ISO 12217-1 NON-SAILING BOATS OF LENGTH GREATER THAN OR EQUAL TO 6 m CALCULATION WORKSHEET No. 1

Design: PD1000

| Design category intended: | Monohull / multihull: multihull | | | | | | |
|--|---------------------------------------|----------------|------------|------------|--|--|--|
| Item | Symbol | Unit | Value | Ref. | | | |
| Length of hull as in ISO 8666 | L _H | m | 10,00 | 3.3.1 | | | |
| Length waterline in loaded arrival condition | L_{WL} | m | 9,29 | 3.3.2 | | | |
| Empty craft condition mass | m _{EC} | kg | 6440 | 3.4.1 | | | |
| standard equipment | | kg | 240 | 3.5.12 | | | |
| water ballast in tanks which are notified in the owner's manual to be filled whenever the boat is afloat | | kg | 0 | 3.4.2 | | | |
| <u>Light craft condition mass</u> = m_{EC} + standard equipment + ballast | $m_{\sf LC}$ | kg | 6680 | 3.4.2 | | | |
| Mass of: | | | | | | | |
| Desired Crew Limit | CL | — | 8 | 3.5.3 | | | |
| Mass of: | | | | | | | |
| desired Crew Limit at 75 kg each | | kg | 600 | 3.4.4 | | | |
| provisions + personal effects | | kg | 320 | 3.4.4 | | | |
| drinking water | | kg | 475 | 3.4.4 | | | |
| fuel | | kg | 160 | 3.4.4 | | | |
| lubricating and hydraulic oils | | kg | 10 | 3.4.4 | | | |
| black water | | kg | 475 | 3.4.4 | | | |
| grey water | | kg | 475 | 3.4.4 | | | |
| any other fluids carried aboard (e.g. in bait tanks) | | kg | 0 | 3.4.4 | | | |
| stores, spare gear and cargo (if any) | | kg | 0 | 3.4.4 | | | |
| optional equipment and fittings not included in basic outfit | | kg | 20 | 3.4.4 | | | |
| inflatable liferaft(s) in excess of essential safety equipment | | kg | 0 | 3.4.4 | | | |
| other small boats carried aboard | | kg | 0 | 3.4.4 | | | |
| margin for future additions | | kg | 50 | 3.4.4 | | | |
| Maximum load = sum of above masses | m_{L} | kg | 2585 | 3.4.4 | | | |
| <u>Maximum load condition mass</u> = $m_{LC} + m_{L}$ | m _{LDC} | kg | 9265 | 3.4.5 | | | |
| mass to be removed for loaded arrival condition | | kg | 693 | 3.4.6 | | | |
| Loaded arrival condition mass | m_{LA} | kg | 8572 | 3.4.6 | | | |
| Mass of: | | | | | | | |
| minimum number of crew according to 3.4.3 | | kg | 150 | 3.4.3a) | | | |
| non-consumable stores and equipment normally aboard | | kg | 20 | 3.4.3b) | | | |
| inflatable liferaft | | kg | Õ | 3.4.3 | | | |
| Load to be included in minimum operating condition | m' | kg | 170 | 3.4.3 | | | |
| Light craft condition mass | m_{LC} | kg | 6680 | 3.4.2 | | | |
| <u>Mass in the minimum operating condition</u> = $m_{LC} + m'_{L}$ | m _{MO} | kg | 6850 | 3.4.3 | | | |
| Is boat sail or non-sail? | | | | 3.1.2, 5.2 | | | |
| reference sail area according to ISO 8666 | As | m ² | 0 | 3.3.8 | | | |
| sail area / displacement ratio = $A_{\rm S}/(m_{\rm LDC})^{2/3}$ | , , , , , , , , , , , , , , , , , , , | _ | Ĭ | 3.1.2, 5.2 | | | |
| <u>CLASSIFIED AS</u> [non-sail if $A_{\rm S}/(m_{\rm LDC})^{2/3} < 0,07$] | L/NON-SAIL? | NON-SAIL | 3.1.2, 5.2 | | | | |
| NB: If NON-SAIL, continue using these wo | rksheets, if SA | IL, use ISO 12 | 217-2 | | | | |
| | | | | | | | |

