DEPT. OF TRANSPORTATION
U. S. COAST GUARD
CG-4006 (R4/67)

SMALL PASSENGER VESSEL STABILITY TEST PROCEDURE

(In accordance with 46 CFR 179.10-1)

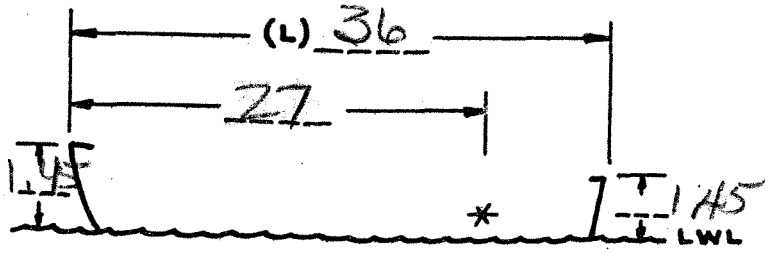
Name of Vessel Fells Point Princess Official No. MD 7290 AN Date 12 AUG 92

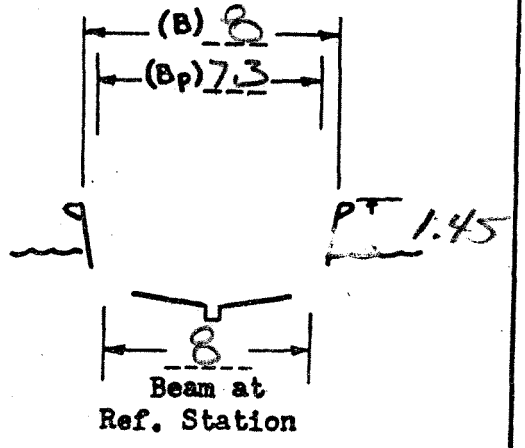
Representing Owner MR. ROD MORGAN Inspector C.R. Collins

Location BALTIMORE, MD Wind: Relative Direction Ø Velocity Ø mph

Mooring arrangement, describe BOW AND STERN PORT + STARBOARD

Route RIVERS & PATAPSCO RIVER Check One ☐ Exposed ☐ Partially Protected ☒ Protected





Indicate on above sketch

1) Profile of sheer line
2) Length over all (L)
3) Station for measuring Reference Freeboard (f)...located in way of least freeboard or at a point 3/4 (L) from the stem if the least freeboard is aft of this point
4) Freeboard to main deck at stem
5) Freeboard to main deck at stern

Indicate on above sketch

1) Round or vee bottom
2) Maximum beam to outside of shell (B)
3) Max. beam accessible to passengers (B_p)
4) Max. beam on deck in way of Freeboard Reference Station.
5) Height of sheer line above load water line in way of Freeboard Ref. Station
6) Height of each deck (including cockpit deck, if any) above load waterline.

All above measurements are to be taken in the loaded condition without list
If cockpit type - show same by dotted line and indicate length ( )

TANKAGE (all tanks are to be 3/4 full at the time of the test)

TANK	CAPACITY	Approx. Location of C.G.	
		Aft of Stem	Above top of keel

BALLAST (if provided, ballast must be on board and in place at time of test)

WEIGHT	MATERIAL	Approx. Location of C.G.	
		Aft of Stem	Above top of keel

(1) TOTAL TEST WEIGHT REQUIRED:

25 (Total No. Passengers) X 140 (Wt./Pass.) = 3500 (Total Test Weight (W)) Lbs.

NOTES: (A) THE TOTAL NUMBER OF PASSENGERS SHALL NOT EXCEED THE NUMBER COMPUTED IN ACCORDANCE WITH 46 CFR 177.25.
(B) WEIGHT PER PASSENGER EQUALS 160 POUNDS, EXCEPT THAT ON "PROTECTED WATERS" WHEN PASSENGER LOAD CONSISTS OF MEN, WOMEN AND CHILDREN; A WEIGHT OF 140 POUNDS PER PASSENGER MAY BE USED.
(C) IF NECESSARY, SHORE OR BRACE THE DECK STRUCTURE TO PROPERLY SUPPORT THE TEST WEIGHTS.

