive air pressure within void spaces which (arguably) prevents water ingress in the event of damage is not considered acceptable as built-in buoyancy (This method is too dependent on the specific location of the damage).

In the event that a void pontoon/pontoon space is not able to be closed watertight then it may not be considered as built-in buoyancy and the space(s) then need to be filled with SAMSA-Approved foam or bottles to achieve the “Minimum Survival Condition Following Damage” (See paragraph 17b).

17. Pontoon boats must be able to survive damage as follows:

a. Extent of Damage

Pontoon vessels must be able to survive; either:

- i. Flooding of the single largest pontoon/compartment; or,
- ii. Flooding of compartment(s) following damage of length; $L = 0.8 + 0.1L$ [m],

whichever of the above results in greater flooding ie. if the largest compartment length; $L > 0.8 + 0.1L$ then only flooding of that compartment must be considered, however if the compartment length; $L \leq 0.8 + 0.1L$, then flooding of compartment(s) resulting of damage of $L = 0.8 + 0.1L$ must be considered.

b. Minimum Survival Condition following damage

Following a damage event, the vessel must at least remain afloat (upright or capsized) with sufficient positive buoyancy to allow the full complement to hold onto/cling to it.

18. A flow chart illustrating the process to be followed for approval of a pontoon boat built-in buoyancy and/or sub-division arrangements is included as Appendix A.
19. Buoyancy Certificate A buoyancy certificate must be generated and retained on board, clearly indicating the means provided to ensure that the vessel will achieve the “minimum survival condition” in the event of damage (See Appendix B).

ESCAPE FROM VESSEL FOLLOWING CAPSIZE

20. It is recognised that pontoon vessels may capsize in the event of damage or as a result of application of external forces (wind, turning, crowding of persons).

In a recent casualty involving the capsize of a pontoon vessel, some of the persons were trapped inside the vessel due to the nature of the enclosed structure of the vessel.

Enclosures on pontoon boats must accordingly be configured so that persons can easily escape from the vessel in the event of capsize while wearing personal floatation devices or life jackets. Such arrangements may be in the form of permanent openings or emergency escape openings which are clearly marked and able to be easily opened to allow persons to escape any enclosure formed by the vessel structure, in the event of capsize. At least two (2) adjacent openings (approximately midships Port/Stbd or Fwd/Aft) must be provided on vessels of less than 9 metres overall length and at least four (4) adjacent openings (Approximately midships Port/Stbd and Fwd/Aft). The area of each emergency escape must be at least 2m^2 .

CONCLUSION

20. This marine notice is published to provide clarity on the application of the Merchant Shipping (National Small Vessel Safety) Regulations, 2007, which are aimed at reducing the loss of life of persons boating (navigating) on South African waters, using pontoon boats (which are not passenger vessels) and may be reviewed from time to time.

05 December 2011

SM6/5/2/1

Issued by and obtainable from:
The South African Maritime Safety Authority
161 Lynnwood Road
Brooklyn, Pretoria

PO Box 13186
Hatfield 0028

Tel: +27 12 366 2600

Fax: +27 12 366 2601

E-mail: marinenotices@samsa.org.za

Web Site : www.samsa.org.za

List of Attachments

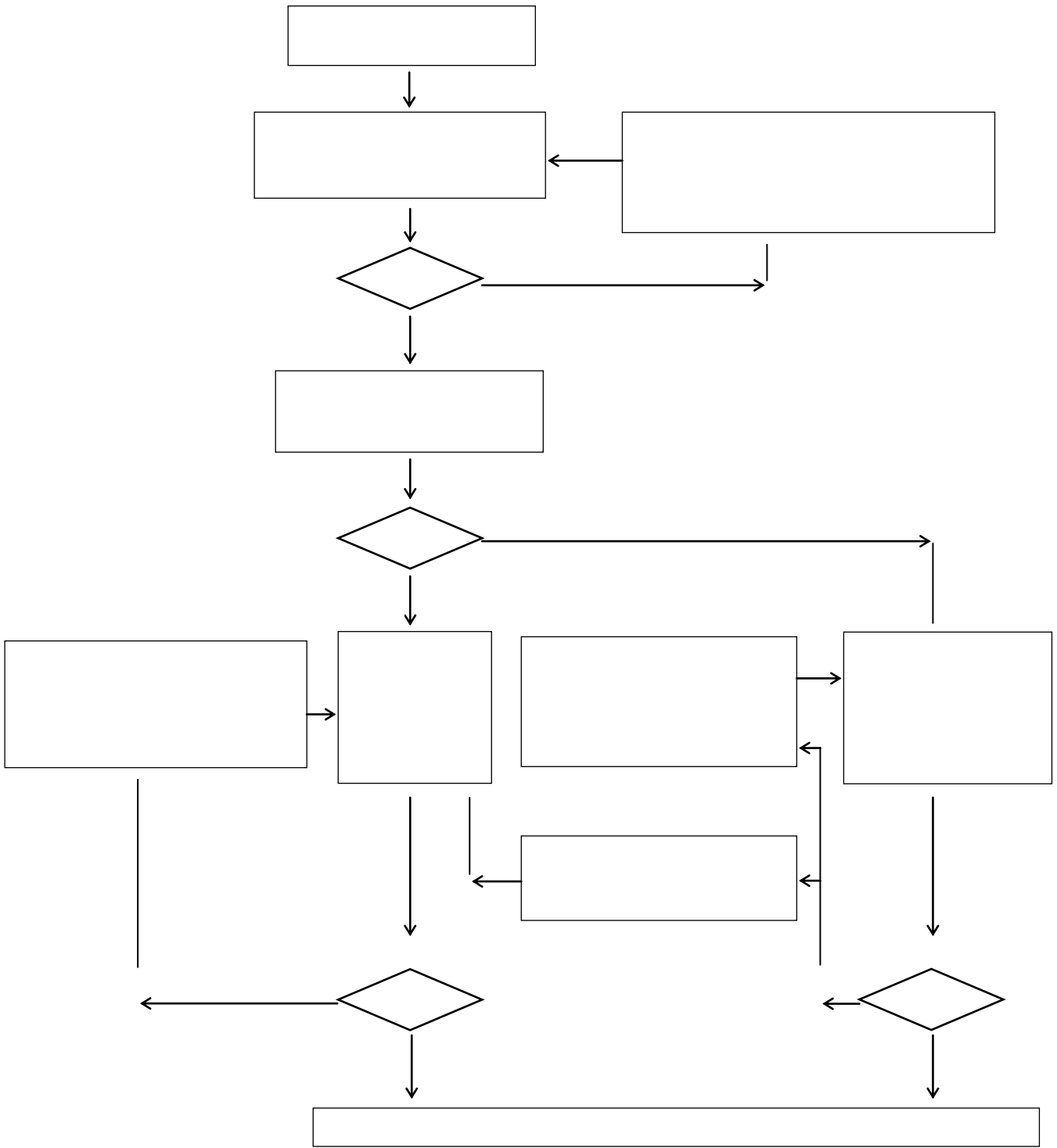
- Appendix A - Flow Chart showing the approval process for pontoon vessel built-in buoyancy and/or sub-division arrangements.
- Appendix B - Example of Buoyancy Certificate with “Lightweight Condition Draught Marks”
- Appendix C - Illustrative Examples
- Appendix D - Built-in Buoyancy Record Form

APPENDIX A

PONTOON BOATS

FLOW CHART ILLUSTRATING PROCESS FOR APPROVAL

OF BUILT-IN BUOYANCY AND/OR SUB-DIVISION ARRANGEMENTS



APPENDIX B
PONTOON BOATS
LIGHTWEIGHT DRAUGHT CONDITION
EXAMPLE BUOYANCY CERTIFICATE

SMALL VESSEL BUOYANCY CERTIFICATE

<u>Vessel Name:</u> REZENEBE	<u>Vessel No.:</u> DTG 0768 R
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Description: Pontoon vessel of Stainless Steel (3CR12) construction operated on Ebenezer dam.

Principal Particulars

Length Overall:	11.600 m	Compartment sub-divisions:	1.200 m
Breadth Overall:	6.000 m	Aft & Fwd Compartments:	1.000 m
Depth (Pontoon):	1.200 m	Pontoon Breadth:	1.200 m

Propulsion The vessel is provided with 2 x 60 hp outboard engine.

Vessel Lightweight Freeboard Marks

(Freeboards measured from top of pontoons)

Fwd Freeboard	745 [mm]
Aft Freeboard	770 [mm]

Vessel Lightweight Inclusive of:

- Engines
- Anchor
- Vessel Equipment
- Safety Equipment

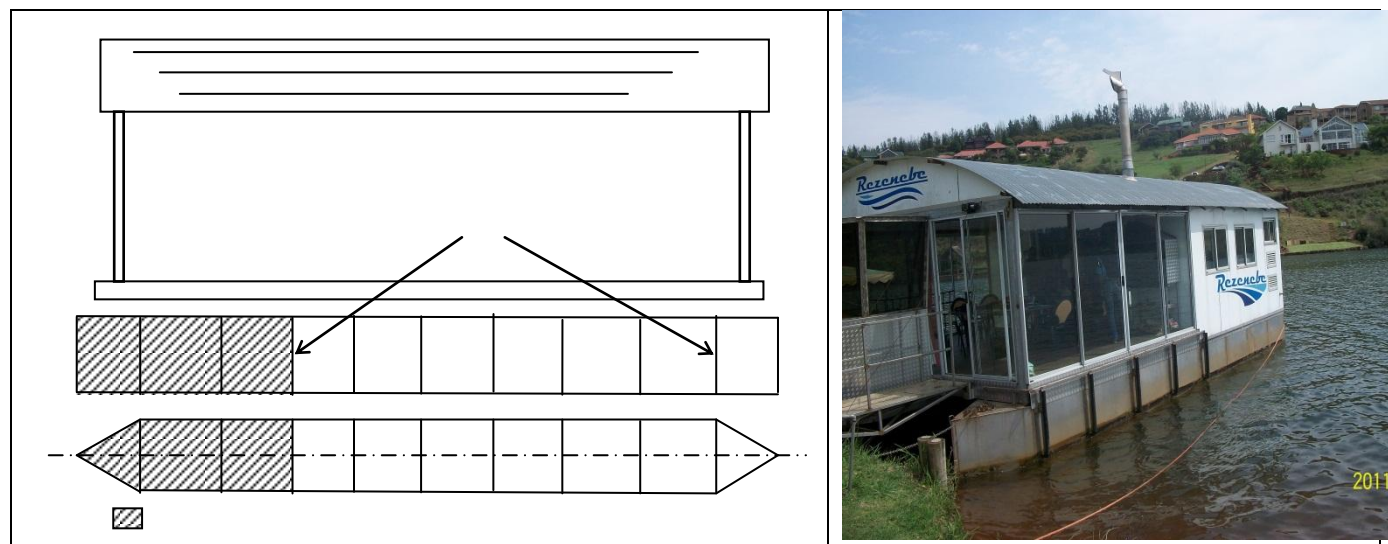
Lightweight freeboard marks provided on the inboard sides of the bow and stern sections.