TESTS TO BE APPLIED

| Question | | | Answer | Ref. |
|------------------------------|--------------------------|---------|--------|-------|
| Is boat fully enclosed? | (see definition in ref.) | YES/NO? | YES | 3.1.6 |
| Is boat partially protected? | (see definition in ref.) | YES/NO? | | 3.1.7 |

| ltem | Symbol | Unit | Value | Ref. |
|--|----------------|----------------|-------|-------|
| Windage area in minimum operating condition | A_{LV} | m ² | 28,58 | 3.3.7 |
| Length waterline in loaded arrival condition | L_{WL} | m | 9,29 | 3.3.2 |
| Beam of hull | B _H | m | 3,97 | 3.3.3 |
| Ratio $A_{LV}/(L_{WL} B_{H})$ | | _ | 0,775 | |

Choose any ONE of the following options, and use all the worksheets indicated for that option.

| Option | | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------|----------------|-------------------|-------------------|---------------|----------------|------------------------|----------------|
| categories pos | sible | A and B | C and D | В | C and D | C and D | C and D |
| decking or cove | ering | fully enclosed | fully enclosed | any amount | any amount | partially protected | any amount |
| downflooding c | openings | 3 | 3 | 3 | 3 | 3 | 3 |
| downflooding a | ingle | 3 | | 3 | | | |
| downflooding | all boats | 3 | 3 | 3 | 3ª | 3 | 3 |
| height test | Annex A method | 4 | 4 | 4 | 4 ^a | 4 | 4 |
| offset load test | | 5 | 5 | 5 | 5 | 5 | 5 |
| resistance to w | aves + wind | 6 | | 6 | | | |
| heel due to wir | id action | | 7 ^b | | 7 ^b | 7 ^b | 7 ^b |
| recess size | | 8 | 8 c | | | | |
| habitable multil | hulls | 9 | 9 | 9 | 9 | 9 | 9 |
| motor sailers | | 9 | 9 | 9 | 9 | 9 | 9 |
| flotation test | | | | 10 | 10 | | |
| flotation material | | | | 10 | 10 | | |
| detection & ren | noval of water | 11 | 11 | 11 | 11 | 11 | 11 |
| SUMMARY | | 12 | 12 | 12 | 12 | 12 | 12 |
| | | | | | | | |

The downflooding height test is not required to be conducted on the following design category C and D boats:
those which, when tested in accordance with F.4, have been shown to support, in addition to the mass required by F.2 and Table F.5, an additional equivalent dry mass (kg) of (75CL + 10 % of dry mass of stores)

and equipment included in the maximum total load), or

those boats that do not take on water when heeled to 90° from the upright in the light craft condition.

^b The application of Worksheet 7 is only required for boats where $A_{LV}/(L_{WL} B_H) > 0.5$.

^c Only required for boats of design category C.

Option selected

2

DOWNFLOODING

Downflooding openings: (all boats)

| Question | | Answer | Ref. |
|---|--------|---------|---------|
| Have all appropriate downflooding openings been identified? | YES/NO | YES | 3.2.1 |
| Have potential downflooding openings within the boat been identified? | YES/NO | YES | 6.1.1.4 |
| Do all closing appliances satisfy ISO 12216? | YES/NO | YES | 6.1.1.1 |
| Hatches or opening type windows are not fitted below minimum height above waterline? | YES/NO | YES | 6.1.1.2 |
| Seacocks comply with requirements? | YES/NO | YES | 6.1.1.3 |
| Are all openings on design category A or B boats fitted with closing appli (Except openings for ventilation and engine combustion) | | 6.1.1.5 | |
| Design categories possible: A or B if all are YES, C or D if first five are | YES | D | 6.1.1 |

Downflooding angle: (design categories A and B only)

| Item | Symbol | Unit | Value | Ref. | | | |
|---|---------------------------|-------------------|-----------------|---------|---------|--|--|
| <u>Required value</u> : (where ϕ_0 = attained angle from offset load test) | | | | | | | |
| Design category A = larger of (ϕ _O + 25) | ° or 30° | φ _{D(R)} | degrees | | Table 3 | | |
| Design category B = larger of (ϕ _O + 15) | $\phi_{D(R)}$ | degrees | | Table 3 | | | |
| Area of openings permitted to be subme | erged = $1,2L_HB_HF_M$ | | cm ² | | 6.1.3 | | |
| Actual downflooding angle: | at mass = $m_{\rm MO}$ | ϕ DA | degrees | | 6.1.3 | | |
| | at mass = m_{LA} | ϕ da | degrees | | 6.1.3 | | |
| Method used to determine ϕ_{DA} : | | | | | | | |
| Design category | possible on downfl | ooding angle | Э | | 6.1.3 | | |