(2) DISTRIBUTION OF TEST WEIGHT:

(a) Distribute the test weight fore and aft so as to obtain the normal operating trim.
(b) Arrange test weight so that its C.G. is approximately 2.5 feet above deck.
(c) The vertical distribution of the test weight shall be such as to simulate the most unfavorable vertical C.G. likely to occur in service. On vessels having one upper deck above the main deck available to passengers, the distribution shall not be less severe than the following —

Total Test Weight (W)..... = 3500

Pass. Capacity of Upper Deck per 46 CFR 177.25 _____ (No. Pass.) X _____ (Wt./Pass.) X 1.33 = Ø Weight on Upper Deck
3500 Weight on Main Deck

(3) LOCATION OF MARK FOR MAXIMUM ALLOWABLE IMMERSION ABOVE UPRIGHT LOAD WATERLINE

(h) = _____ Ft.

N/A

~~Apply (a), (b) or (c) according to type of vessel OR (d) if that gives a lesser value for the height of the mark~~

(a) Flush Deck Type Vessels (including well deck vessels where freeboard is measured to the weather deck)

_____ (Reference Freeboard (f)) ÷ 2 = _____ (Height of Mark (h) above L.W.L.)

(b) Cockpit Type Vessels

Length over all.....(L) ___
Length of cockpit...(ℓ) ___
Ref. Freeboard.....(f) ___ (meas'd to gunwale)
Height of Mark.....(h) ___ above L.W.L.
As per applicable formula →

On Exposed Waters

$$h = \frac{f(2L - 1.5\ell)}{4L}$$

On Protected or Partially-protected Waters

$$h = \frac{f(2L - \ell)}{4L}$$

(c) Open-Boat Type Vessels

_____ (Reference Freeboard (f)) ÷ 4 = _____ (Height of Mark (h) above L.W.L.)

(d) For All Types of Vessels

To limit the final angle of list to 14°, as required by 46 CFR 179.[illegible]-1(g), the height of the Mark (h) shall, in no case, exceed the following —

_____ (Beam at Ref. Station) ÷ 8 = _____ (Max. (h) for any type vessel)

(4) REQUIRED HEELING MOMENT:
(Apply (a) or (b), whichever is greater

(a) Passenger Heeling Moment (M_p)

7.3 (Maximum Beam Accessible to Pass. (B_p)) x 3500 (Total Test Weight (W)) ÷ 6 = 4258 Ft.Lbs.

(b) Wind Heeling Moment (M_w)

See sheet 4.....5352 Ft. Lbs.

(5) WEIGHT MOVEMENT:

(A) THE HEELING MOMENT REQUIRED BY ITEM (4) SHALL BE OBTAINED BY A TRANSVERSE MOVEMENT OF THE TEST WEIGHTS.
(B) THE TEST SHALL BE CONDUCTED WITH ALL PORTLIGHTS SECURED BUT WITH ANY NON-RETURN VALVES OR FLAPS ON SCUPPERS OR DECK DRAINS RESTRAINED IN THE OPEN POSITION.
(C) THE VESSEL IS TO BE FULLY AFLOAT AND ALL MOORING LINES ARE TO BE SLACK DURING THE TEST.
(D) DURING LOADING AND MOVING OF TEST WEIGHTS, CARE SHOULD BE TAKEN IF THERE IS EVIDENCE OF LOW STABILITY. THIS MAY BE TAKEN TO BE THE CASE WHENEVER THE EFFECT OF ANY ADDED OR SHIFTED WEIGHT INCREMENT IS NOTED TO BE MORE THAN THAT OF A PRECEDING INCREMENT OF THE SAME SIZE, OR WHEN THE CHINE OR BILGE AMIDSHIPS COMES APPRECIABLY OUT OF THE WATER AS A RESULT OF THE HEEL.
(E) CARE IS TO BE EXERCISED THAT THE VESSEL IS NOT LISTED EXCESSIVELY EITHER DUE TO WEIGHT MOVEMENT OR SUPERIMPOSED ROLL WHICH COULD CAUSE THE TEST WEIGHTS TO TOPPLE OR SHIP'S GEAR TO COME ADRIFT.
(F) WHILE THE VESSEL IS LISTED, CHECK FOR OPEN SEAMS, LOOSE HULL FITTINGS, ETC., WHICH ARE NOT NORMALLY IMMERSED AND WHICH COULD CAUSE FLOODING OF THE VESSEL.