Vessel Maximum Operational Loads

Max. Number of Persons =	14 x 75 kg =	1050 kg
Fuel load (max) =	130 + 50 =	180 kg
Equipment & crew effects =		<u>350 kg</u>

Vessel Lightweight

Lightweight determined from f/board measurements & Hull Geometry.
Vessel Lightweight ≈ 9900 kg



Survivability in the Event of Damage

1. Vessel buoyancy is provided in the form of two (2) pontoons, internally sub-divided (10 Watertight Compartments).
2. The pontoons are of sealed (welded construction) and no means is provided to drain water from the pontoons in the event of water ingress. It is accordingly required that the vessel remains afloat, without capsizing, in the event of reasonable damage taking place: Extent of Damage = $0.8 + 0.1L = 1.96$ [m].
3. Largest floodable volume = 3 compartments (aft port) = $(2 \times 1.20) + 1.00 = 3.40$ [m]
Reserve of Buoyancy in the Event of Damage (Extent of Damage) ≈ 4300 [litres]

Note: Reserve of buoyancy calculated iwo damaged pontoon with loads assumed evenly distributed.

Conclusion and Comments

1. Pontoon sub-divisions are sufficient to ensure that the vessel will not capsize in the event of damage (See Sketch).
2. Buoyancy of pontoons is sufficient to ensure that the vessel will remain afloat (buoyant) in the event of capsize so that the full complement can hold on to the vessel.
3. The vessel hull condition must be assessed prior to every voyage. If water ingress is suspected the hulls must be inspected, any water found removed and the cause of water ingress repaired prior to the vessel being operated.
4. This buoyancy certificate is valid for the vessel configuration as at the time of inspection. Any modifications or changes in operation which increase the vessel weight or reduce the hulls buoyancy will invalidate this certificate.

Signature (Person Responsible for Built-in Buoyancy
Installation/Watertight Sub-division Evaluation)

Date

APPENDIX C
PONTOON BOATS
EXPANDED ILLUSTRATIVE EXAMPLES
BUILT-IN BUOYANCY CALCULATION

Built-in Buoyancy Calculation

Expanded Illustrative Example

Pontoon Boats

INTRODUCTION

This expanded illustrative example provides guidance on the methods which may be followed to theoretically confirm that pontoon boats are provided with sufficient buoyancy to confirm compliance with the Merchant Shipping (National Small Vessel Safety) Regulations, 2007 ie. In the event of damage (flooding, swamping or capsized) category R pontoon boats are required to remain afloat with sufficient buoyancy to allow the full complement to hold on to the boat.

Persons understanding the principles presented in the illustrative example will be able to provide clear guidance on the amount, type and position of built-in buoyancy or extent of sub-division required to be provided in a pontoon boat (non-passenger vessel) which is to be built or retro-fitted and also to accurately assess the validity of a Buoyancy Certificate presented at the time of survey.

Persons conducting surveys on behalf of SAMSAs are expected to have a sound understanding of the principles and methods of calculation presented in this illustrative example.

In calculating or confirming the requirements for sub-division/built-in buoyancy, the following steps should be followed:

STEP 1 - Confirm the Applicability of the Method This method may be used for pontoon boats vessels of wood, GRP, steel or aluminium construction, provided that the correct factor (K_{factor}) is used (See STEP 5).

STEP 2 - Determine the Lightweight of the Pontoon Boat The most accurate method of establishing the pontoon boat weight is to take the boat and trailer to a weigh-bridge and to obtain a weight print-out. The boat should then be removed from the trailer and a second weight printout obtained. The boat weight can then be determined by deducting the trailer weight from the boat and trailer weight.

An alternative method could be to suspend the boat from slings from a crane or gantry with a calibrated load cell fitted in line.

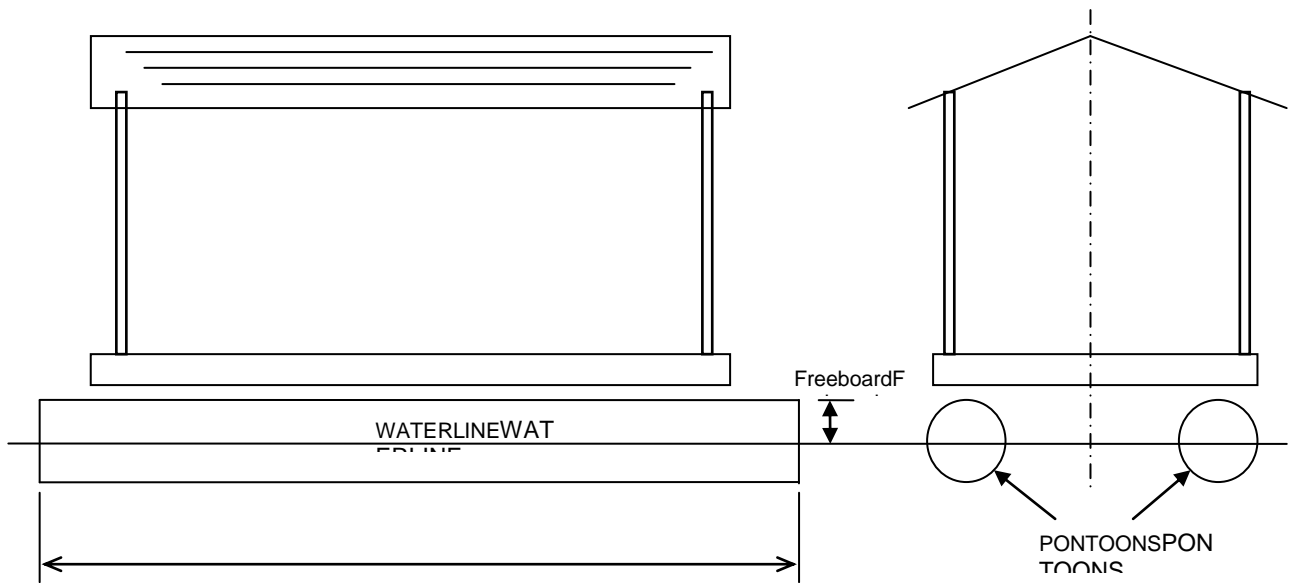
Eg.	Boat and trailer Weight =	2600 kg
	Less Trailer Weight =	820 kg
	Less Engines weight =	<u>100 kg</u>
	Boat Lightweight =	<u>1680 kg</u>

A third possibility exists for pontoon boats, particularly those which are not trailer-borne, in that the shapes of the pontoons are normally such that the underwater volume of the hull can be relatively easily calculated from Archimedes Principle.

Archimedes Principle states that when a body is partially or completely immersed in a fluid, it appears to suffer a loss of mass equal to the mass of the fluid it displaces.

If therefore we are able to calculate the mass of the fluid which the pontoons displace then that mass is equal to the mass of the pontoon boat.

Expanded Illustrative Example – Pontoon Boats (continued)



Drawing 1 - Schematic of Pontoon Boat

Using Archimedes Principle the mass of the boat may be calculated from the formula:

MASS BOAT = MASS OF WATER DISPLACED BY PONTOONS (M_w) (Shaded Area's on Drawing 1)

ie. $M_B = M_w = V_w \times SG \dots\dots\dots (1)$

with; $V_w =$ Volume of submerged pontoons
 $SG =$ Specific Gravity of Water
 ≈ 1.0 for Fresh Water

In the above formula, the calculation of the volume of the submerged pontoons may be easily carried out if the area of the hull sections and length of the pontoon at the waterline is known. ie.

$V_w = A_{\text{UNDERWATER HULL SECTION}} \times L_{\text{WATERLINE}} \dots\dots\dots (2)$

The following typical hull sections may be found on pontoon boats:

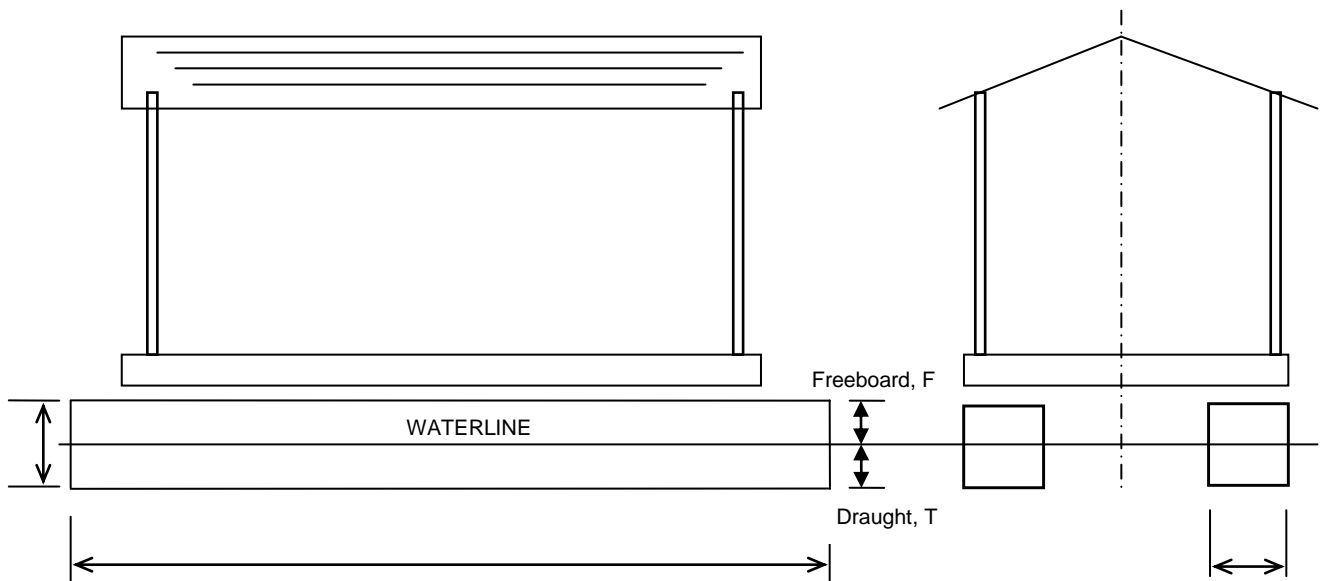
Rectangular Hull Section	Triangular Hull Section	Circular Hull Section	Conventional Hull Section

Drawing 2 - Sketch of Typical Pontoon Boat Hull Sections

Expanded Illustrative Example – Pontoon Boats (continued)

The area of the hull section can normally be calculated relatively easily eg.