Downflooding height: (all except exempt boats)

| | Requirement | | Basic requirement | Reduced value for small openings | Reduced value at outboard | Increased value at bow |
|---|------------------|---------------------------------------|--|---|---------------------------------|---------------------------|
| applicable to | | all options | all options but only if figures are used | options 3, 4 | options 3, 4, 6 | |
| ref. | | | 6.1.2.2 a) | 6.1.2.2 d) | 6.1.2.2 c) | 6.1.2.2 b) |
| obtained from Figs. 2 + 3 or Annex A? | | Annex A | = basic \times 0,75 | = basic \times 0,80 | = basic × 1,15 | |
| maximum ai | rea of small ope | nings (50 <i>L</i> _H ²) (I | mm^2) = 5000 | 3750 | | |
| Required | Fig. 3/An'x A | Category A | | | | |
| downflood | Fig. 3/An'x A | Category B | | | | |
| height | Fig. 3/An'x A | Category C | | | | |
| $h_{D(R)}$ (m) | Fig. 4/An'x A | Category D | 0,4 | | | |
| Actual downflooding height h _D | | 0,51 | | | | |
| Design category possible | | 0,2 | | | | |
| D | esign category | / possible on c | lownflooding hei | ght = lowest of a | bove | |

DOWNFLOODING HEIGHT

Calculation using Annex A assuming use of option

| Item | | Sym- bol | Unit | Opening 1 | Opening 2 | Opening 3 | Opening 4 |
|---|--|-----------------------|-----------------|--------------|--------------|--------------|--------------|
| Position of openings: | | | | | | | |
| Least longitudinal distance from bow/stern | | | m | -0,23 | 1,8 | 1,1 | |
| Least transverse distance fro | om gunwale | у | m | 2,24 | 0,46 | 0,46 | |
| F_1 = greater of $(1 - x/L_H)$ or (| $(1 - y/B_{\rm H}) =$ | <i>F</i> ₁ | | 0,98 | 0,82 | 0,89 | |
| Size of openings: | | | | | | | |
| Total combined area of oper downflooding opening | nings to top of any | а | mm ² | 50 | 100000 | 100000 | |
| Longitudinal distance of ope bow | ning from tip of | x'D | m | 10,2 | 8,3 | 1,1 | |
| Limiting value of $a = (30L_H)^2$ | | | mm ² | 90000 | 90000 | 90000 | |
| If $a \ge (30L_{\rm H})^2$, $F_2 = 1,0$ If $a < (30L_{\rm H})^2$, $F_2 = 1 + \frac{x'_{\rm D}}{L_{\rm H}} \left(\frac{\sqrt{a}}{75L_{\rm H}} - 0,4 \right)$ | | | _ | 0,60 | 1,0 | 1,0 | |
| Size of recesses: | | | | | | | |
| Volume of recesses which are not quick- draining in accordance with ISO 11812 | | V _R | m ³ | | | | |
| Freeboard amidships (see 3 | .3.5) | F_{M} | m | | | | |
| $k = V_{R} / (L_{H} B_{H} F_{M})$ | | k | | | | | |
| If opening is not a recess, If recess is quick-draining, If recess is not quick-draining | $F_3 = 1,0$ $F_3 = 0,7$ g, $F_3 = (0,7 + k^{0,5})$ | F_3 | _ | 0,7 | 1,0 | 1,0 | |
| Displacement: | | | | | | | |
| Loaded displacement volum | e (see 3.4.5) | V_{D} | m ³ | 8,35 | | | |
| $B = B_{\rm H}$ for monohulls, $B_{\rm WL}$ fo | r multihulls | В | m | 1,72 | | | |
| $F_4 = [(10 V_D)/(L_H \cdot B^2)]^{1/3}$ | | F_4 | _ | 1,41 | | | |
| Flotation: | | | | | | | |
| For boats using option 3 or 4 For all other boats, | $F_5 = 0.8$ $F_5 = 1.0$ | F_5 | — | 1,0 | | | |
| Required calc. height: = F_1 | $F_2F_3F_4F_5L_{\rm H}/15$ | $h_{D(R)}$ | m | 0,39 | 0,77 | 0,84 | |
| Required downflooding | Category A | $h_{D(R)}$ | m | | | | |
| Height with | Category B | $h_{D(R)}$ | m | | | | |
| Limits applied | Category C | h _{D(R)} | m | | | | |
| (see Annex A, Table A.1) | Category D | h _{D(R)} | m | 0,2 | 0,4 | 0,4 | |
| Measured downflooding h | eight: | h_{D} | m | | | | |
| | Design categ | ory po | ssible: | | | | |
| | | | | | lowest | of above = | |