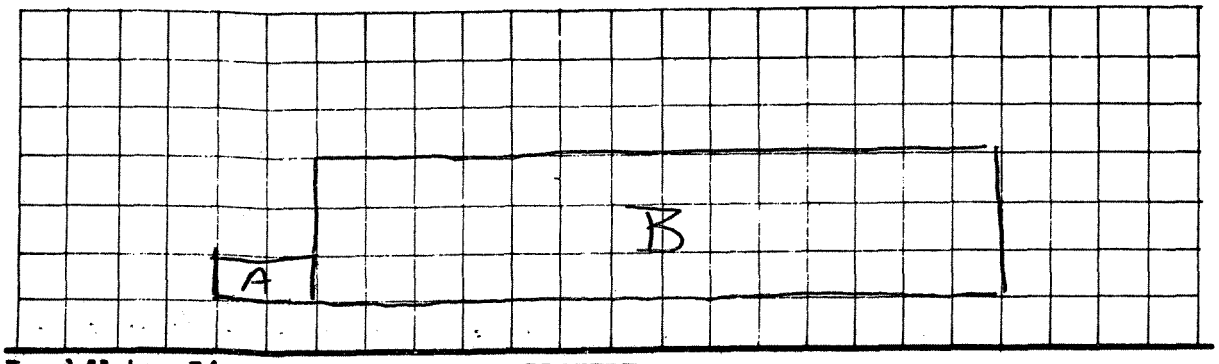
QUANTITY	WEIGHT PER UNIT-LBS.	DISTANCE MOVED-FT.	MOMENT - FT. LBS.
4	871.5	1.5	5229
1	150	1.5	225
		TOTAL HEELING MOMENT	5454

(6) HEIGHT OF REFERENCE MARK ABOVE WATERLINE AFTER WEIGHT MOVEMENT:

Height of Mark (h) Above Waterline = ____ Ft.

(a) If the vessel lists to the reference mark (h) before the full heeling moment is applied, the test shall be stopped and the vessel fails the test.
(b) If any portlights are found to be at or near the waterline at the final angle of list, such portlights on each side shall be permanently closed.
(c) If any scuppers or drains are found to be below the waterline at the final angle of list so as to permit the entry of water into the hull or onto the deck, such openings on each side shall be provided with automatic non-return valves.

WIND HEEL CALCULATION
(Refer to Item 4b)



Load Water Line

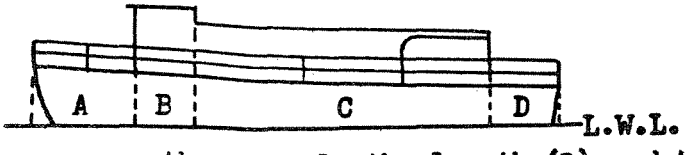
-PROFILE-
(SKETCH PROFILE IN ACCORDANCE WITH INSTRUCTIONS BELOW)

SECTION	L	V	A (L x V)	H (½ V)	A x H
A	4.25	1.45	6.162	.725	4.46
B	31.6	6.7	211.72	3.35	709.26
				Sum (A x H)	713.72

Wind Heel (M_W): 713.72 (Sum (A x H)) x 7.5 (P) = 5352.9 Ft. Lbs.