For a pontoon vessel with rectangular hull sections:



Drawing 3 - Sketch of Pontoon Boat with Rectangular Hull Sections (Dimensions in mm)

For the example shown above, the Mean Draught of the pontoon boat in the water is measured as being 280 [mm].

$$\text{Note: Mean Draught} = \frac{\text{DRAUGHT}_{\text{FORWARD}} + \text{DRAUGHT}_{\text{AFT}}}{2}$$

$$\begin{aligned} \text{In Equation 2 - } V_w &= A_{\text{UNDERWATER HULL SECTION}} \times L_{\text{WATERLINE}} \\ &= 2 \times (0.500 \times 0.280) \times 6.00 \quad (\text{For 2 x Pontoons}) \\ &= 2 \times 0.140 \times 6.00 \\ &= \underline{1.680 \text{ [m}^3\text{]}} \text{ or } \underline{1680 \text{ [litres]}} \end{aligned}$$

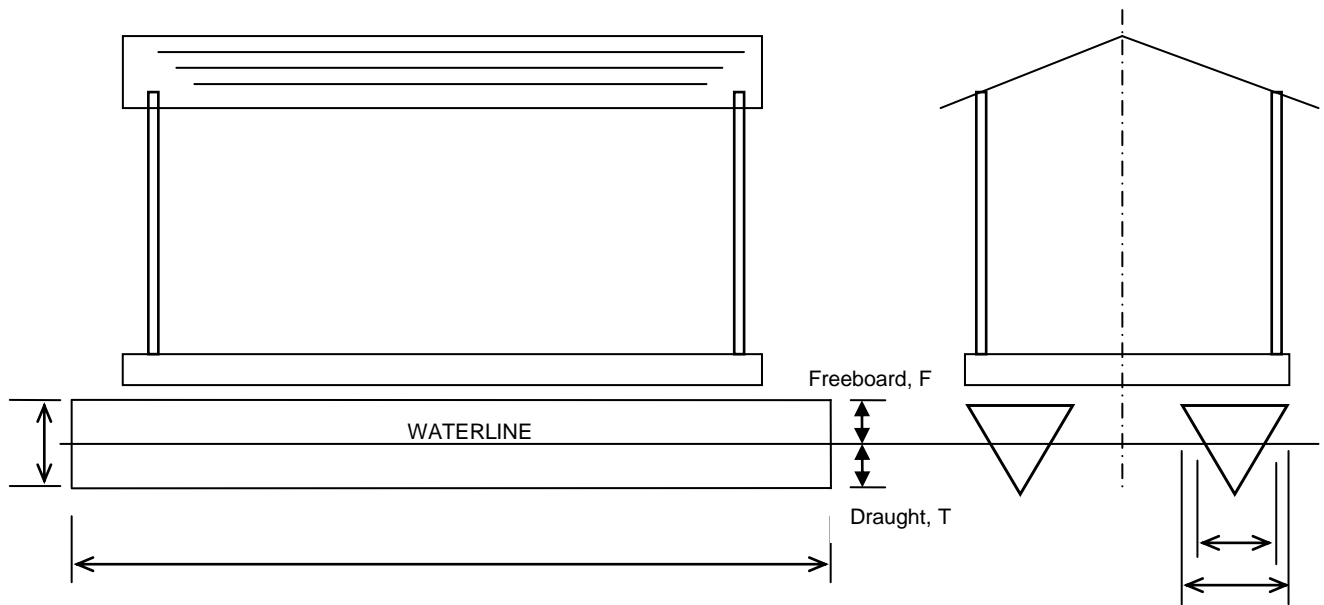
$$\begin{aligned} \text{In Equation 1 - } M_w &= V_w \times SG \\ &= 1.680 \times 1.0 \\ &= \underline{1.680 \text{ [tonnes]}} \text{ or } \underline{1680 \text{ [kg]}} \\ &= M_B \end{aligned}$$

Therefore; The Light Weight of the Pontoon Boat equals

Boat Weight	1680 [kg]	
Less Engine Weight	<u>100 [kg]</u>	(Mean Draught measured with engines attached in this eg)
	<u>1580 [kg]</u>	

Expanded Illustrative Example – Pontoon Boats (continued)

For a pontoon vessel with triangular hull sections:



Drawing 3 - Sketch of Pontoon Boat with Triangular Hull Sections (Dimensions in mm)

For the example shown above, the Mean Draught of the pontoon boat in the water is measured as being 500 [mm].

Note: Mean Draught = $\frac{\text{DRAUGHT}_{\text{FORWARD}} + \text{DRAUGHT}_{\text{AFT}}}{2}$

In Equation 2 - $V_w = A_{\text{UNDERWATER HULL SECTION}} \times L_{\text{WATERLINE}}$
 $= 2 \times (\frac{1}{2} \times B_{\text{WATERLINE}} \times \text{Draught}) \times 6.00$ (For 2 x Pontoons)
 $= 2 \times (\frac{1}{2} \times 0.550 \times 0.500) \times 6.00$
 $= 2 \times 0.1375 \times 6.00$
 $= \underline{1.650 \text{ [m}^3\text{]}}$ or $\underline{1650 \text{ [litres]}}$

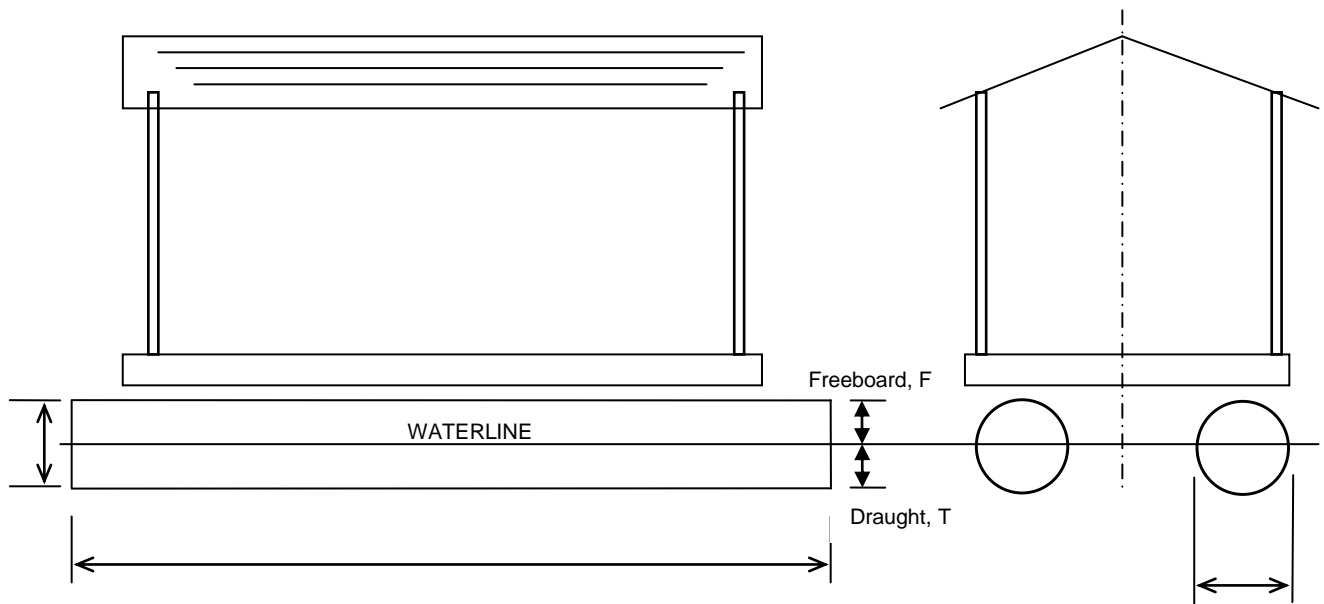
In Equation 1 - $M_w = V_w \times SG$
 $= 1.650 \times 1.0$
 $= \underline{1.650 \text{ [tonnes]}}$ or $\underline{1650 \text{ [kg]}}$
 $= M_B$

Therefore; The Light Weight of the Pontoon Boat equals

Boat Weight	<u>1650 [kg]</u>	
Less Engine Weight	<u>100 [kg]</u>	(Mean Draught measured with engines attached in this eg)
	<u>1550 [kg]</u>	

Expanded Illustrative Example – Pontoon Boats (continued)

For a pontoon vessel with circular hull sections:



Drawing 3 - Sketch of Pontoon Boat with Circular Hull Sections (Dimensions in mm)

For the example shown above, the Mean Draught of the pontoon boat in the water is measured as being 290 [mm].

Note: Mean Draught =
$$\frac{\text{DRAUGHT}_{\text{FORWARD}} + \text{DRAUGHT}_{\text{AFT}}}{2}$$

In Equation 2 -
$$V_w = A_{\text{UNDERWATER HULL SECTION}} \times L_{\text{WATERLINE}}$$

$$= 2 \times \left(\frac{\text{Draught, } T}{\text{Pontoon Diameter, } D} \right) \times \pi \times D^2 / 4 \times 6.00 \quad (\text{For 2 x Pontoons})$$

$$= 2 \times \left(\frac{0.290}{0.600} \right) \times \pi \times 0.60^2 / 4 \times 6.00$$

$$= 2 \times 0.483 \times 0.283 \times 6.00$$

$$= \underline{1.640 \text{ [m}^3\text{]}} \text{ or } \underline{1640 \text{ [litres]}}$$

In Equation 1 -
$$M_w = V_w \times SG$$

$$= 1.640 \times 1.0$$

$$= \underline{1.640 \text{ [tonnes]}} \text{ or } \underline{1640 \text{ [kg]}}$$