HEEL DUE TO WIND ACTION

Design categories C and D only

NB: This sheet is to be completed for both minimum operating condition and loaded arrival condition. **Initial check:**

| Item | Symbol | Unit | Value at m _{MO} | Ref. | | | | |
|---|-----------------|--------|--------------------------|-------|--|--|--|--|
| Windage area (NOT subject to minimum of 0,55 $L_{WL} B_{H}$) | A _{LV} | m² | 28,58 | 3.3.7 | | | | |
| Length waterline | L_{WL} | m | 9,29 | 3.3.2 | | | | |
| Beam of hull | B _H | m | 3,97 | 3.3.3 | | | | |
| Ratio $A_{LV}/(L_{WL} B_{H})$ | | _ | 0,775 | | | | | |
| Is ratio $A_{LV}/(L_{WL} B_{H})$ equal to or greater than 0,55? | | YES/NO | YES | 6.4 | | | | |
| If answer is NO, no further assessment is required. | | | | | | | | |

Calculation of wind heeling moment:

| Item | Symbol | Unit | m_{LA} | m _{MO} | Ref. |
|--|----------------|------|----------|-----------------|-----------------|
| Length waterline | L_{WL} | m | 9,34 | 9,29 | 3.3.2 |
| Draught at the mid-point of L_{WL} | T _M | m | 0,33 | 0,28 | 6.3.2 |
| Lever between centroids of above and below water areas | h | m | 1,76 | 1,76 | 6.3.2 |
| Calculation wind speed (17 m/s for Category C, 13 m/s for Category D) | ν _W | m/s | 13 | 13 | 3.5.1 |
| Wind heeling moment = 0,53 $A_{LV} h v_W^2$ or = 0,30 $A_{LV}(A_{LV}/L_{WL} + T_M) v_W^2$ | M_{W} | N∙m | 4912 | 4863 | 6.3.2, 6.4.2 |

Angle of heel due to wind:

| Item | Symbol | Unit | m _{LA} | m _{MO} | Ref. |
|--|---|---------|-----------------|-----------------|-------|
| FROM RIGHTING MOMENT CURVE: | ϕ_{W} | degrees | | | 6.4.3 |
| OR ALTERNATIVELY: wind heeling moment $M_{\rm W}$ divided by 9,806 | | kg.m | 501 | 496 | |
| Angle of heel due to wind when moment above applied | ϕ_{W} | degrees | | | 6.4.3 |
| Maximum permitted angle of heel during offset load test (from Worksheet 3) | φ _{0(R)} | degrees | 16,8 | | 6.2.3 |
| Downflooding angle | ϕ_{D} | degrees | | | 3.2.2 |
| Maximum permitted heel due to wind = lesser of $0.7\phi_{O(R)}$ degree and $0.7\phi_{D}$ | | | 22,2 | 28,7 | 6.4.3 |
| Is angle of heel due to wind less than permitted value? YES/NO | | YES | YES | 6.4.3 | |
| Design category possible on wind hee | Design category possible on wind heeling = | | | | |