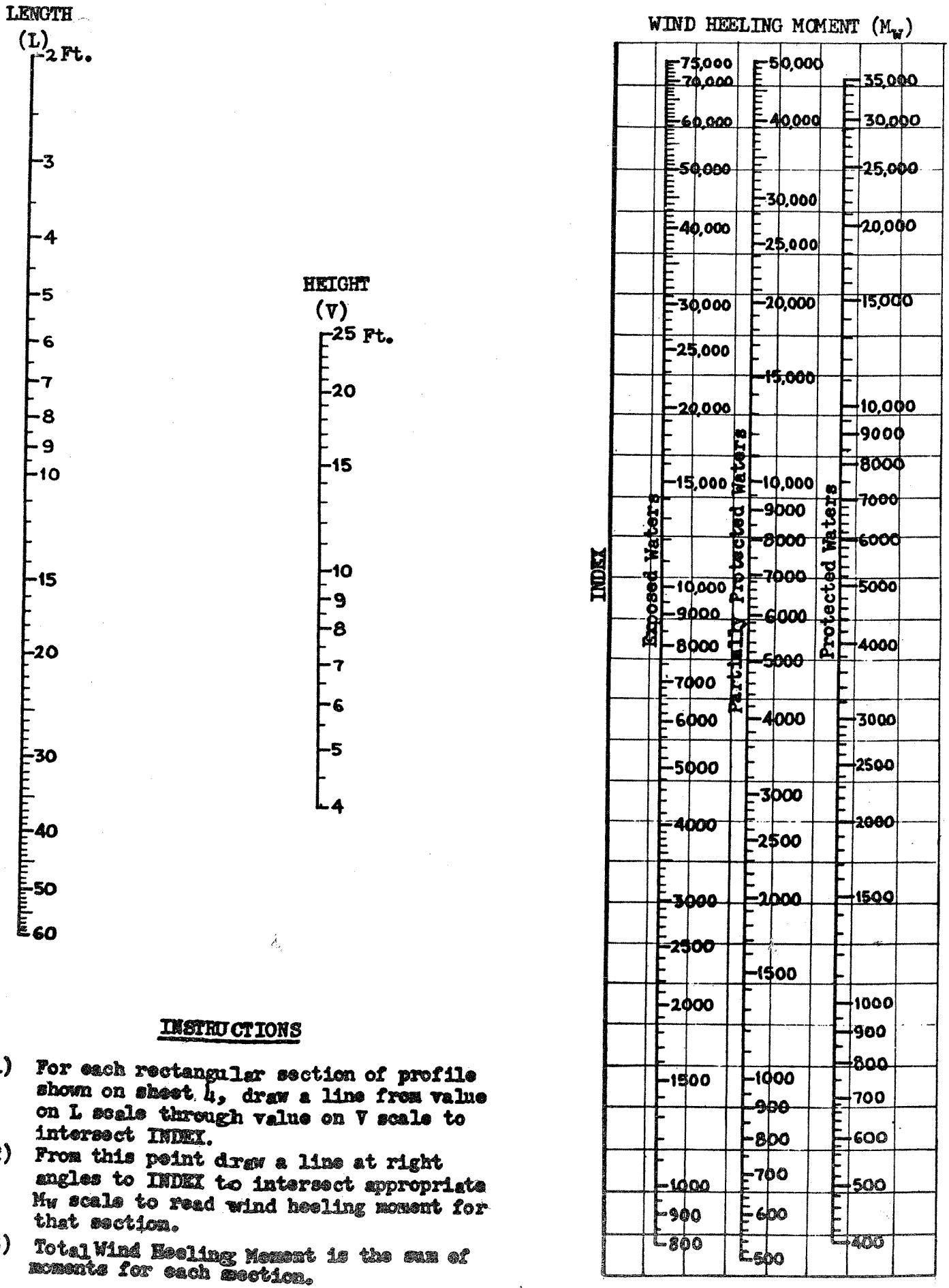
INSTRUCTIONS

(1) Block off the profile of the vessel into rectangles, as shown below. Include passenger railings and structural canopies.



(2) Measure, on the vessel, the length (L) and the height (V) of each rectangle and enter in Table.
(3) Complete the Table as indicated, add the products in the last column and multiply this sum by the appropriate "P" value to obtain the Wind Heeling Moment (M_W). Check results on sheet 5.

Values of "P"	
Exposed Waters	15.0
Partially Protected Waters	10.0
Protected Waters	7.5



INSTRUCTIONS

(1) For each rectangular section of profile shown on sheet 4, draw a line from value on L scale through value on V scale to intersect INDEX.

(2) From this point draw a line at right angles to INDEX to intersect appropriate M_W scale to read wind heeling moment for that section.

(3) Total Wind Heeling Moment is the sum of moments for each section.

TWENTY-FIVE PERCENT TEST

(This test is not a necessary part of the Simplified Stability Procedure but it may be used as a preliminary check when the stability is believed to be marginal.)