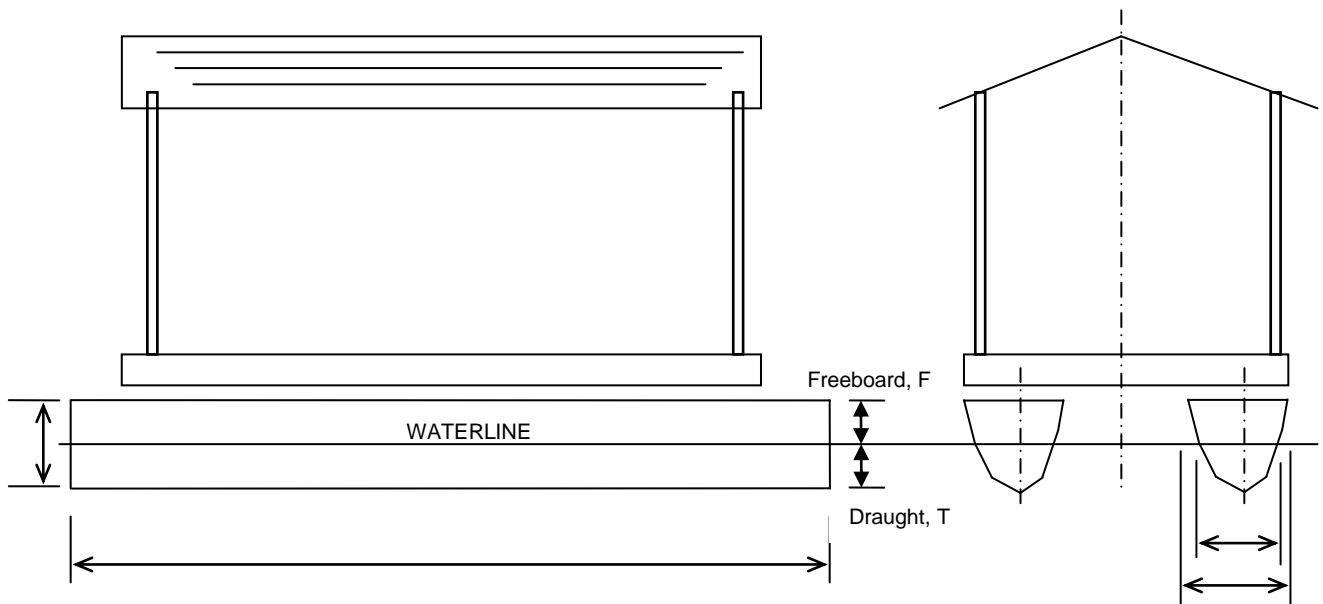
$$= M_B$$

Therefore; The Light Weight of the Pontoon Boat equals

	Boat Weight	1640 [kg]	
Less	Engine Weight	<u>100 [kg]</u>	(Mean Draught measured with engines attached in this eg)
		<u>1540 [kg]</u>	

Expanded Illustrative Example – Pontoon Boats (continued)

For a pontoon vessel with conventional monohull shaped hull sections:



Drawing 3 - Sketch of Pontoon Boat with Conventional Monohull Shaped Hull Sections (Dimensions in mm)

For the example shown above, the Mean Draught of the pontoon boat in the water is measured as being 500 [mm].

Notes: Mean Draught = $\frac{\text{DRAUGHT}_{\text{FORWARD}} + \text{DRAUGHT}_{\text{AFT}}}{2}$

If the area of the hull section cannot be calculated by simple geometry equations then the area of the hull section may be calculated from the equation:

$$A_{\text{UNDERWATER HULL SECTION}} = C_p \times B_{\text{WATERLINE}} \times \text{Draught} \quad \text{with } C_p = 0.6$$

$$= 0.6 \times B_{\text{WATERLINE}} \times \text{Draught}$$

Then in Equation 2 -

$$V_w = A_{\text{UNDERWATER HULL SECTION}} \times L_{\text{WATERLINE}}$$

$$= 2 \times (0.6 \times B_{\text{WATERLINE}} \times \text{Draught}) \times 6.00 \quad (\text{For 2 x Pontoons})$$

$$= 2 \times (0.6 \times 0.550 \times 0.500) \times 6.00$$

$$= 2 \times 0.1380 \times 6.00$$

$$= \underline{1.656 \text{ [m}^3\text{]}} \quad \text{or} \quad \underline{1656 \text{ [litres]}}$$

In Equation 1 -

$$M_w = V_w \times SG$$

$$= 1.656 \times 1.0$$

$$= \underline{1.656 \text{ [tonnes]}} \quad \text{or} \quad \underline{1656 \text{ [kg]}}$$

$$= M_B$$

Therefore; The Light Weight of the Pontoon Boat equals

Boat Weight	1656 [kg]	
Less Engine Weight	<u>100 [kg]</u>	(Mean Draught measured with engines attached in this eg)
	<u>1556 [kg]</u>	

Expanded Illustrative Example – Pontoon Boats (continued)

The preceding sections have illustrated that the light weight (or displacement) of a pontoon boat can normally be calculated relatively easily due to the geometry of the hull sections. There may however be cases where the hull geometry is such that the lightweight cannot be calculated as shown. In these cases a number of alternative methods may be used eg.

- a. Model the hull in a computer (hydrostatics program).
- b. Weigh the pontoon boat

Once the lightweight of the pontoon boat has been calculated, the total weight of the boat is determined as follows:

STEP 3 - **Estimate the Deadweight of the Boat, Cargo and Equipment** Weights which are expected to remain on or contribute to the weight of the vessel in the event of capsizing must be taken into account. These include the weight of the engines, cargo, etc.

Eg. Engines = 100 kg
Equipment = 200 kg (Anchor, Equipment, Safety Equipment, etc)
Total = 300 kg

Note: In the example shown, the boat was weighed with the engines attached. The engine weights were deducted to obtain the boat lightweight and then added as deadweight.

STEP 4 - **Determine the Total Weight of the Boat**

Eg. Total Weight = Lightweight + Deadweight (Lightweight taken from rectangular hull section eg.)
= 1580 kg + 300 kg
= 1880 kg

SUMMARY: STEPS 2 – 4 are followed to determine the **Total Weight of the Boat (Process A)**

Assuming an even weight distribution, each pontoon therefore needs to provide buoyancy for a weight of $1880/2 = 940$ [kg] in operation.

STEP 5 - **Determine the Additional Weight of Built-in Buoyancy (BIB) Required to be Provided for the Boat**

Additional Weight of BIB Required = Total Weight of Boat \times K_{factor}

with; The K_{factor} to be used based on the construction material(s) of the boat

- ie. **Category R Operation (Weight of Crew not considered)**
- | | |
|---|-----------------------------|
| Complete Pontoon Boat of Wood/GRP Construction - | $K_{\text{factor}} = 30\%$ |
| Pontoons of Steel/Aluminium and Structure(s) of Wood/GRP – | $K_{\text{factor}} = 60\%$ |
| Pontoons of GRP/Other Polymer and Structure(s) of Steel/Aluminium - | $K_{\text{factor}} = 60\%$ |
| Complete Pontoon Boat of Steel/Aluminium Construction - | $K_{\text{factor}} = 100\%$ |

Eg. The Pontoon Boat is provided with aluminium pontoon and structures of wood:

Therefore;

Weight of Additional BIB Required = Total Weight of Boat \times K_{factor}
= 1880 \times 60%
= 1128 kg

Expanded Illustrative Example – Pontoon Boats (continued)

STEP 6 - **Determine the Additional Volume of Built-in Buoyancy Required ($V_{BIB\ REQUIRED}$)** The built-in buoyancy volume requirement is calculated taking the specific gravity of the water in which the boat will operate - Fresh water an average specific gravity of 1.0. ie.

$$\begin{aligned} \text{Weight} &= \text{SG} \times \text{Volume} \\ \text{Therefore Volume} &= \text{Weight/SG} \\ &= 1128/1.0 \\ &= \underline{1128 \text{ [litres]}} \text{ or } \underline{1.128 \text{ [m}^3\text{]}} \\ &= V_{BIB\ REQUIRED} \end{aligned}$$

SUMMARY: STEPS 5 & 6 are followed to determine the Volume of Additional Built-in Buoyancy Required to be provided for the Boat (Process B)

STEP 7 - **Evaluate the built-in buoyancy provisions of the pontoon boat for the event of the pontoon boat being in a “damaged” condition (Flooded, Swamped or Capsized)**

A number of configurations may exist for pontoon boats ie. Pontoon boat consisting of:

- a. Two or more pontoon units not sub-divided internally.
- b. Two or more pontoon units, sub-divided.
- c. Numerous independent flotation units (200 litre drums or similar).

The following principles apply for the eventuality of Damage:

- a. Extent of Damage

Pontoon vessels must be able to survive; either:

- i. Flooding of the single largest pontoon/compartment; or,
- ii. Flooding of compartment(s) following damage of length; $L = 0.8 + 0.1L$ [m], whichever of the above results in greater flooding ie. if the largest compartment length; $L > 0.8 + 0.1L$ then only flooding of that compartment must be considered, however if the compartment length; $L \leq 0.8 + 0.1L$, then flooding of compartment(s) resulting in damage of $L = 0.8 + 0.1L$ must be considered.

- b. Minimum Survival Condition following damage

Following a damage event, the vessel must at least remain afloat (upright or capsized) with sufficient positive buoyancy to allow the full complement to hold onto/cling to it.

- c. Acceptable Buoyancy

- i. Void Spaces Void pontoons and/or pontoon spaces may be considered as providing buoyancy in the event of damage provided that they remain watertight with the vessel in the damaged condition ie. if the vessel remains upright then the space(s) must be watertight in this condition, however, if the vessel capsizes the space(s) must then be designed so that they will remain watertight in that condition.

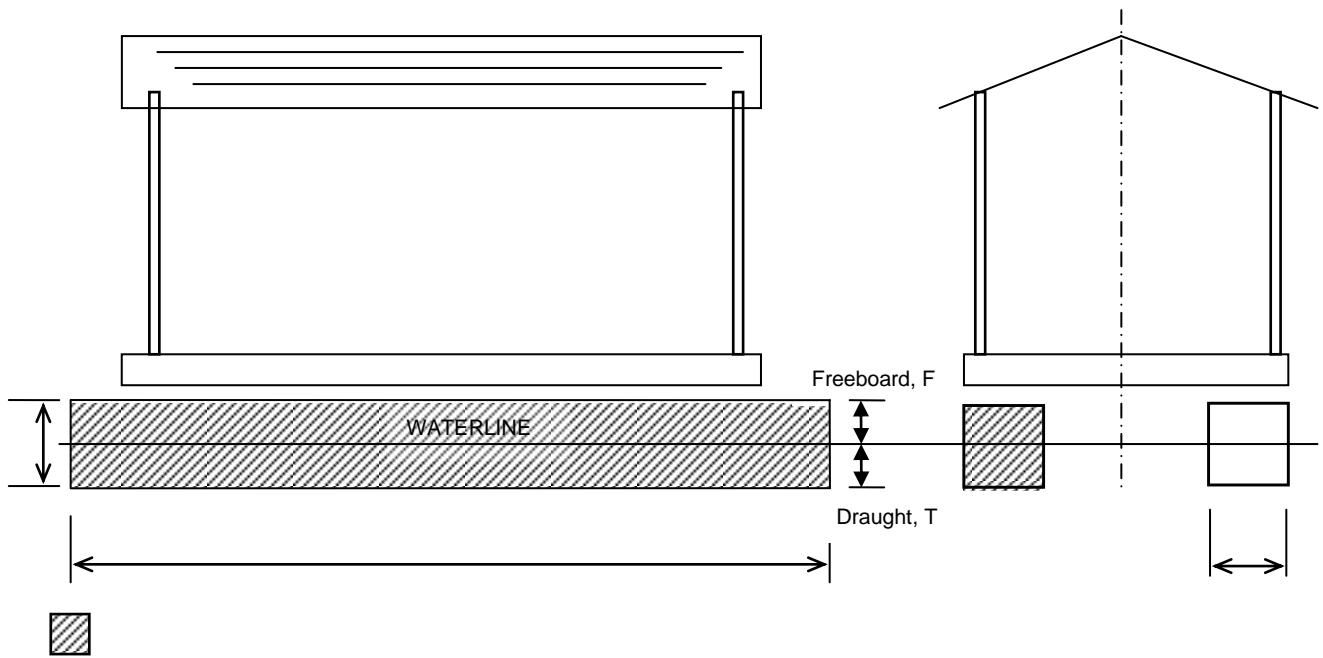
Positive air pressure within void spaces which (arguably) prevents water ingress in the event of damage is not considered acceptable as built-in buoyancy (This method is too dependent on the specific location of the damage).