SUMMARY

| Design description: HABITABLE MULTIHULL MOTOR BOAT | | | | | | | |
|--|---|-------------------|------------------------|-----------------|----------|-------------------|--|
| Design category intended: D Crew limit: 8 Date: | | | | | | | |
| Sheet | Item | Symbol | Uni | t | Value | | |
| | Length of hull: (as in ISO 8666) | | L_{H} | m | | 10,00 | |
| | Length waterline in loaded arrival condition: | | L_{WL} | m | | 9,29 | |
| | Mass: | | | | | | |
| | Empty craft mass | | $m_{\sf EC}$ | kg | | 6440 | |
| 1 | Maximum load | | m_{L} | kg | | 2585 | |
| 1 | Light craft condition mass | | m_{LC} | kg | | 6680 | |
| | Maximum load condition mass = $m_{LC} + m_{L}$ | | $m_{\rm LDC}$ | kg | | 9265 | |
| | Loaded arrival condition mass | | m_{LA} | kg | | 8572 | |
| | Minimum operating condition mass | | m _{MO} | kg | | 6850 | |
| | <u>Is boat sail or non-sail?</u> | | SAIL | ./NON-S | AIL | NON-SAIL | |
| 2 | Option selected: | | | | | 2 | |
| 3 | Downflooding openings: Are all requirement | ents met? | | YES/ | NO | YES | |
| | | 11 | Desuid | Act | ual | Pass/ | |
| 3 | Downflooding angle: (Categories A and B only) | Unit | Requ'a | m _{MO} | m_{LA} | _A Fail | |
| | | deg | ≥ | | | | |
| | Downflooding height: Worksheet used: | • | | | | | |
| | basic requirement | m | ≥ 0,4 | 0,55 | 0,5 | 51 | |
| 3 & 4 | reduced height for small openings (sheet 4 only) | m | ≥ | | | | |
| | reduced height at outboard (options 3 + 4 only) | m | ≥ | | | | |
| | increased height at bow (options 3, 4, 6 only) | m | ≥ | | | | |
| | Offset load test: | | | | | | |
| | testing for least stability: maximum heel angle | degrees | < 25 | | 15, | 9 | |
| 5 | testing for least freeboard: heeled freeboard margin | mm | ≥ 100 | | 18 | 9 | |
| | maximum crew limit for stability | | | | 8 | | |
| | maximum crew limit for freeboard | | | | 8 | | |
| | Resistance to waves+wind: (options 1, 3) at m_{LA} and a | t m _{MO} | | | | | |
| | Rolling in beam waves and wind: ratio A_2/A_1 | | ≥ 1,0 | | | | |
| 6 | Resistance to waves: value of ϕ_{GZmax} | degrees | | | | | |
| | value of RM_{30} or RM_{max} | N∙m | > | | | | |
| | value of GZ ₃₀ or GZ _{max} | m | ≥ | | | | |
| | Heel due to wind: (options 2, 4, 5, 6) at m_{LA} and at m_{MC} |) | | | | | |
| 7 | Is ratio $A_{LV}/(L_{WL} B_H) \le 0.55?$ | ١ | YES /NO | NO | N | 2 | |
| 1 | If YES: at m_{LA} : heel angle due to wind | degrees | < | | | | |
| | if required at $\overline{m_{MO}}$: heel angle due to wind | degrees | < | | | | |
| | Recess size: (options 1 and 2 except category D) | | | | | | |
| 8 | Simplified method: max reduction in GM _T | % | ≤ 12 | | 8 | | |
| | Direct calculation: margin righting over heeling mom't | N∙m | ≥ 2580 | 3 | 820 | | |

| Sheet | Item | | | Pass/Fail |
|--|--|------------------------|-----------|-----------|
| 9 | Habitable multibulls: Is Category C boat Vulnerable to inversion? | | YES/NO | NO |
| | Complies with ISO 12217-2:2013, 7.12 for inverted buoyancy? | | PASS/FAIL | |
| | Complies with ISO 12217-2:2013, 7.13 | 3 for means of escape? | PASS/FAIL | |
| 9 | Motor sailers | | | |
| | Complies with requirement for excess of RM _{max} over M _W ? PASS/F | | PASS/FAIL | |
| 10 | Flotation test: (options 3 and 4 only) All preparations completed? YES/NO | | | |
| | Swamped stability: 5 min after swamping, does boat heel less than 45°? | | | |
| | Load test: 5 min after swamping, does boat float level with 2/3 periphery showing? | | | |
| | Flotation elements: do all elements comply with all the requirements? | | | |
| 11 | Detection & removal of water: are all requirements satisfied? YES/NO | | | |
| NB: Boat must pass all requirements applicable to selected option to be given intended design category. | | | | |
| Design category given: | | Assessed by: | | |

ISO 12217-1 CALCULATION WORKSHEET No. 12 (continued)

SUMMARY