1. After the Required Test Weight (W) has been placed on board and the Freeboard (f) has been measured, rig a pendulum free to swing athwartships at any convenient location on the vessel. Arrange it so that the bob is about 1/8" above the deck. Make a chalk mark on the deck directly beneath the bob.

2. Move the test weight to obtain a heeling moment equal to 1/4 of the Required Heeling Moment (4). It is suggested that the weights having the longest levers be moved so as to minimize the amount of weight handled.

One-quarter Heeling Moment:	_____ Req'd. H.M. (4)	÷ 4	=	_____ Ft. Lbs.

3. After the weight has been moved, make a chalk mark on the deck directly beneath the pendulum bob, then --

Distance from pivot to deck is pendulum length (pend. l.)
Distance between chalk marks is pendulum deflection (pend. d.)

4. Before proceeding with the Simplified Stability Procedure, the following calculations may be carried out to anticipate the results of the test:

Approximate Maximum Allowable Heeling Moment

$$\frac{2 \times \underset{\text{1/4 H.M.}}{____} \times \underset{\text{pend. l.}}{____} \times \underset{\text{Ht. of Mark (H)}}{____}}{\underset{\text{pend. d.}}{____} \times \underset{\text{Beam at Freeboard Ref. Station}}{____}} = _____ \text{ Ft. Lbs.}$$

If Maximum Allowable Heeling Moment is LESS than the Required Heeling Moment (4), the vessel will probably fail the test by the amount indicated below --

Req'd. Heeling Moment = _____

Allow. Heeling Moment = _____

Difference = _____

If Passenger Heel (4a) applies:

Approx. No. Passengers in Excess

$$\frac{6 \times \underset{\text{Diff.}}{____}}{\underset{\text{Wt/Pass}}{____} \times \underset{B_p}{____}} = _____$$

If Wind Heel (4b) applies:

Approx. Excess Wind Moment (Sum AxH)

$$\underset{\text{Diff.}}{____} \div \underset{\text{"p"}}{____} = _____$$

STABILITY TEST PROCEDURE
FOR VESSELS CARRYING PASSENGERS AND CARGO

(1) For vessels carrying cargo as well as passengers, follow the same test procedure as for vessels carrying passengers alone except that, in addition to the passenger test weight, the maximum deadweight of cargo permitted shall be on board, in place, and so arranged as to simulate the most unfavorable vertical center of gravity likely to occur in service.

(2) Specify the maximum deadweight of cargo permitted to be carried:

WEIGHT OF CARGO Pounds	Approx. Location of C.G.	
	Aft of Stem	Above Top of Keel

(3) Complete the 25% Test based on the Passenger Heeling Moment or the Wind Heeling Moment whichever is applicable and note the anticipated test result.

(4) If the anticipated result of the test indicates that the vessel will fail, the entire test must be repeated with a reduced number of passengers and/or a reduced amount of cargo, or by utilizing any other corrective measure available.

(5) If the anticipated result of the test indicates that the vessel will pass, then with the vessel in the heeled condition and being cautious not to disturb any of the test weights which were shifted in order to heel the vessel; remove approximately one-quarter of the cargo from the vessel exercising great care to remove it from or symmetrically about the centerline.

(a) If the pendulum deflection DECREASES or remains unchanged -- replace the cargo which was removed and complete the stability test procedure.

(b) If the pendulum deflection INCREASES it indicates that the cargo may be improving the stability of the vessel. Therefore, remove all of the cargo from the vessel, replace the test weights in their original position so as to remove all list, remeasure the freeboard (f), and repeat the 25% Test in its entirety for the new condition of loading. If this second 25% Test indicates that the vessel will pass, complete the stability test procedure.

(6) If the vessel passes the stability test procedure under these conditions, it is deemed to have adequate stability for the safe carriage of passengers allowed regardless of whether or not cargo, not in excess of the amount specified in Item (2) above, is carried.