- ii. Built-in Buoyancy approved built-in buoyancy may be provided, inside the pontoons and/or in other spaces to ensure that the minimum survival condition following damage is achieved.

Expanded Illustrative Example – Pontoon Boats (continued)

Using the pontoon boat with rectangular hull sections for the illustrative example:

Case 1 - The pontoons are not provided with sub-division



Extent of Damage:

In the event of damage of longitudinal extent equal to or greater than;

$$\begin{aligned}
 0.8 + 0.1 L &= 0.8 + (0.1 \times 6) \\
 &= 0.8 + 0.6 \\
 &= 1.4 \text{ [m]}
 \end{aligned}$$

In the event of the above damage, one complete pontoon will flood. It must therefore be confirmed that:

- a. The remaining pontoon will remain watertight in the event of capsize of the pontoon boat.
- b. The remaining pontoon will provide sufficient buoyancy.

The minimum standard of survivability of a pontoon boat is that in the event of damage (flooding, swamping or capsize) it must remain with sufficient buoyancy to allow the full complement to hold on to it.

The question of whether the pontoon boat will capsize or not is an important one however as in the event of capsize, the surveyor must satisfy him or herself that the remaining pontoon/flotation units will remain watertight.

To establish whether or not the pontoon boat will capsize, the total weight of the boat **plus** the crew **plus** the fuel **plus** any other weights on board must be taken into account eg. The pontoon boat in question is certificated to carry 6 persons.

Therefore; Weight to determine capsize = Total weight of Boat + Weight of Crew + Weight of Fuel

$$\begin{aligned}
 &= 1880 + (6 \times 75) + 20 \\
 &= 2350 \text{ [kg]}
 \end{aligned}$$

Assuming an even weight distribution, each pontoon must therefore support a weight of $2350/2 = 1175$ [kg] in the event of damage ie. If the remaining buoyancy of the damaged pontoon is less than 1175 [kg], the pontoon boat will capsize and it must be ensured that the remaining pontoon/flotation unit(s) will remain watertight and provide sufficient buoyancy for the pontoon boat to remain afloat.

Expanded Illustrative Example – Pontoon Boats (continued)

Minimum Survival Condition following Damage

The volume of the remaining pontoon may be calculated as follows:

$$\begin{aligned} V_{\text{PONTOON}} &= A_{\text{HULL SECTION}} \times L \\ &= 0.6 \times 0.5 \times 6.0 \\ &= 1.800 \text{ [m}^3\text{]} = V_{\text{BUOYANCY OF PONTOON}} \end{aligned}$$

$$\text{From Steps 5 \& 6; } V_{\text{BIB REQUIRED}} = 1.128 \text{ [m}^3\text{]}$$

$$V_{\text{BUOYANCY}} > V_{\text{BIB REQUIRED}}$$

Therefore it can be concluded that in the event of damage, the pontoon boat will capsize, however, the buoyancy of the remaining pontoon will be sufficient to keep the vessel afloat (Provided that the pontoon configuration is such that it will remain watertight in the capsized condition).

Case 1 (Derivative A) - The pontoons are not provided with sub-division, however the pontoons and structure are fabricated from aluminium.

The K_{factor} would now be 100% and revisiting Steps 5 & 6;

$$\begin{aligned} \text{Weight of Additional BIB Required} &= \text{Total Weight of Boat} \times K_{\text{factor}} \\ &= 1880 \times 100\% \\ &= \underline{1880 \text{ kg}} \end{aligned}$$

$$\begin{aligned} \text{Therefore; } V_{\text{BIB REQUIRED}} &= 1880/1.0 \\ &= \underline{1880 \text{ [litres]}} \text{ or } \underline{1.880 \text{ [m}^3\text{]}} \end{aligned}$$

$$\text{The volume of a single pontoon; } V_{\text{PONTOON}} = 1.800 \text{ [m}^3\text{]} = V_{\text{BUOYANCY}}$$

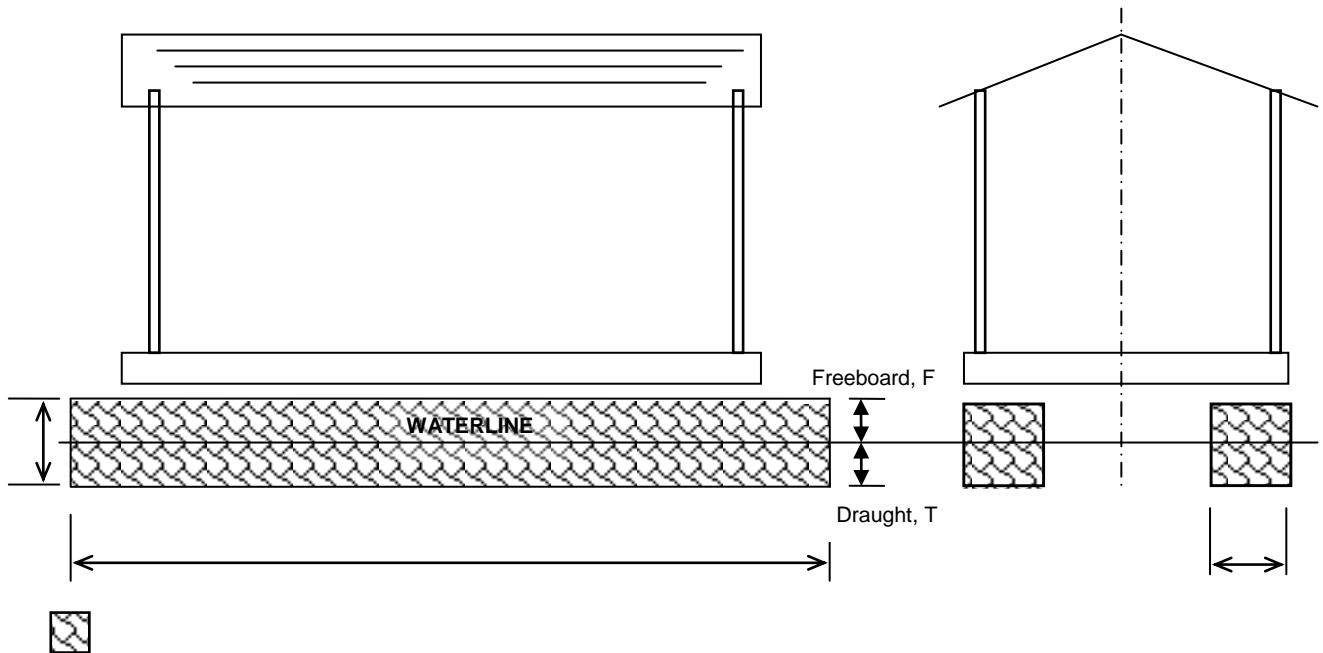
$$V_{\text{BUOYANCY}} < V_{\text{BIB REQUIRED}}$$

Therefore it can be concluded that in the event of damage, the pontoon boat will capsize and sink. The following options must be considered to achieve compliance with the minimum standard:

- a. Reduce the weight of the pontoon boat.
- b. Sub-divide the pontoons
- c. Introduce at least 0.08 [m³] or 80 [litres] of approved Built-in Buoyancy into each pontoon.

Expanded Illustrative Example – Pontoon Boats (continued)

Case 1 (Derivative B) - For the pontoon boat under consideration (Aluminium hull and wood structure). The pontoons are not provided with sub-division, however, arrangements are not in place to ensure that the pontoons remain watertight in the event of capsize. The pontoons are however filled with tightly packed approved bottles).



The volume of built-in buoyancy installed must be calculated. This can be carried out by either counting the number of approved bottles installed or by estimating the **permeability** of the installed Built-in Buoyancy ie.

$$\text{Permeability} = \frac{\text{Volume of Actual Space Filled with Built-in Buoyancy}}{\text{Total Volume of Space in which the Built-in Buoyancy is located}} \times 100 [\%]$$

with values of Built-in Buoyancy Permeabilities as follows:

Foam -	100%
Bottles (Tightly packed) -	60%
Bottles (Loosely packed) -	50%

$$\begin{aligned} \text{Therefore } V_{\text{BIB INSTALLED}} &= \text{Volume Pontoons} \times \text{Permeability} \\ &= 2 \times 1.800 \times 60\% \quad \quad \quad (2 \text{ x pontoons}) \\ &= 2 \times 1.080 \\ &= 2.160 \text{ [m}^3\text{]} \quad \quad \quad (1.080 \text{ [m}^3\text{]} \text{ per pontoon}) \end{aligned}$$

$$V_{\text{BIB REQUIRED}} = 1.128 \text{ [m}^3\text{]}$$

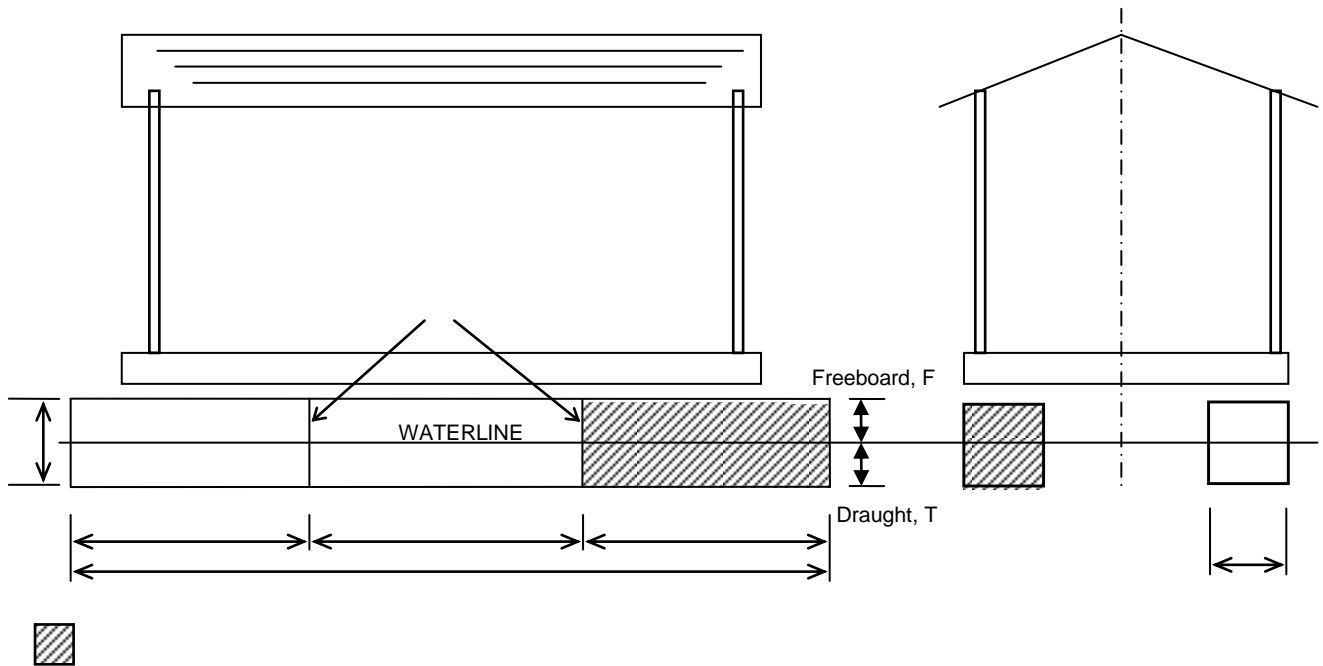
$$V_{\text{BIB INSTALLED}} > V_{\text{BIB REQUIRED}}$$