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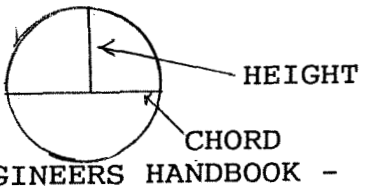
STABILITY CALCULATIONS FOR PONTOON VESSELS



H = HEIGHT
C = CHORD
Ref A = MARKS' MECHANICAL ENGINEERS HANDBOOK -
Mathematical tables, Segements of circles given H/C

Area of sections "A & B" = 315.462 at position L1 as determined by the following calculation:

H/C = 14/29 = .482 From column "A" of Ref "A" = .7770

H X C X .7770 = 14 X 29 X .7770 = 315.462 cu. in.

Area of section "A" = 209.19 at position L2 as determined by the following calculation:

H/C = 11/25 = .44 from column "A" of Ref "A" = .7607

H X C X .7607 = 11 X 25 X .7607 = 209.19

Area of Section "B" = 106.272 as dtermined by the following calculation:

315.462	- area of sections A & B
-209.19	- area of section A
106.272	- area of section B

With the load in the 2nd position the area of section A must be equal to or greater than section B.

Segments of Circles, Given h/c

Given: h = height; c = chord. (For explanation of this table, see p. 1–38)

$\frac{h}{c}$	$\frac{\text{Diam}}{c}$	Diff	$\frac{\text{Arc}}{c}$	Diff	$\frac{\text{Area}}{h \times c}$	Diff	Central angle, v	Diff	$\frac{h}{\text{Diam}}$	Diff
.00			1.000	0	.6667	0	0.00°	458	.0000	4
1	25.010	12490	1.000	1	.6667	2	4.58	458	.0004	12
2	12.520	*4157	1.001	1	.6669	2	9.16	457	.0016	20
3	8.363	*2073	1.002	2	.6671	4	13.73	457	.0036	28
4	6.290	*1240	1.004	3	.6675	5	18.30	454	.0064	35
.05	5.050	*823	1.007	3	.6680	6	22.84°	453	.0099	43
6	4.227	*586	1.010	3	.6686	7	27.37	451	.0142	50
7	3.641	*436	1.013	4	.6693	8	31.88	448	.0192	58
8	3.205	*337	1.017	4	.6701	9	36.36	446	.0250	64
9	2.868	*268	1.021	5	.6710	10	40.82	442	.0314	71
.10	2.600	*217	1.026	6	.6720	11	45.24°	439	.0385	77
1	2.383	*180	1.032	6	.6731	12	49.63	435	.0462	83
2	2.203	*150	1.038	6	.6743	13	53.98	432	.0545	88
3	2.053	*127	1.044	7	.6756	14	58.30	427	.0633	94
4	1.926	*109	1.051	8	.6770	15	62.57	423	.0727	99
.15	1.817	*94	1.059	8	.6785	16	66.80°	418	.0826	103
6	1.723	*82	1.067	8	.6801	17	70.98	413	.0929	107
7	1.641	*72	1.075	9	.6818	18	75.11	409	.1036	111
8	1.569	*63	1.084	10	.6836	19	79.20	403	.1147	116
9	1.506	56	1.094	9	.6855	20	83.23	399	.1263	116
.20	1.450	50	1.103	11	.6875	21	87.21°	392	.1379	120
1	1.400	44	1.114	10	.6896	22	91.13	387	.1499	123
2	1.356	39	1.124	12	.6918	23	95.00	381	.1622	124
3	1.317	35	1.136	11	.6941	24	98.81	375	.1746	127
4	1.282	32	1.147	12	.6965	24	102.56	370	.1873	127
.25	1.250	28	1.159	12	.6989	25	106.26°	364	.2000	128
6	1.222	26	1.171	13	.7014	27	109.90	358	.2128	130
7	1.196	23	1.184	13	.7041	27	113.48	352	.2258	129
8	1.173	21	1.197	14	.7068	28	117.00	345	.2387	130
9	1.152	19	1.211	14	.7096	29	120.45	341	.2517	130
.30	1.133	17	1.225	14	.7125	29	123.86°	334	.2647	130
1	1.116	15	1.239	15	.7154	31	127.20	328	.2777	129
2	1.101	13	1.254	15	.7185	31	130.48	322	.2906	128
3	1.088	13	1.269	15	.7216	32	133.70	316	.3034	128
4	1.075	11	1.284	16	.7248	32	136.86	311	.3162	127
.35	1.064	10	1.300	16	.7280	34	139.97°	305	.3289	125
6	1.054	8	1.316	16	.7314	34	143.02	299	.3414	124
7	1.046	8	1.332	17	.7348	35	146.01	293	.3538	123
8	1.038	7	1.349	17	.7383	36	148.94	288	.3661	122
9	1.031	6	1.366	17	.7419	36	151.82	282	.3783	119
.40	1.025	5	1.383	18	.7455	37	154.64°	277	.3902	119
1	1.020	5	1.401	18	.7492	38	157.41	271	.4021	116
2	1.015	4	1.419	18	.7530	38	160.12	266	.4137	115
3	1.011	3	1.437	18	.7568	39	162.78	261	.4252	112
4	1.008	2	1.455	19	.7607	40	165.39	256	.4364	111
.45	1.006	3	1.474	19	.7647	40	167.95°	251	.4475	109
6	1.003	1	1.493	19	.7687	41	170.46	245	.4584	107
7	1.002	1	1.512	19	.7728	41	172.91	241	.4691	105
8	1.001	1	1.531	20	.7769	42	175.32	237	.4796	103
9	1.000	0	1.551	20	.7811	43	177.69	231	.4899	101
.50	1.000		1.571		.7854		180.00°		.5000	

* Interpolation may be inaccurate at these points.

6.D.2.c.(6) (g) (cont'd) during a vessel's service. Examples are lattice leg sections on MODU's and drilling related equipment. Since a detailed historical record of changes made to a vessel may not be maintained, the outfitting of a vessel at the time of a stability test or deadweight survey needs to be accurately documented.

3. Simplified Stability Tests For Small Passenger Vessels (46 CFR 171.030).

a. General. The following small passenger vessels will normally be permitted to perform the simplified stability test described in 46 CFR 171.030 in lieu of an inclining experiment:

(1) "S" vessels carrying 150 passengers or less on domestic voyages; and

(2) "S" vessels carrying 12 passengers or less on international voyages.

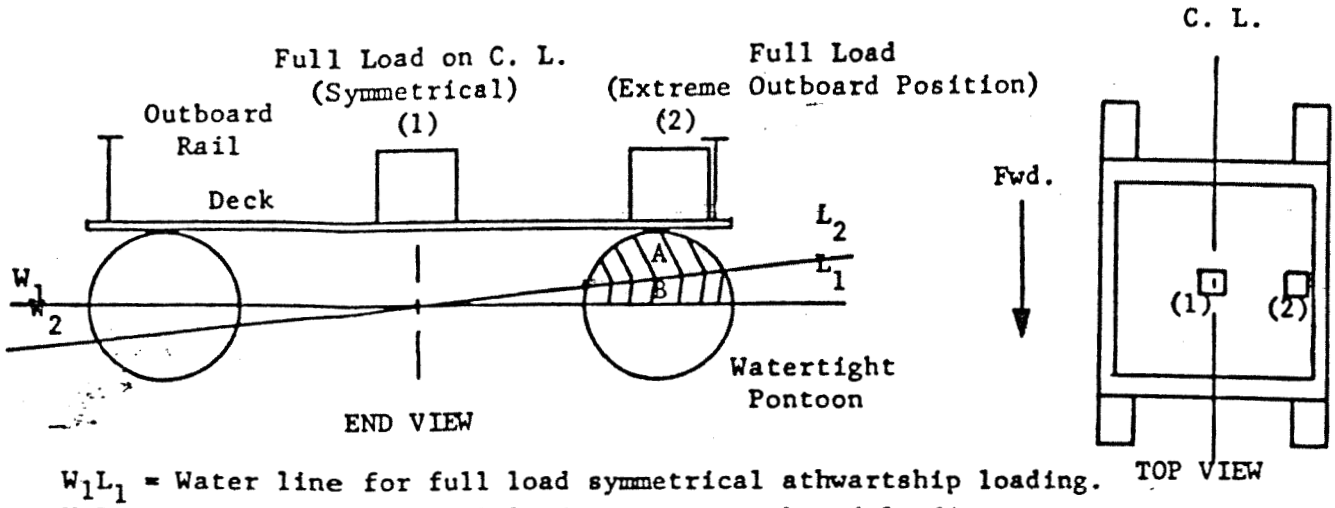
b. Pontoon-Type Vessels. Figures 6-2 and 6-3 outline the recommended procedures for a stability proof test for pontoon-type small passenger vessels under 65 feet in length and restricted to protected waters. Calculations based on the manufacturer's weight certificate may be accepted in lieu of a proof test. A proof test is to be used when the number of pontoons does not exceed two. On vessels with more than two pontoons, the MSC shall be consulted. The MSC will determine if stability can be evaluated with a proof test or if stability must be evaluated using an inclining experiment and calculations.