Remark: While the installed built-in buoyancy is sufficient for the vessel to remain afloat in the event of damage, it can be seen that the vessel can be expected to capsize in the event of damage (1.080 [m³] is less than the total weight of the boat per pontoon of 1175 [kg]). Given the small difference, the owner might be encouraged to install a 95 [kg] of BIB per side to ensure that the vessel does not capsize in the event of damage.

Expanded Illustrative Example – Pontoon Boats (continued)

Using the pontoon boat with rectangular hull sections for the illustrative example:

Case 2 - The pontoons are provided with watertight sub-divisions



Extent of Damage:

In the event of damage of longitudinal extent equal to or greater than;

$$\begin{aligned}
 0.8 + 0.1 L &= 0.8 + (0.1 \times 6) \\
 &= 0.8 + 0.6 \\
 &= 1.4 \text{ [m]}
 \end{aligned}$$

In the event of the above damage, the shaded section of the pontoon will flood. It must therefore be identified whether:

- a. The pontoon boat will capsize as a result of the damage.
- b. In the event of capsize whether the intact sections of the pontoons will remain watertight.
- c. The remaining intact pontoons will provide sufficient buoyancy for the vessel to remain afloat.

Minimum Survival Condition following Damage

The volume of the partially damaged pontoon and intact pontoon may be calculated as follows:

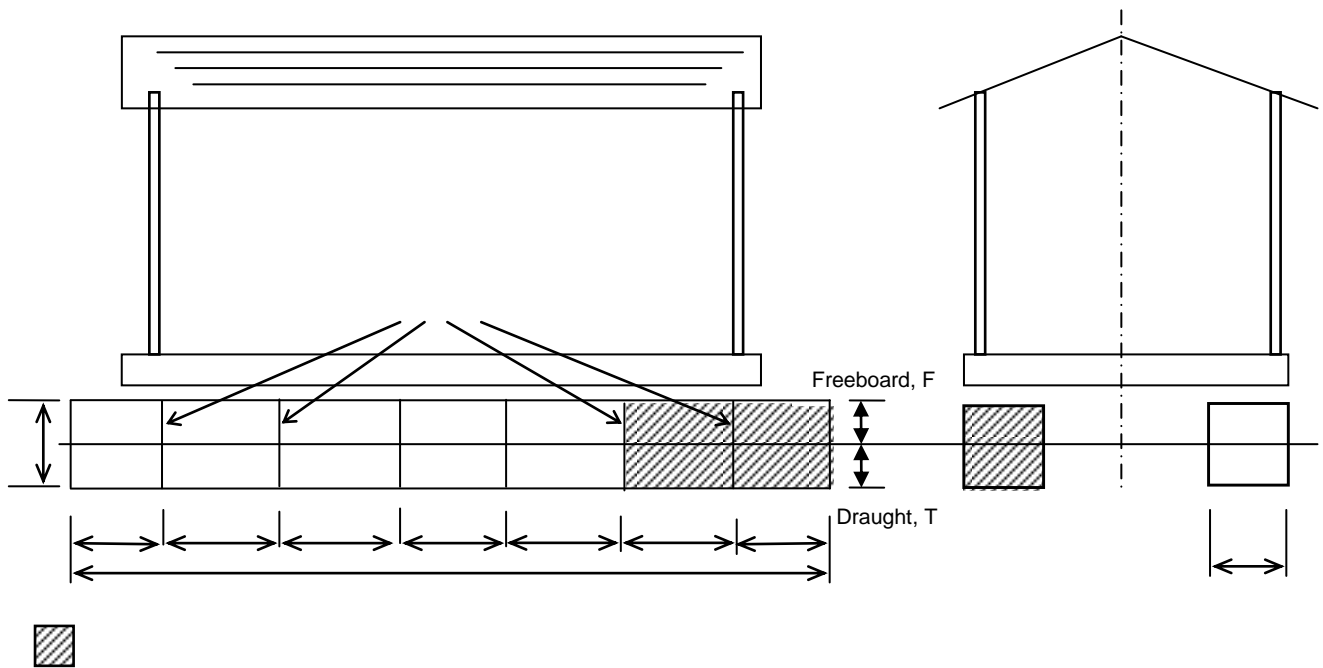
$$\begin{aligned}
 V_{\text{PONTOON}} &= A_{\text{HULL SECTION}} \times L_{\text{UNDAMAGED LENGTH}} + A_{\text{HULL SECTION}} \times L_{\text{PONTOON}} \\
 &= 0.6 \times 0.5 \times 4.0 + 0.6 \times 0.5 \times 6.0 \\
 &= 1.200 + 1.800 \\
 &= 3.000 \text{ [m}^3\text{]} = V_{\text{BUOYANCY OF PONTOONS}}
 \end{aligned}$$

From Steps 5 & 6; $V_{\text{BIB REQUIRED}} = 1.128 \text{ [m}^3\text{]}$
 $V_{\text{BUOYANCY}} > V_{\text{BIB REQUIRED}}$

Therefore it can be concluded that in the event of damage, the pontoon boat will have sufficient buoyancy to remain afloat. It can further be assumed that the pontoon boat will not capsize due to the fact that the remaining 1200 litres of buoyancy in the damaged pontoon will support half of the pontoon boat weight of 1175 [kg] with the buoyancy of the intact pontoon (1800 litres) supporting the other 1175 [kg].

Expanded Illustrative Example – Pontoon Boats (continued)

Case 2 (Derivative A) - The pontoons are provided with watertight sub-divisions



Extent of Damage:

$$\begin{aligned}
 \text{In the event of damage of longitudinal extent equal to or greater than;} & 0.8 + 0.1 L = & 0.8 + (0.1 \times 6) \\
 & = & 0.8 + 0.6 \\
 & = & 1.4 \text{ [m]}
 \end{aligned}$$

In the event of the above damage, the shaded section of the pontoon will flood. It must therefore be identified whether:

- The pontoon boat will capsize as a result of the damage.
- In the event of capsize whether the intact sections of the pontoons will remain watertight.
- The remaining intact pontoons will provide sufficient buoyancy for the vessel to remain afloat.

Minimum Survival Condition following Damage

The volume of the partially damaged pontoon and intact pontoon may be calculated as follows:

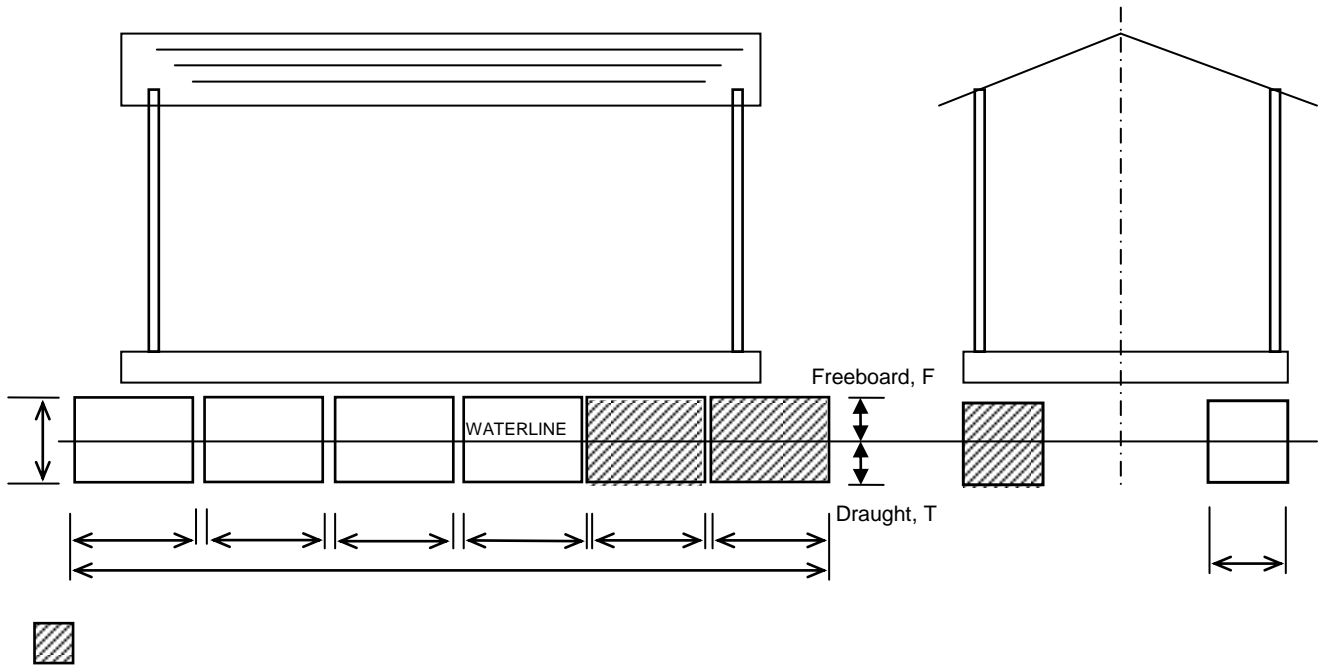
$$\begin{aligned}
 V_{\text{PONTOON}} &= A_{\text{HULL SECTION}} \times L_{\text{UNDAMAGED LENGTH}} & + & A_{\text{HULL SECTION}} \times L_{\text{PONTOON}} \\
 &= 0.6 \times 0.5 \times 4.50 + & 0.6 \times 0.5 \times 6.0 \\
 &= 1.350 & + & 1.800 \\
 &= 3.150 \text{ [m}^3\text{]} & = & V_{\text{BUOYANCY OF PONTOONS}}
 \end{aligned}$$

From Steps 5 & 6; $V_{\text{BIB REQUIRED}} = 1.128 \text{ [m}^3\text{]}$
 $V_{\text{BUOYANCY}} > V_{\text{BIB REQUIRED}}$

Therefore it can be concluded that in the event of damage, the pontoon boat will have sufficient buoyancy to remain afloat. It can further be assumed that the pontoon boat will not capsize due to the fact that the remaining 1350 litres of buoyancy in the damaged pontoon will support half of the pontoon boat weight of 1175 [kg] with the buoyancy of the intact pontoon (1800 litres) supporting the other 1175 [kg].