c. SOLAS Applicable Vessels. A simplified stability test may be substituted for the inclining experiment and for the stability calculations required by SOLAS provided exemptions from the stability requirements of SOLAS 74, as amended, are issued. Volume II of this manual (9.H.3.a) and SOLAS 74, Chapter II-1, Regulation 1.4, provide for such exemptions. All domestic requirements must be met to qualify for SOLAS exemptions.

4. Evaluation Of Weight Changes To Lightship. During its service life a vessel may be modified without changing its buoyant hull form. A complete inclining is required unless the changes are minor or do not adversely impact the vessel's stability. Weight calculations are acceptable if the MSC determines they are accurate, or acceptable penalties in VCG are applied to the calculations. The nature of the weights changed is critical to the accuracy of calculations. Often, miscellaneous changes with a total weight greater than 2 percent of lightship displacement will necessitate a deadweight survey (or even a complete inclining) to verify calculations. Weight changes should be combined for the total change,

FIGURE 6-2

TRANSVERSE STABILITY STANDARD

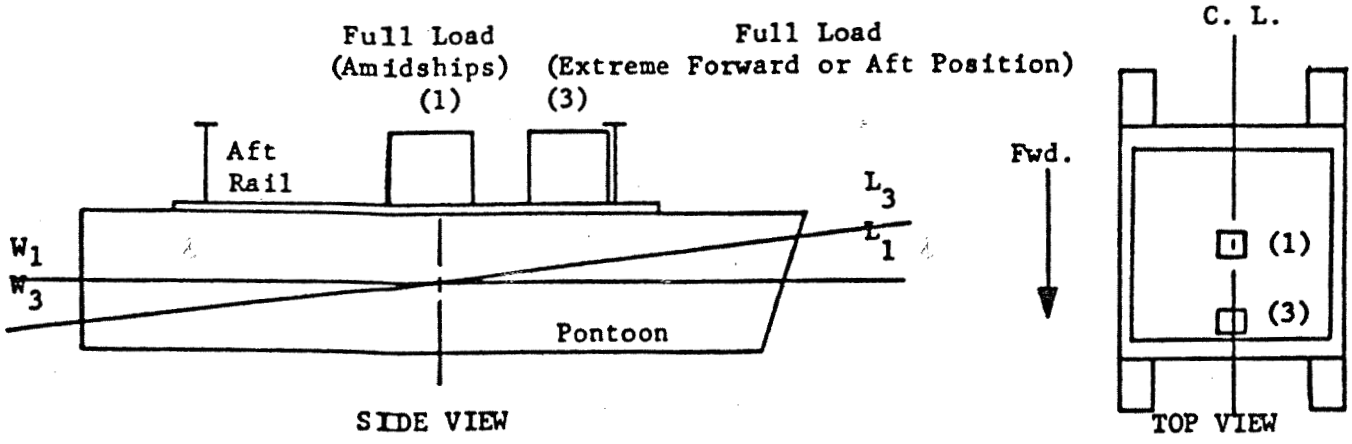


W_1L_1 = Water line for full load symmetrical athwartship loading.
W_2L_2 = Water line for full load, extreme outboard loading.

With load in extreme outboard position, position (2), area (A) must be equal to or greater than area (B).

FIGURE 6-3

LONGITUDINAL STABILITY STANDARD



W_1L_1 = Water line for full load symmetrical longitudinal loading.
W_3L_3 = Water line for full load, loading at deck end, forward or aft.

With load in extreme forward or aft position, top of pontoon must not be submerged.