Expanded Illustrative Example – Pontoon Boats (continued)

Case 3 - The pontoons consist of numerous independent flotation units



Extent of Damage:

$$\begin{aligned}
 \text{In the event of damage of longitudinal extent equal to or greater than;} & 0.8 + 0.1 L = & 0.8 + (0.1 \times 6) \\
 & & = 0.8 + 0.6 \\
 & & = 1.4 \text{ [m]}
 \end{aligned}$$

The extent of damage which the vessel must be able to survive is therefore an event which results in flooding of two (2) flotation units.

In the event of the above damage, the shaded section of the pontoon will flood. It must therefore be identified whether:

- The pontoon boat will capsize as a result of the damage.
- In the event of capsize whether the intact sections of the pontoons will remain watertight.
- The remaining intact pontoons will provide sufficient buoyancy for the vessel to remain afloat.

Minimum Survival Condition following Damage

The volume of the partially damaged pontoon and intact pontoon may be calculated as follows:

$$\begin{aligned}
 V_{\text{PONTOON}} &= V_{\text{DAMAGED SIDE}} & + & V_{\text{UNDAMAGED SIDE}} \\
 &= 4 \times (V_{\text{INTACT FLOTATION UNITS}}) & + & 6 \times (V_{\text{INTACT FLOTATION UNITS}}) \\
 &= 4 \times (0.6 \times 0.5 \times 0.8) & + & 6 \times (0.6 \times 0.5 \times 0.8) \\
 &= 4 \times 0.240 & + & 6 \times 0.240 \\
 &= 0.96 + 1.44 \\
 &= 2.400 \text{ [m}^3\text{]} & = & V_{\text{BUOYANCY OF PONTOONS}}
 \end{aligned}$$

From Steps 5 & 6; $V_{\text{BIB REQUIRED}} = 1.128 \text{ [m}^3\text{]}$

$$V_{\text{BUOYANCY}} > V_{\text{BIB REQUIRED}}$$

Therefore it can be concluded that in the event of damage, the pontoon boat will have sufficient buoyancy to remain afloat. It can further be assumed that the pontoon boat will capsize due to the fact that the remaining 960 litres of buoyancy in the damaged pontoon will support half of the pontoon boat weight of 1175 [kg]. It must therefore be confirmed that the flotation units will remain watertight in the capsized condition.

STEP 8 - A Buoyancy Certificate must be generated for the vessel (See Appendix A for Example).

APPENDIX D
PONTOON BOATS
BUILT-IN BUOYANCY RECORD FORM

PONTOON BOATS BUILT-IN BUOYANCY RECORD FORM

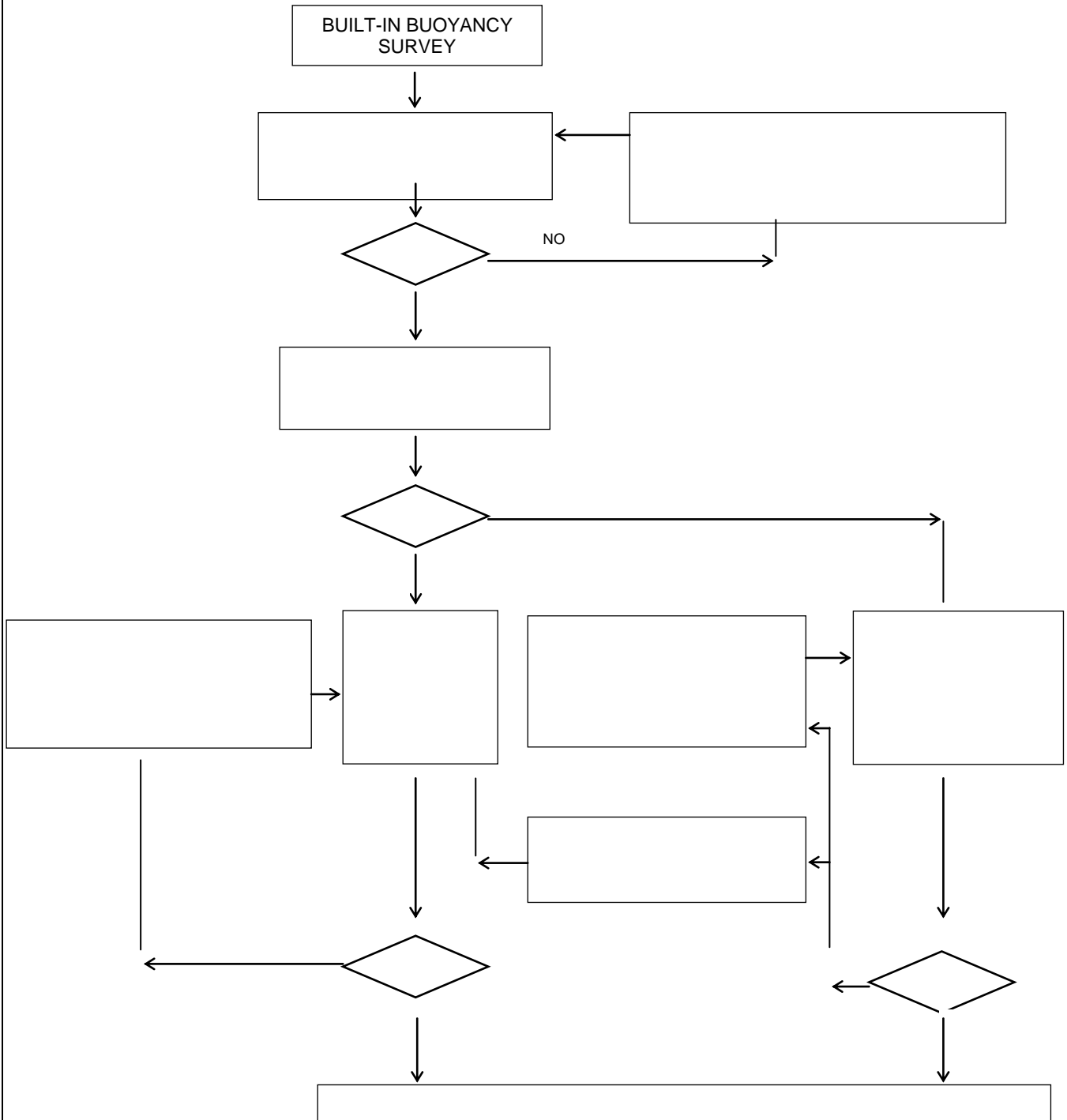
This form may only be used by surveyors to confirm the built-in buoyancy provisions of category R pontoon boats which are not passenger vessels.

Criteria 1: All vessels must have provisions in place to allow the condition of the hulls to be determined prior to the vessel being operated and/or during operation (All vessels must comply with these criteria).

Criteria 2: Provisions must be in place to empty water from the hulls in the event of water ingress taking place.

If criteria 1 and criteria 2 are complied with and pontoons will remain watertight in the event of capsize or pontoons are filled with Built-in Buoyancy; then complete **PARTS A, B, C & D.**

If criteria 1 is complied with but not criteria 2; then complete **PARTS A, B, E & F.**



Flow Chart – Summary of Process for Approval of Pontoon Vessel Built-in Buoyancy and/or Sub-division

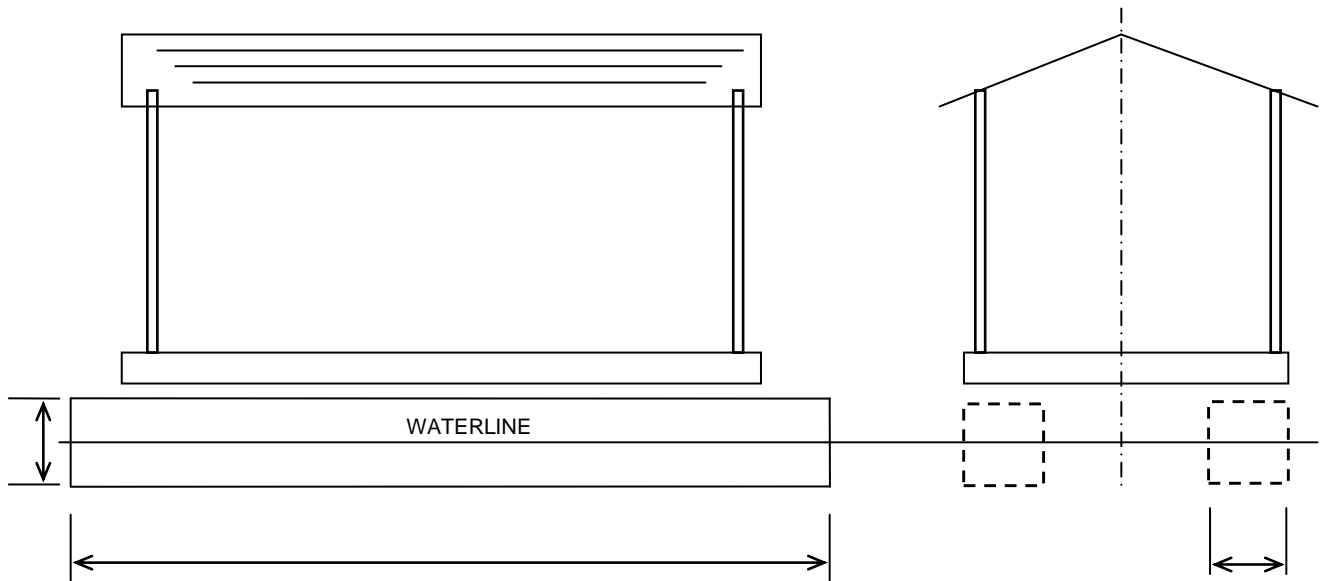
PART A - GENERAL INFORMATION & VESSEL PARTICULARS

Name of Vessel: _____ Off No. _____

Owner/Representative: _____ Date: _____

Surveyor(s): _____

Description of Vessel Operation:



With reference to the sketch above; List the following vessel particulars:

- a. Length Overall; L = _____ [m]
- b. Pontoon Depth; D = _____ [m]
- c. Pontoon Breadth; B = _____ [m]

PART B - CALCULATION OF VESSEL LIGHT WEIGHT

The vessel lightweight is defined as the weight of the boat plus items fixed to the boat (eg. engines, batteries, anchors) which will remain attached to the boat in the event of capsize.

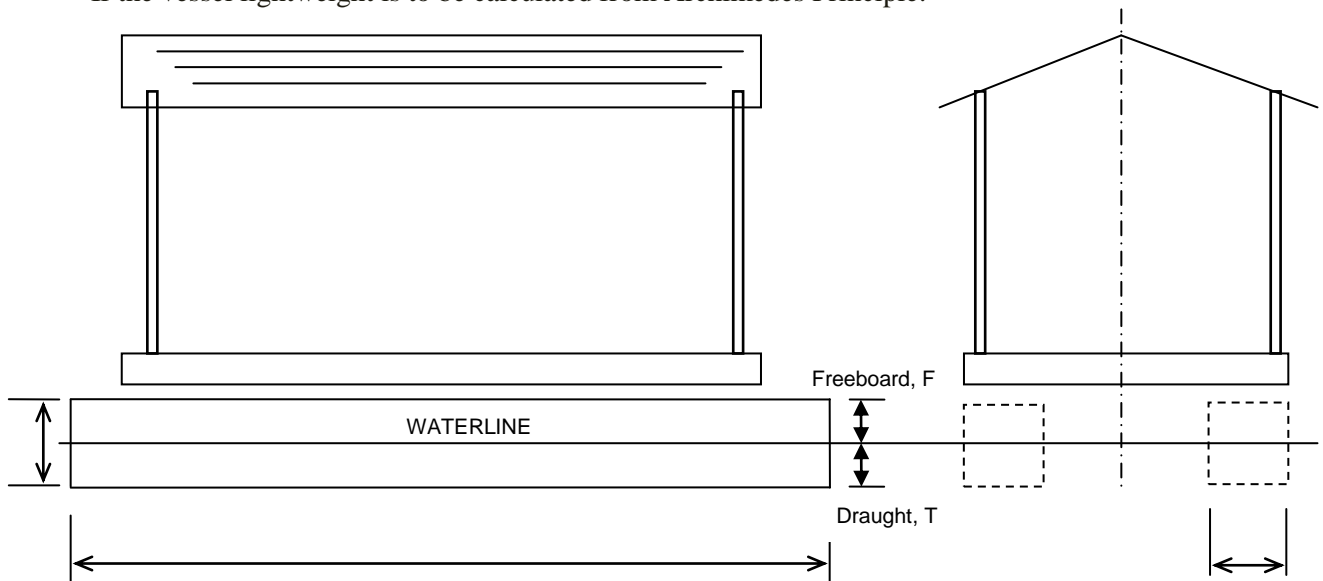
The vessel lightweight may either be obtained by weighing the vessel or by Archimedes Principle (Weight of Boat = Weight of water displaced by the Boat)

If the weight of the boat has been obtained by weighing complete the below table:

Description	Weight [kg]
Weight of Boat as weighed	
Add engine weights	
Add other fixed weights	
Add other fixed weights	
Therefore; Lightweight of Boat =	

Table 1

If the vessel lightweight is to be calculated from Archimedes Principle:



$$M_w = V_w = A_{\text{UNDERWATER HULL SECTIONS}} \times L_{\text{WATERLINE}} \dots (2)$$

With reference to the illustrative example (Appendix B) Calculate the weight of the pontoon boat using Equation (2) in the space provided on the following page and then complete Table 1.

Summary of Vessel Lightweight condition:

DESCRIPTION	PORT [mm]	STBD [mm]	MEAN [mm]
Freeboard Aft			
Freeboard Fwd			

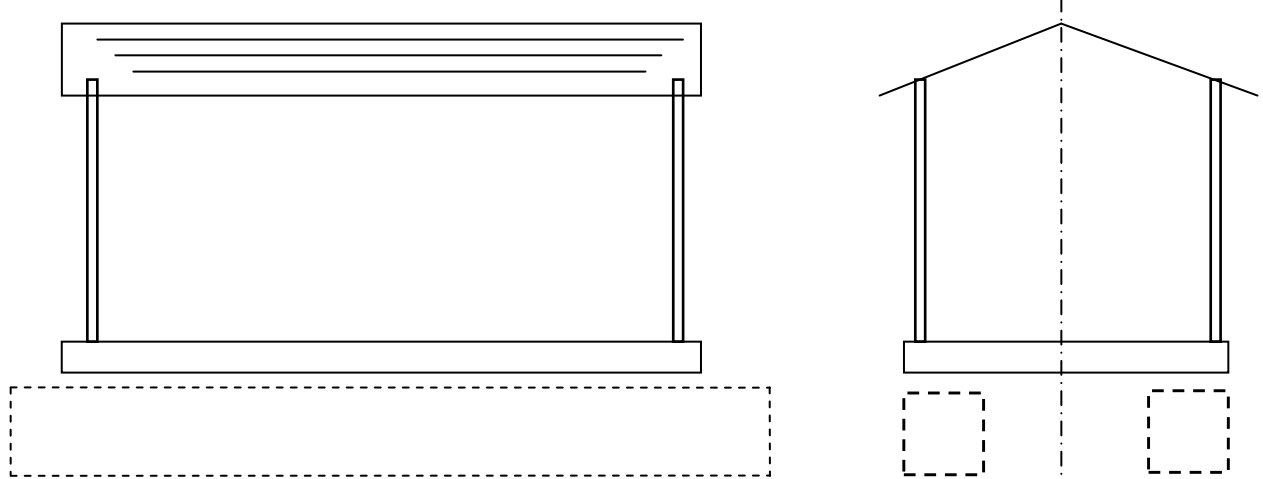
No.	Description of Weights included in Vessel Lightweight
1.	Vessel Hull & Structure
2.	
3.	
4.	
5.	
6.	
7.	

PART D - CALCULATE PONTOON BUOYANCY FOLLOWING DAMAGE

Calculate the pontoon vessel buoyancy following damage (Damage = Extent of Damage or Largest Floodable Compartment, whichever is the greatest).

Extent of Damage = $0.8 + 0.1L$ = _____ [m]

Sketch the pontoon vessel configuration and resultant flooding as a result of the above "Extent of Damage"



Calculate: $V_{BUOYANCY} = V_{DAMAGED\ PONTOON} + V_{UNDAMAGED\ PONTOON}$
 $V_{DAMAGED\ PONTOON} =$ _____

 _____ [m³]

Note: The volume of the damaged pontoon is equal to the buoyancy which the pontoon will retain following damage. This buoyancy may be a result of pontoon sub-division or Built-in Buoyancy or both).

$V_{UNDAMAGED\ PONTOON} =$ _____

 _____ [m³]

Therefore; $V_{BUOYANCY} =$ _____ [m³]
 $V_{BIB\ REQUIRED} =$ _____ [m³] (from Part C)
 $V_{BUOYANCY} > V_{BIB\ REQUIRED} ?$ YES / NO (Circle correct answer)

If Yes - Vessel is in compliance with NSVR; If No - Vessel is not in compliance with NSVR

Reserve of Buoyancy = $V_{BUOYANCY} - V_{BIB\ REQUIRED} =$ _____ [m³]

PART E - CALCULATE THE WEIGHTS FOR CAPSIZE CONDITION OF THE BOAT

Complete the table below:

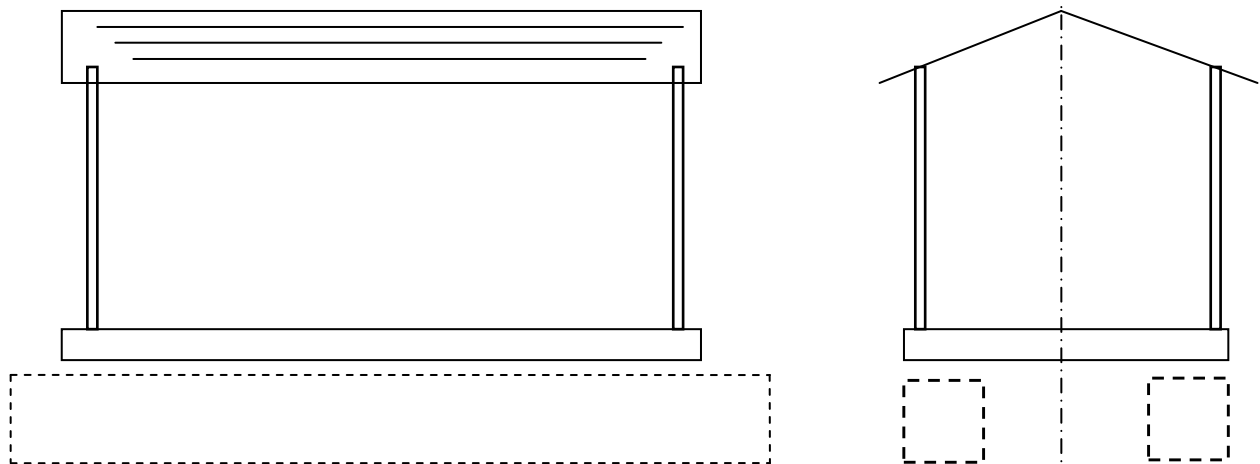
Description	Weight [kg]
Lightweight of Boat (from Part B)	
Add Crew Weight (75 kg per person)	
Add Fuel Weight	
Add Miscellaneous Weights_1	
Add Miscellaneous Weights_2	
Therefore; Total Weight of Boat =	
$\div 2$	
Min. Required Pontoon Buoyancy to avoid Capsize; $V_{CAPSIZE} =$	[m³]

PART F - CALCULATE PONTOON BUOYANCY FOLLOWING DAMAGE

With reference to the Illustrative Example (Appendix C), calculate the pontoon vessel buoyancy following damage

Extent of Damage = $0.8 + 0.1L =$ _____ [m]

Sketch the pontoon vessel configuration and resultant flooding as a result of the above "Extent of Damage"



Calculate: $\frac{V_{BUOYANCY}}{V_{DAMAGED\ PONTON}} = V_{DAMAGED\ PONTON}$ (Pontoon Vessel may not capsize)

_____ [m³]

Note: The volume of the damaged pontoon is equal to the buoyancy which the pontoon will retain following damage. This buoyancy may be a result of pontoon sub-division or Built-in Buoyancy or both.

$V_{DAMAGED\ PONTON} > V_{CAPSIZE} ?$ YES / NO

If Yes – Vessel is in compliance with NSVR; If No – Vessel is not in compliance with NSVR

Reserve of Buoyancy (To avoid capsizing) = $V_{BUOYANCY} - V_{BIB\ REQUIRED} =$ _____ [m³]